

CHAPTER 13

Caseless and Expellable Ammunition

Introduction and Early Development

This chapter covers both caseless and expellable experimental cartridges. Caseless includes two general types; where the case material is *combustible* and actually adds to the propellant gases produced, and *consumable*, where the case is consumed upon firing but does not contribute to the buildup of gas pressure. Most U.S. military caseless cartridges use a combustible case. *Expellable* is a type of cartridge where the case is actually expelled intact or in fragments down the bore and out the muzzle when fired. This type of round is also called *expendable*.

The caseless cartridge concept presented a number of advantages over conventional metallic-cased ammunition in terms of reduction in the use of strategic material, cost, weight, and bulk. In addition, because the case was consumed upon firing, the extraction and ejection phase of the weapon's functioning cycle was eliminated. However, the technical problems presented by the need for an adequate chamber gas seal, extraction of an unfired round, and the vulnerability of the exposed propellant that made up the case were never completely solved. As a result, development of caseless small arms weapons and ammunition was substantially reduced in scope about 1976, but did continue as individual laboratory projects in an attempt to overcome the problem areas indicated above.

It should be noted that measurements of these types of rounds are not always as exact as those of

conventional metallic cartridges because of the nature of the case material itself and the possibility of deterioration over time which could cause distortion of some or all of the original dimensions. Under the circumstances, measurements of caseless and expellable cartridge and components listed in this chapter are only approximate.

Cal. .125 to Cal. .220 Caseless Cartridges

During 1960, Frankford Arsenal developed a Cal. .125 caseless flechette cartridge for testing by the U.S. Army Medical Wound Ballistic Laboratory. This cartridge was designated the FAT 143 by the Arsenal. The case was made from a cylindrically-molded propellant charge and had a diameter of 0.328 in. with a 1.035-in. overall length.

Two projectiles were designed: the first was called the "Finex" and had expandable fins; the second was called "Fincon" and had fixed fins (Fig. 435). Both weighed 18 grs. and had bimetallic noses and Mallory Metal booms and fins.



FIG. 435. *Cal. .125 Caseless Flechette Cartridge FAT 143 (Fincon) (from FA Tech Rept. R-1696, Fig. 2, Sept. 1963).*

Diam. .328 Flechette diam. .1249 Length 1.035
OAL 1.605

The “Fincon” projectile was designated FAT 175 and when assembled in the propellant charge, had a cartridge overall length of 1.605 in. (FA Tech Rept. R-1696, Sept. 1963).

During 1964-1965, Frankford Arsenal developed a 3.18mm combustible caseless ball cartridge, but except for the fact that it was dual-primed and for a classified project, no other details are available (FA Tech Rept. R-1797, Jan. 1966). During this same time period, a Cal. .17 caseless round was also developed at the Arsenal. This round used a 27-gr. GM FMJ boattail bullet with lead core pressed into a molded propellant cylinder. Case length was 0.96 in. and cartridge overall length was 1.41 in. (Fig. 436-A). This type of round has also been examined with a case length of 0.803 in. and overall length of 1.08 in. (Fig 436-B).

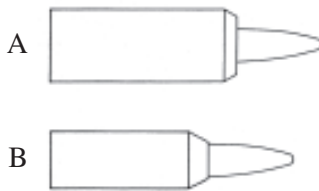


FIG. 436. Cal. .17 Caseless Cartridges, Frankford Arsenal 1964-1965 (from specimens).

	A	B
Diam.	.374	.299
Length	.956	.803
Bullet diam.	.172	.170
OAL	1.391	1.076

A Cal. .217 caseless round was developed by Frankford Arsenal during 1960-1961 in conjunction with the Cal. .125 covered previously. This round had a fixed fin (Fincon) flechette design loaded into the same propellant cylinder that was used with the Cal. .125 round; however, because of a shorter flechette, the cartridge overall length was only 1.473 in. (FA Tech Rept. R-1696, Sept. 1963).

During this period, Frankford Arsenal also experimented with a Cal. .220 caseless flechette round called the FAT 144 which used an odd pointed

cylindrical projectile with a tail boom. It is assumed that this projectile was developed for a specific test purpose or to simulate a future design. The projectile was made of aluminum and, including the boom, was 1.615 in. long. Two different lengths of propellant cylinder were used, each having a base collar around the combustible primer. The shorter had a case length of 0.845 in. and an overall cartridge length of 1.715 in. (Fig. 437). The longer had a case length of 0.910 in. and cartridge overall length of 1.777 in. A similar round has also been examined with a copper alloy or copper-coated projectile of the same configuration loaded into a propellant cylinder about 1.12 in. long.



FIG. 437. Cal. .220 Caseless Flechette Cartridge FAT 144 (from specimen).

Diam. .216 Bullet diam. .218 Length .848 OAL 1.715

5.56mm Caseless Cartridges

Starting in the early 1960s, a major development effort was carried out by Frankford Arsenal and with contractors to design a caseless 5.56mm cartridge using the basic design developed for the 7.62mm caseless in 1959. One of the first rounds was developed under an R&D contract with Remington Arms Co. in 1960 using a consumable case enclosed by an off-white plastic material. The case had a diameter of 0.275 in. and a length of 0.525 in. (Fig. 438).



