Chapter 6. Introduction to Gyrojets

"Gyrojet is not a 'caseless cartridge' development. The Gyrojet propellant is a solid fuel and is ignited by a percussion primer. When fired, the complete rocket, including the primer, thrusts forward and accelerates rapidly and accurately toward the target. Nothing is left in the chamber to be ejected as in conventional guns."

— MBA's first news release, July 1, 1965

MBA co-founder Arthur Biehl coined the term *Gyrojet* in 1961, and ***GYRO-JET*** became an MBA registered trademark, number 799,701, on December 7, 1965. MBA described its Gyrojets as, *"unguided, miniature, spin-stabilized rockets."* Biehl and Mainhardt both liked the way the word sounded and read even though the Gyrojet was in fact a *rocket* with self-contained fuel and oxidizer, not a jet, which requires atmospheric oxygen to burn its fuel to produce thrust.

When I asked him about this apparent error, Mainhardt rationalized the discrepancy by explaining that the rocket exhaust *jetted* out of the nozzle ports. Right or wrong, the name stuck and Gyrojet ammunition and firearms are now the weapons most collectors associate with MBA. They are certainly the most thoroughly developed, with many more variations than any other MBA ordnance product. They were also produced in the largest numbers, with millions of 13mm Gyro-Signal survival flares and launchers being made for U.S. and foreign military organizations.

Gyrojets range in size from the first one made, an experimental 2.8mm version, to one of the last, a 40mm variation. By far, the most "common" Gyrojets, all of which are scarce, are variations of the 13mm.

As noted in chapter 2, MBA was inconsistent when it assigned caliber designations to its Gyrojets. In some cases the company used the metric system with millimeters, and in other cases it used the English system with inches. In a few instances it used *both* systems for the same cartridge, e.g., the .30 caliber/ 7.62mm. As is almost always the case with small arms ammunition, the given caliber should not be taken literally as the exact outside diameter of the rocket. I have measured hundreds of 12mm and 13mm Gyrojets and discovered that the actual outside diameter of most "12mm" rounds is 12.54mm, and 12.94mm for most "13mm" versions. A Gyrojet collector without a precision digital caliper will have a tough time telling the difference between apparently identical 12mm and 13mm rounds.

Regardless of the caliber or specific model, all Gyrojets share a common characteristic: they are stabilized in flight by high-temperature, high-velocity gas "jetting" through angled *ports* (holes) in their *nozzles* (bases).

The thrust produced by the burning propellant has two components, forward and angled. The forward thrust propels the Gyrojet ahead and the angled thrust causes it to spin. Some Gyrojets spin clockwise (CW) and others spin counterclockwise (CCW). When describing Gyrojets in this book as spinning CW or CCW, I'll view the rockets from behind. The greater the port angle, the faster the Gyrojet will spin and the more stable it will be. However, high spin rates result in high hoop stress caused by centrifugal force. In some models, such as the so-called .50 BMG Gyrojet, this stress was high enough to cause the rocket to come apart in flight, which is why that model failed.

Obviously, if more of the total available thrust was used to spin the rocket, less was available to accelerate it forward to the target. The challenge for MBA was to find exactly the right angle for the ports so that enough spin was created to stabilize the Gyrojet, but not more. Most Gyrojets have ports angled at about 15 degrees, which results in 85 percent of the total thrust produced being used for forward motion and 15 percent used to create spin.

Why Gyrojets?

Why didn't MBA just stick with the Finjets and Lancejets it had spent so much time, effort, and money to develop? From the beginning, MBA experienced a strong reluctance by its primary target customer, the

U.S. military, to adopt a totally new small arms weapons technology unlike anything it had seen before and that was unproven, especially as the conflict in Vietnam was ramping up. Mainhardt and Biehl spent every available dollar on marketing the Finjets and Lancejets they had developed to the U.S. military, including making many trips from California to Washington, D.C., for personal contacts and demonstrations. At one point, the entire MBA work force was laid off because of the lack of revenue to pay salaries. If a new product had not been developed, MBA would have failed in 1961. Fortunately, the Prince Trust's financial support and a few government research and development contracts allowed the company to survive, if just barely.

Gyrojets, unlike Finjets and Lancejets, could be designed to look somewhat like standard military pistol ammunition. The similarity in appearance of a .45-caliber Gyrojet, designed to be fired in a modified M1911A1 pistol, and a .45 ACP ball cartridge is easy to see, and this was no coincidence. Mainhardt quoted Biehl as suggesting, "*Why don't we make it look like a .45 ACP?*" referring to both the Gyrojet ammunition and the pistol that fired it.

Fig. 6–1. *.45-caliber Gyrojet (left) and .45 ACP ball round.*

Gyrojets could be fired from handguns and longarms that were very similar in appearance to existing military weapons, and in fact, MBA designed its firearms specifically to look like then-current military rifles and pistols.

Gyrojet ammunition could easily be loaded into clips or magazines like conventional ammunition, and it would function well in semiautomatic or full-automatic modes. In short, the technology distance from normal military firearms to Gyrojets was a lot shorter than it was to Finjets or Lancejets. By reducing the apparent differences between the .45 ACP Model 1911A1 and the Gyrojet pistol, and between the M16 rifle and the Gyrojet carbine, MBA could concentrate its marketing efforts on selling the U.S. military on the advantages of the Gyrojet over conventional weapons. MBA listed several advantages and disadvantages of Gyrojets *compared to Finjets* in MB-82 [a major 508-page MBA publication from 1962].

Advantages:

— Potentially, Gyrojets could be more accurate.

— Gyrojets had a greater packing density in a given volume. They had no fins to take up space.

— Gyrojets needed nothing to protect fins.

— Gyrojets were easier to fire, and shorter launchers could be used.

— Gyrojets had less drag than Finjets.

— Gyrojets were easier to store.

— Gyrojet cases were easier to manufacture.

— Gyrojets were the only practical model for space or vacuum applications, and NASA was one of MBA's target customers.

Disadvantages:

— Gyrojets had smaller Length/Diameter ratios (they were shorter, compared to their diameter) so less propellant could be loaded for a given caliber.

— Gyrojets could not be fired forward from aircraft unless their spin was extremely high initially, and an extremely high spin caused them to self-destruct.

— Gyrojets had some accuracy-reducing forces that Finjets did not have.

— Different spin rates were required for different angles of fire.

— Gyrojet manufacturing tolerances were more critical than for Finjets.

— Gyrojet stability and other factors were more difficult to analyze theoretically.

MBA touted the following advantages of Gyrojets *over conventional weapons:*

— *Almost no recoil.* Unlike a regular cartridge, almost all of the pressure involved in firing a Gyrojet was contained in its case, with practically none acting against the firearm to push it back in recoil. This low recoil allowed for accurate second and subsequent shots. It could also help reduce training time for new recruits since they would not have to get used to the recoil of a conventional pistol or rifle.

— *Very quiet.* A Gyrojet firearm has no muzzle blast, and subsonic rockets produce no shock wave. Those that did produce a supersonic "crack," did so out in front of the shooter where almost all of the Gyrojet's acceleration took place.

— *Lightweight.* A Gyrojet's vented barrel was not pressurized during firing, so the gun could be made of lightweight alloys of aluminum, magnesium, and even plastics.

— *Less complicated design.* All of the Gyrojet rocket (including the spent primer) left the barrel, with nothing left behind that had to be extracted and ejected from of the weapon.

— *Less expensive*. Gyrojets *could have* cost much less than conventional firearms, at least *if they had been made in the same quantities*, because of their lightweight materials, very simple designs, generous tolerances, and few parts, which were easily made by die casting.

— *High firing rates.* Most of the Gyrojet's propellant burned outside the vented barrel, ahead of the shooter. Therefore, very little heat and friction was generated in the gun. This cool operation, combined with no extraction or ejection, allowed for very high firing rates in full-automatic Gyrojets.

— *Greater effectiveness downrange.* Since the Gyrojet continued to accelerate after it left the barrel, it had a higher velocity downrange at the target where it "counted most," while the conventional bullet, with its highest velocity at its muzzle, had slowed and lost some of its terminal performance. The total burning time for a typical 13mm Gyrojet was 0.12 second, and burnout velocity was 1,250 fps. The Gyrojet's kinetic energy downrange was almost twice that of a .45 ACP bullet.

These advantages sound good, and MBA emphasized them. But to be fair, I should also point out three significant *disadvantages* of Gyrojets when compared to conventional firearms:

— *Low muzzle velocity*. As described and illustrated on page xii of the book's introduction, when a Gyrojet is fired, it accelerates slowly, moving forward to rotate the pistol's hammer back and down out of its way and cocking it in the process. It then leaves the barrel at a fraction of its final velocity, which is achieved about 45 feet downrange in the case of a standard 13mm Gyrojet. There are a couple of documented cases of persons being shot multiple times with a Gyrojet at point-blank range (a foot or less) with little apparent effect. In one case, after shooting his intended robbery victim six times (the pistol's capacity), a criminal threw down his stolen Gyrojet in disgust and ran away, leaving a very surprised, but grateful, uninjured storekeeper behind. A very low muzzle velocity in a defensive handgun where combat ranges can be quite short was a serious disadvantage that MBA never overcame.

— *High dispersion, low accuracy.* Gyrojet rockets experienced a large number of unfavorable ballistic influences as they left the pistol's barrel at a relatively low velocity. One of these is called *tipping error,* where the nose of the Gyrojet, no longer being supported by the barrel, was very slightly tipped down by gravity while the base of the rocket was still being supported in the barrel. This caused the rocket's thrust to be misaligned as it emerged from the barrel. Tipping error is greater at low muzzle velocities.

In addition, the Gyrojet's stability was dependent on its nozzle ports being very precisely aligned with each another. In fact, *nozzle port misalignment was the primary reason for the Gyrojet's inaccuracy.* Unfortunately, the large production quantities MBA hoped for that would have supported the purchase of expensive production machinery, which could have consistently produced Gyrojet ammunition to very tight tolerances, never materialized. Every Gyrojet, Finjet, and Lancejet made was assembled by hand.