FIG. 438. 5.56mm Caseless Ball Cartridge, Remington R&D Contract, 1960 (from specimen).

Diam. .275 Bullet diam. .223 Length .525 OAL 1.017

A dummy or display round has been examined with a solid off-white plastic case with a cartridge overall

length of 1.02 in. The bullets in both rounds appear to be .223 Remington with full metal jackets.

During 1962, Frankford Arsenal, using a black molded propellant case furnished by Hercules Powder Co., loaded a small lot of ball cartridges using the M193 bullet. The case diameter was 0.450 in. with a length of 0.651 in. (Fig. 439).



FIG. 439. 5.56mm Frankford Arsenal Caseless Cartridge with Hercules Molded Propellant Case, 1962 (from specimen).

Diam. .450 Bullet diam. .223 Length .651 OAL .990

A dummy round from the same period has a solid aluminum body with an M193 ball bullet and an inert brass primer in the base. The case diameter is 0.470 in. with a length of 0.564 in. (Fig. 440).



FIG. 440. 5.56mm Hercules Caseless Aluminum Dummy Cartridge (from specimen).

Diam. .470 Bullet diam. .223 Length .564 OAL 1.005

In 1964 and continuing through 1966, Frankford Arsenal experimented with a steel “stub” head attached to a caseless body (Fig. 441).



FIG. 441. 5.56mm “Stub” Head Caseless Cartridge (from specimen).

Rim diam. .374 Case length 1.543 Head diam. .374
Bullet diam. .222 OAL 1.994

The head was about 0.50 in. high and was attached to a molded propellant charge about 1.13 in. long. The case was cylindrical with a tapered shoulder at the mouth which held a GM-jacketed M193 ball bullet. The “stub” head was pocketed for a standard No. 41 primer, although the round examined had no primer.

Contracts were also made during this time for development of 5.56mm caseless cartridges. Aircraft Armaments, General Motors Corp. (Aerospace Operations Division), and Hercules Powder Co. all submitted molded propellant designs using the M193 ball bullet. Aircraft Armaments used a dual primer with igniter disc sealed with red lacquer, General Motors used an off-white primer with orange sealant, and Hercules used a yellow-brown case with yellowish primer seal. These all had case diameters of about 0.336 in., lengths of 0.988 in., and cartridge overall lengths of 1.453 in.

During early 1967, A.J. Grandy, an engineer assigned to the Frankford Arsenal Ammunition Development & Engineering Laboratories, submitted a proposal for a 5.56mm Caseless Cartridge and Rifle System in response to a Request for Proposal from Rock Island Arsenal (RFQ DAAF-01-67-Q-1421). The cartridge design is shown on drawing FC 14443 dated 22 June 1967, which illustrates a Mylar-coated molded propellant case having an enlarged body diameter containing the primer and a conventional GM FMJ bullet inserted in the case mouth (FA TR P68-1-1 dated July, 1967) (Fig. 442).



FIG. 442. 5.56mm Grandy Caseless Cartridge (from Dwg. FC 14443, 22 June 1967).

No dimensions given.

It is doubtful that this design proceeded beyond the study phase of development, since the proposal was

not approved and no record of test or fabrication could be located.

A number of different 5.56mm caseless rounds have been examined that were made at Frankford Arsenal during 1967-1972. The earlier types appear to have a propellant cylinder without bevel (90-degree shoulder), while later loadings have a beveled forward portion. Case lengths are between 0.955 and 0.980 in. and with the M193 ball bullet, the cartridge overall lengths are between 1.446 and 1.469 in. Case diameters vary even more, ranging from 0.321 to 0.387 in. (Fig. 443).

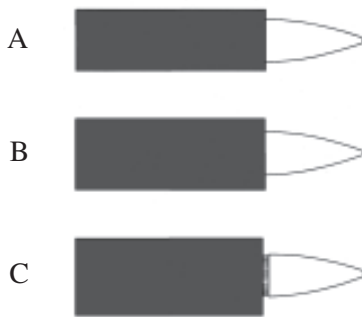


FIG. 443. 5.56mm Caseless Cartridges with 90-Degree Shoulders (from specimens).

	A	B	C
Diam.	.321	.363	.387
Length	.968	.980	.955
OAL	1.446	1.469	1.469

Most have a blackish IMR propellant appearance. White, yellow, and pink dots applied to the body or base of the case have been noted to identify the different solvents used to mold the case, but other colors were also probably used. Different primers were also identified by colors, with black, brown, green, off-white, orange, and yellow lacquer seals having been noted, and again, other colors were also probably used. When a high-temperature coating was used over the case, this normally gave an off-white, yellowish, or light to dark gray finish.