An inexpensive, lightweight military firearm can offer important advantages to an Army which has to buy it and to soldiers who have to carry it, but if it cannot consistently hit its target, it has no real advantage.

In the words of one government critic reviewing a report of a feasibility study of small arms rocket ammunition concepts submitted to the Advanced Research Projects Agency (ARPA) by the AAI Corporation in 1971, *"[It's] Gyrojet all over again. If the target is close enough to hit, you can't kill it. If you can kill it, you can't hit it."*

– *High Cost.* Because they *never reached high production rates* (except for the 13mm flares), Gyrojet weapons and rockets were quite expensive. During a time in the mid-1960s when surplus Model 1903 Springfields, M1 Carbines, and 9mm Lugers could be had for $40 each, with their ammunition costing about six cents a round, standard MBA 13mm Gyrojet handguns cost $165 at retail, and 13mm ammunition was $31.20 for a 24-round box. If you bought a six-round box, the cost per round was $1.50.

Gyrojet Rocket Components

Regardless of caliber, all *production* Gyrojet rockets had the same basic components:

— *Igniter*; a small piece of treated paper folded to fit inside the grain's perforation, or a piece of treated cotton cord.

— *Case*; screw-machined or deep-drawn carbon steel, generally copper plated against corrosion. Cases normally had either a typical roundnose ogive or a pointed conical nose.

— *Nozzle*; machined carbon steel, almost always with either two (late) or four (early) drilled, tapered ports. Some low-quantity nozzles designed to save money were stamped.

— *Primer*; standard off-the-shelf small pistol primer with brass, copper, or nickel cups.

— *Propellant grain*; double-base nitrocellulose, extruded with center perforation and turned to shape on a doweling machine.

Igniter

During early tests, MBA discovered that a separate igniter which provided *second fire* was required to reliably and uniformly ignite Gyrojet propellant grains. In most early experimental Gyrojets, the Boron Potassium Nitrate ($BKNO_3$) coating on copper wire fuses that were inserted through the grain's central perforation served to uniformly ignite them.

However, when MBA made the shift from pyrotechnic fuses to standard small pistol primers, another igniter had to be developed because the primer alone was not sufficient to ensure the grain's uniform ignition. The $BKNO_3$ compound had worked well in earlier fuse applications, and MBA selected it for its first new igniter. A small quantity of it was formed into a pellet and placed in a cutout in the nose of the grain, as shown below in Figure 6–2(*A*). This ignited the propellant reliably, but the compound was dirty and burned pieces of it tended to fly back in the shooter's face. In addition, having all of the igniter concentrated at the front of the propellant grain instead of being more evenly distributed in the grain's perforation made it harder to achieve uniform ignition.

Further experimentation resulted in MBA adopting treated paper strips similar to magician's flash paper, shown in Figure 6–2(*B*), or nitrated guncotton cord, shown in Figure 6–2(*C*). These two methods seem to have been used interchangeably in late production 12mm and 13mm Gyrojets.

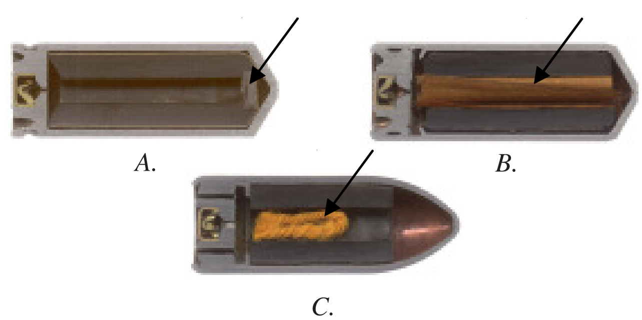

Fig. 6–2. *Gyrojet igniters. (A.) $BKNO_3$ pellet in a propellant grain's nose cutout. Early .49 caliber. (B.) Treated paper strip, 13mm wadcutter. Note the broached ring formed behind the grain to hold it in place away from the nozzle port inlets. (C.) Nitrated guncotton cord, 13mm with powder-metal nozzle. Note the retaining ring inserted behind the grain to hold it in place away from the nozzle port inlets. Actual size.*

Case

The typical 12mm or 13mm Gyrojet case was made of carbon steel. Olin (Winchester), Inc. of East Alton, Illinois, made deep-drawn, copper-plated, steel cases for MBA, and local machine shops with screw machines were used for quantity production of machined steel cases. Although MBA had the capability of producing Gyrojet cases in small prototype quantities in-house, most of its production consisted of the assembly of components made by outside contractors.

Stainless steel was also used for cases, but mainly in the larger calibers. Cases for dummy presentation Gyrojets were often nickel-plated, and a few dummies have been seen with zinc or cadmium plating.

Some cases were left plain to save money, especially those that were expected to be fired in testing before they could corrode. Aluminum, sometimes anodized, was tried experimentally in .25 caliber, .50 caliber, and others. Turned brass cases were also tested in several calibers, mainly in the .45-caliber range.

MBA preferred to use existing off-the-shelf components whenever possible, so many of the .30- and .50-caliber Gyrojets used conventional bullet jackets, draw pieces, or even complete bullets with their cores removed, as cases. Fiberglass was used as the case material in MBA's 40mm cloud-seeding Gyrojet. Typical Gyrojet cases are shown below in Figure 6–3. Other cases are described and shown later in the chapters covering their specific calibers and types.

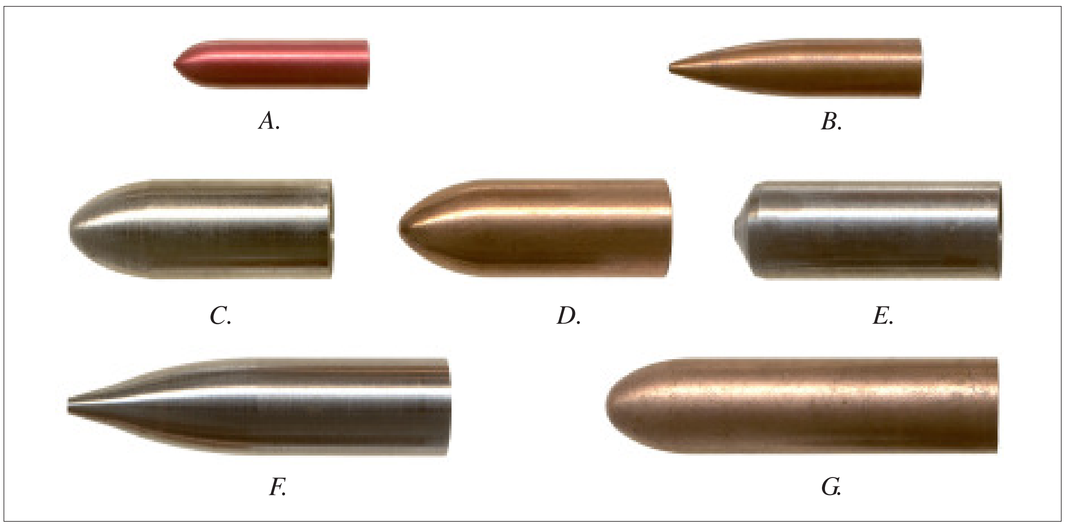

Fig. 6–3. *Gyrojet Cases. (A.) .25 Caliber, anodized aluminum. (B.) .30 Caliber, Gilding Metal Clad Steel (GMCS). (C.) 13mm, plain steel. (D.) 13mm, copper-plated steel. (E.) 13mm "wadcutter," plain steel. (F.) .50 Caliber K.E. (Kinetic Energy), plain steel. (G.) 12mm Long, copper-plated steel. Actual size.*

MBA also sometimes converted unrelated items into Gyrojet rocket cases, including the 18.7mm-diameter, nickel-plated Crosman "Powerlet" compressed-gas bottles used in air guns, shown next in Figure 6–4. Mainhardt told me that any strong metal cylinder with one end closed was a potential Gyrojet case, including .45-caliber, 500-grain rifle bullets, which were sometimes nickel-plated.

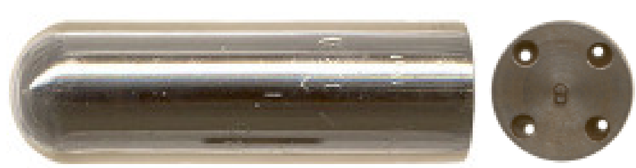

Fig. 6–4. *18.7mm "Gyrojet" case, converted, and its nozzle. The significance of the 8 on the nozzle is unknown. Actual size.*

Nozzle

Four basic spin-nozzle designs were tested during early Gyrojet development. One of these was an unusual type of nozzle that was tried as a means of simplifying manufacture and reducing costs. In this design, the base of the Gyrojet case was simply crimped into a crude nozzle, as shown below in Figure 6–5. This design is sometimes referred to by collectors as a "pinched-base" Gyrojet, because of its appearance. By pinching the rear of the case with a slight twist, angled ports were created.

Figure 6–5 below shows a pinched-base rocket with a three-port configuration. Two, four, and more ports were also tried. These are very scarce, and the only ones known are in the Woodin Laboratory collection.

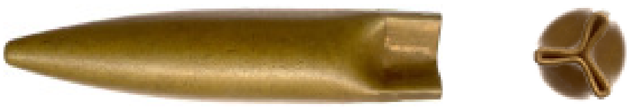

Fig. 6–5. *Pinched-base .50-caliber (12.87 x 58.08mm) Gyrojet and its nozzle. This Gyrojet has a small remnant of* $BKNO_3$*-coated copper wire fuse in the center of its nozzle. Actual size.*

The pinched-base Gyrojet's propellant was ignited by a fuse inserted through one of the ports. Both static and flight tests of the design were conducted and the tests indicated that it was at least feasible. The work-hardened brass case used with one version did not open up at internal pressures of about 1,500 psi, and flight tests proved that the rocket was moderately stable. However, the dispersion of this relatively crude design was very high and it was not adopted. Other pinched base specimens are shown in later chapters with their specific calibers.

Another nozzle type tried was a broached spiral design in a plastic nozzle. This was done with a heated drill bit which was force-twisted through a nylon nozzle port that had been predrilled to 0.016 inch. The nylon was melted to conform to the shape of the bit. When fired in limited tests, the nozzle quickly eroded, removing all spiral channeling and resulting in a smooth nozzle port with no spin. No actual specimen of this nozzle is known.

The third type of nozzle used a fluted vane in the exhaust stream. This produced only 3 percent of the required spin, and it was quickly discarded. I have no drawing or other information about this Gyrojet. However, I think it is likely that the .30-caliber specimen shown below in Figure 6–6 is an example of this very unusual design.

Fig. 6–6. *.30-caliber (7.62 x 38.4mm) Gyrojet with fluted-vane nozzle, actual size . Nozzle shown 2x actual size. Key-chain dummy souvenir. Woodin Laboratory.*

The fourth type of nozzle was the design that MBA adopted for production. It was a separate nozzle with two or more ports drilled at an angle to cause spin. These ports, which were tapered, were individually drilled in a fixture called "Bertha" by MBA machinists, and those who had mastered the complex operation were highly valued because they were so few in number. Drilling nozzle ports was very problematic. Expensive special-order, custom, tapered drill bits were used, and these frequently broke, sometimes while drilling the fourth port of a four-port nozzle, which meant that the nozzle and the bit became scrap.

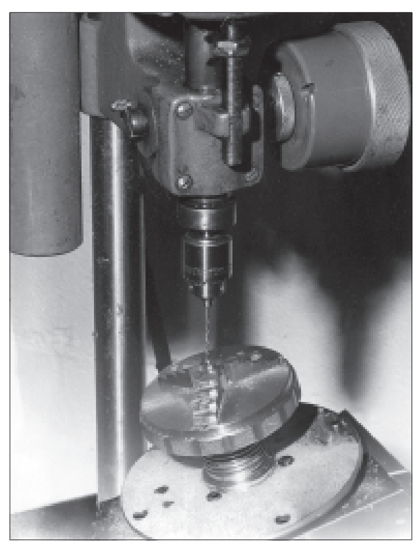

Fig. 6–7. *"Bertha" port-drilling fixture. MBA photo.*

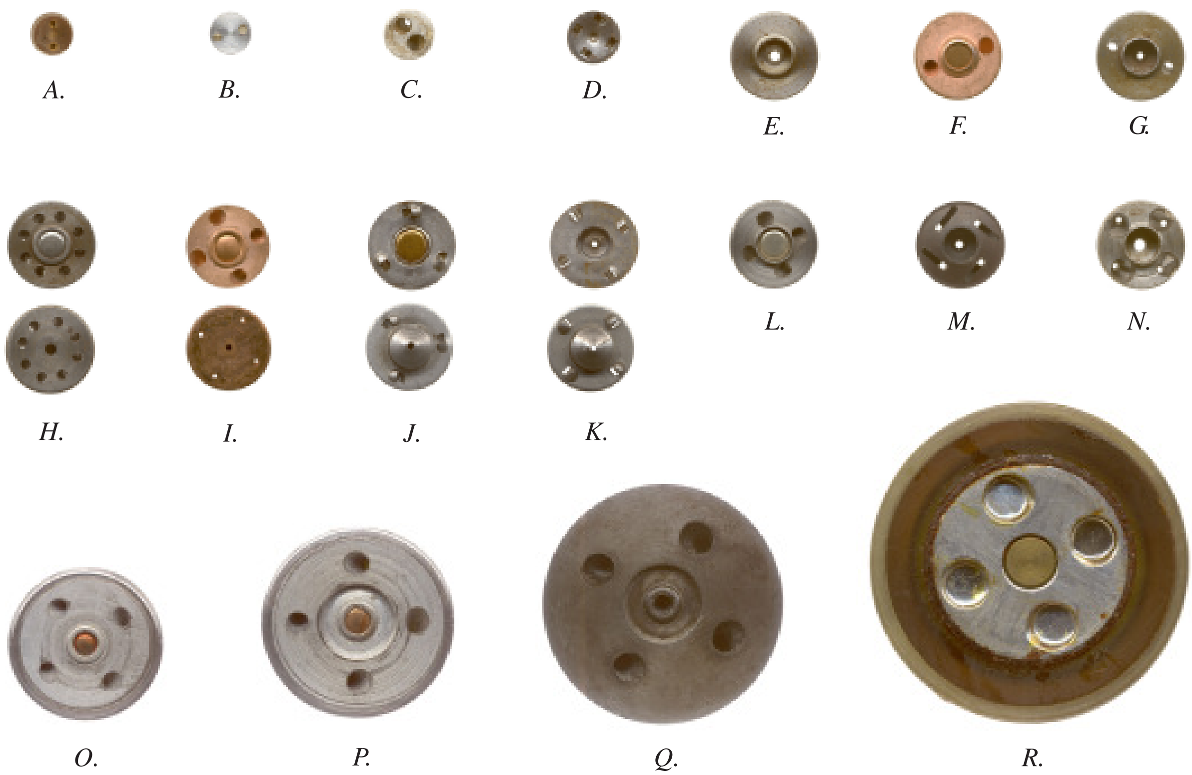

Fig. 6–8. *Gyrojet nozzles, all shown actual size. (A.) .25 caliber, phenolic resin, 2 ports. (B.) .25 caliber, aluminum, 2 ports. (C.) .30 caliber, aluminum, 2 ports. (D.) .30 caliber delay fuse, punched steel. (E.) 13mm, steel blank, not drilled. (F.) 12mm, copper-plated steel, 2 ports. (G.) 12mm, plain steel, 2 ports. (H.) 13mm, plain steel, 8 ports, outlet (top) and inlet views. (I.) 13mm, copper-plated steel, 4 ports. The "standard" 13mm production nozzle, outlet (top) and inlet views. (J.) 12mm, punched steel, 3 tangs, outlet (top) and inlet views. (K.) 12mm, punched steel, 4 tangs, outlet (top) and inlet views. (L.) 13mm, plain steel, 4 ports. (M.) 12mm powder metal, 4 straight slots. (N.) 13mm, plain steel, 4 large ports. (O.) 20mm, plated steel, 4 ports. (P.) 25mm, plated steel, 4 ports. (Q.) 30mm, plain steel, 4 ports. (R.) 40mm, aluminum, steel, and fiberglass, 4 sealed ports.*

The basic problem was that drilling ports at an angle caused the stress on the bit to be not only unequal, but also constantly changing as the bit rotated, and this caused breakage. When one port was successfully drilled, the fixture holding the nozzle had to be rotated by hand to position it for the next operation, and so on. Any play in the holding fixture or drill press would cause port misalignment.

Fig. 6–9. *MBA tapered drill bits. Actual size.*

Mainhardt told me the story of two young engineers who approached MBA with a design for a machine that could drill four nozzle ports simultaneously and accurately. Mainhardt gave them $10,000 and told them he would buy the machine if it could be made. Several months later the pair returned to MBA with the news that they had failed to develop a four-port machine, but that they had succeeded in making one that could automatically drill *two* nozzle ports simultaneously. At the time, MBA was beginning large scale production of the 13mm Gyro-Signal distress flare, which didn't need to be very accurate. Mainhardt said that two ports were good enough for the flares, and he bought the machine.

Testing of the two-port nozzles in distress flare rockets showed that they worked extremely well. As a result, they were tried in other Gyrojets, where they also performed much better than expected. Because of this, late production 13mm Gyrojets are sometimes seen with the same two-port nozzles used in 13mm flares. In addition, some 12mm Gyrojets, which were the last ones made, used the two-port nozzle.

Nozzle ports were drilled at angles from 7 degrees up to 35 degrees, with 15 degrees being typical. Early experimental nozzles were made of nylon, aluminum, phenolic resin, and melamine. Each nozzle, whatever the type or caliber, had a minimum of two ports and some had up to ten ports.

Most nozzles included a primer pocket and flash hole. Production nozzles were machined, and many were then copper-plated to prevent corrosion; however, some were left plain. Others were stamped from sheet steel with tangs formed to deflect exhaust gasses and create spin.

Another nozzle was made by compressing powdered metal in a die under very high pressure and then sintering (heating to just below the melting point to relieve stress) it. These powder-metal nozzles have three or four slots instead of round ports, and the slots are either curved or straight. According to Mainhardt, the powder-metal nozzles were the best MBA made, and they are often seen in late 12mm Gyrojets. They were inexpensive, accurate, and were made with just two operations, compressing into shape and sintering.

Primer

MBA used normal, off-the-shelf, 0.175-inch, small pistol primers as *first fire* in its production Gyrojets. When research for this book began, I thought that nickel-plated primer cups indicated dummy Gyrojets because so many dummies have them. I later acquired a few fired Gyrojets with nickel primers, and I also found some unfired live rounds with them. So we know that at least *some* live Gyrojets were loaded with nickel primers. But not many, except for the .49 caliber.

Mainhardt confirmed that MBA bought primers from local sources like the San Francisco Gun Exchange, and generally didn't care whether they were nickel, brass, or copper. MBA liked the primers that were used in hand grenades because they were surefire. Unfortunately, they were not always available when MBA needed them.

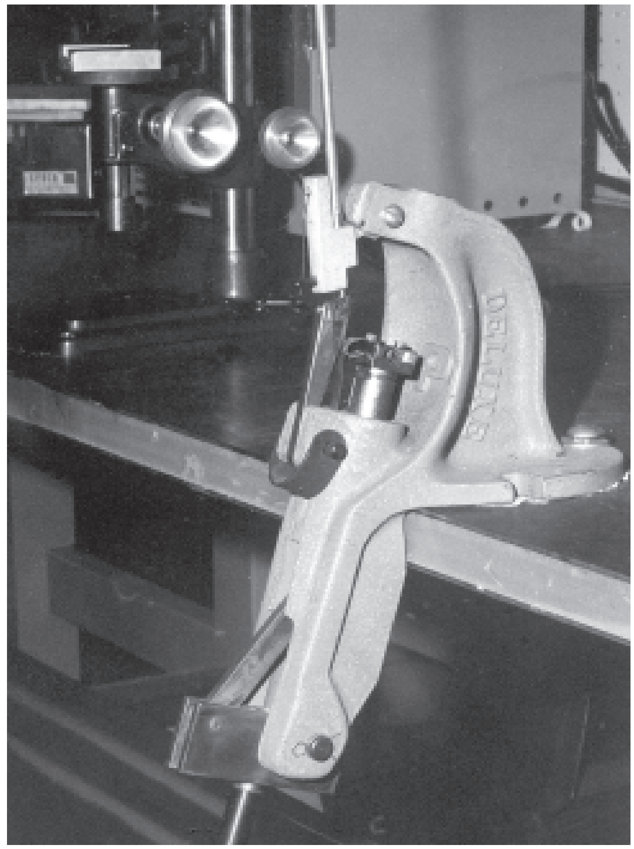

Fig. 6–10. *Standard reloading press used by MBA for loading primers in Gyrojet nozzles. MBA photo.*

Because the primers stayed with the Gyrojet during firing, and were not supported by a breech face at ignition, most were heavily crimped in place. As a result, blown primers were not a problem for MBA. Most production Gyrojets used ring-crimping for their primers, but stab crimps and staking were also used.

When MBA assembled Gyrojets, treated cotton cord or paper igniters (second fire) were inserted in the propellant grains, which were then placed in the cases. Segmented broached rings were then machined, or separate metal rings were inserted as spacers to keep the grains away from the nozzles as they burned. Small pistol primers were seated in drilled nozzles using a hand reloading press, shown in Figure 6–10. The primers were then crimped in the nozzles in a separate operation, shown below in Figure 6–11, before the nozzles were loaded in the cases. Nozzles were secured by cannelures rolled in the cases to match the grooves in the sides of the nozzles, or by the ends of the cases being rolled over.

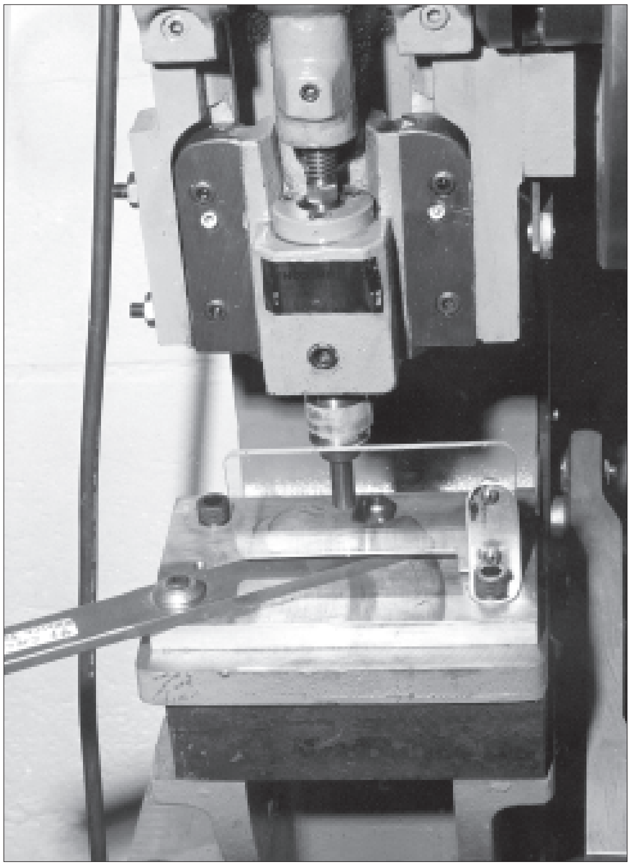

Fig. 6–11. *Gyrojet primer-crimping fixture. MBA photo.*

Propellant

MBA used only single pieces of nitroglycerin and nitrocellulose double-base propellant called *grains*, not to be confused with the grain as a unit of weight. This propellant was cheap, was easy to extrude and machine, would not detonate, and it burned cleanly, producing nontoxic gasses.

MBA never used flaked or granulated gunpowder since it could not have been retained in the case away from the nozzle port inlets, which it would instantly have clogged on firing. The cylindrical grains had a lengthwise hole, or perforation, and were designed to burn only from the inside out. They were held in place forward, away from the nozzle port inlets, by broached rings of metal, as shown in Figure 6–2(*B*), or by separate spacer rings inserted in the case in front of the nozzle, as shown in Figure 6–2(*C*). Some dummy rounds have solid pieces of rubber rod cut to length to simulate the live propellant grain, perhaps to duplicate the weight of a live round.

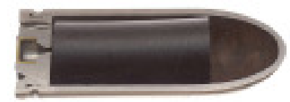

Fig. 6–12. *Nickel-plated 13mm Gyrojet dummy section with rubber "grain." Note the empty nickel-plated primer cup. Actual size.*

MBA acquired much of its propellant from the Hercules Powder Company. The propellant was the same used in some military rockets such as the "Bazooka," and was formed into long strands. When preparing it for loading, MBA first ran the strands through a doweling fixture to size the outside diameter, as shown below in Figure 6-13.

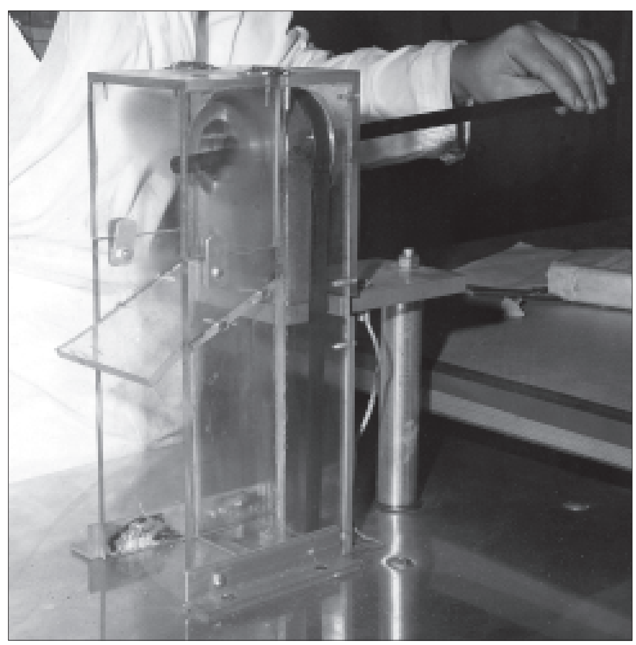

Fig. 6–13. *Propellant grain doweling fixture. MBA photo.*

The strands were then cut into individual grains of the required length, and these were individually turned on a lathe to form the tapered nose and beveled rear end, as shown below in Figure 6–14.

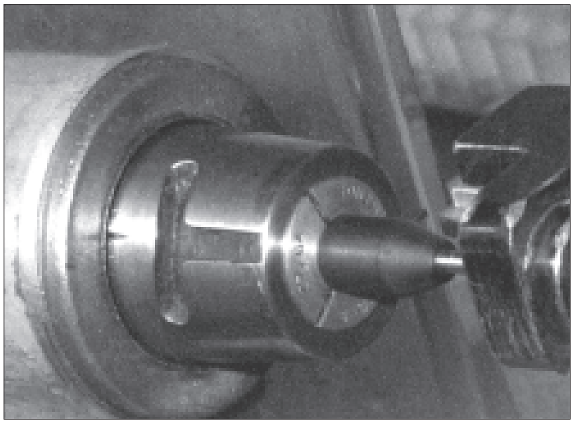

Fig. 6–14. *Turning propellant grain on a lathe. MBA photo.*

Finally, an inhibitor was applied to the outside surface of the grains, as shown next in Figure 6–15. This ensured that the grain burned only from the inside out. It also insulated the steel case against the extreme heat of firing. After trying several potential inhibitors, MBA found that titanium oxide worked best. There was one grade of white outside house paint available in the San Francisco Bay area with a high concentration of titanium oxide, Moore's Number Eight, which MBA applied to their propellant grains in a spray booth. When other rocket company personnel visited MBA and asked how the company made such a good inhibitor, Mainhardt told them to buy a gallon at their local paint store and give it a try.

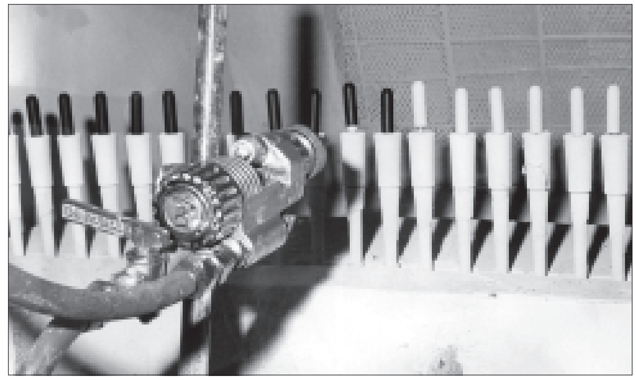

Fig. 6–15. *Applying titanium oxide in spray booth. MBA photo.*

Sealer

MBA knew that Gyrojets would be exposed to heat and humidity, especially in the jungles of Vietnam, and used two waterproofing seals in its production Gyrojets. One was a clear lacquer-type, food-grade solution named "Humiseal," which was painted around the primer and the case/nozzle joint. The liquid normally had a small amount of red food dye mixed in so its presence could be verified during visual quality inspections.

The second seal was a thin piece of adhesive-treated tinfoil applied to the inside of the nozzle prior to loading. The foil was punctured over the primer flash hole but was left intact over the port inlets so moisture could not seep into the case through them. On firing, the pressure easily blew out the foil over the ports. These seals worked so well the Gyrojets they protected could be fired underwater.

— End of Chapter —

This sample chapter is one of 26 chapters in the book, *An Introduction to MBA Gyrojets and Other Ordnance* by Mel Carpenter. See the Book Contents page for a complete listing of all 26 chapters, plus the Glossary, Patents and Trademarks, Handgun Instructions and Components, Bibliography, and Index.