Rounds with a case having a mouth bevel have a case length between 0.966 and 0.998 in., and with

the M193 ball bullet, the cartridge overall length was between 1.450 and 1.477 in. As with the cylindrical case type, the diameters vary from 0.336 to 0.370 in. (Fig. 444).



FIG. 444. 5.56mm Caseless Cartridge with Beveled Shoulder (from specimen).

Diam. .363 Bullet diam. .223 Length .975 OAL 1.468

Some variations have been examined, including a round with yellow primer and a "D" label on the side, and a round with a dark brown lacquered case with orange primer, the latter from Lot FA B-1 with the FA 961 primer. Both of these rounds have a case length of 0.968 in. and a cartridge overall length of 1.474 in. Another rather unusual variation has a cylindrical case body with a tapered portion to the mouth starting about midbody. The entire case has a greenish color with slight grooves either cut or formed into the surface. Case length is about 0.974 in. with a cylinder diameter of 0.349 in. and a mouth diameter of about 0.300 in. (Fig. 445).



FIG. 445. 5.56mm Caseless Cartridge with Tapered Case (from specimen).

Head diam. .349 Length .974 Neck diam. .300
Bullet diam. .223 OAL 1.474

A similar round has a slightly longer case length of 0.987 in. and a green lacquered primer.

During August 1967, Frankford Arsenal let an R&D contract to the Delco Electronics Division, General Motors for the design and fabrication of 5.56mm caseless test rounds using a molded propellant case. These were to be loaded with both a flechette and a

standard M193 ball bullet for ballistic tests. The flechette loading designed by Delco used a 17.5 gr. charge of IMR 4895 blended with a solvent mixture to mold the propellant into a cylindrical case. The flechette weighed 10.2 grs. and was assembled in a GM sabot attached to the forward part of the case. However, there is no record of any test firings and it is doubtful that this design progressed beyond the study phase of development. The round using the M193 bullet was loaded and tested and had a 25 gr. IMR 4895 molded propellant charge formed into a case with a length of about .967 in. and a diameter of approximately 0.370 in. The case also had a 30-degree mouth bevel and was loaded to a cartridge overall length of 1.486-1.500 in. (Rept. FA TR 68-06, Jan. 1968) (Fig. 446).



FIG. 446. 5.56mm Caseless Cartridge with M193 Ball Bullet (from specimen).

Diam. .370 Bullet diam. .224 Length .967 OAL 1.486

The development activity at Frankford Arsenal on the 5.56mm caseless cartridge was greatly increased during 1968-1970 with over 200 experimental loadings being made and tested. This was primarily due to a decision made by Munitions Command in 1968 to reduce the development effort on the 7.62mm caseless weapon and ammunition and concentrate on caliber 5.56mm, where it was thought the technical barriers could be more readily overcome.

It is beyond the scope of this volume to list every experiment conducted; however, the following summarizes the primary developments and designs.

During June 1969, Frankford Arsenal started the experimental fabrication of 5.56mm caseless rounds using the M193 ball bullet and molded propellant cylinders. These were pocketed for both single and dual primers and during late 1969, rounds with four different primer lots were sent to Rock Island

Arsenal for erosion tests in a special test fixture. These were:

Lot CP 27, 969 rounds

Lot CP 34, 970 rounds

Lot WW 2A, 1,130 rounds

Lot FA 982, 2,120 rounds

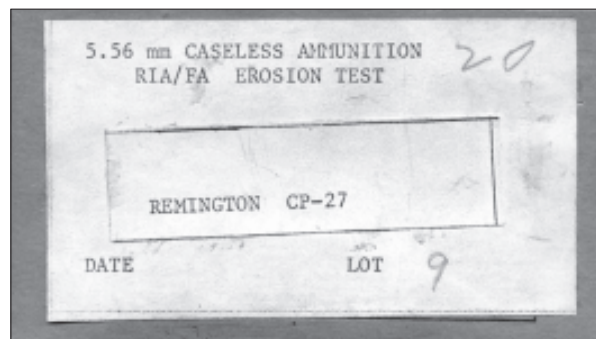


Figure 35 in Frankford Arsenal Report FA-TR-75040 shows a caseless cartridge captioned "Original Design" with single primer and "bullet plug" that may be one of these lots, but that has not been verified. The purpose of the bullet plug is not known but is thought to hold the loose propellant inside the cylinder close to the primer for proper ignition (Fig. 447).



FIG. 447. 5.56mm Caseless Cartridge, Original Design (from Fig. 35, FA-TR-75040).

Diam. .370 Bullet diam. .223 Length .966 OAL 1.450

The case was made from IMR 4809 powder, molded with a binder under pressure, and was cylindrical with a bevel at the mouth. The case length was 0.966 in., the diameter was 0.370 in., and the overall length with the M193 bullet loaded was 1.450 in. The configuration of these rounds would set the standard for many of the test rounds loaded later. The primer was normally loaded flush or slightly recessed in the base of the cylinder. Both dual (called "Duo") and single combustible primers were used with this round. The Duo primer cavity was about 0.323 in.

deep and the single primer cavity 0.210 in. deep respectively; both were about 0.245 in. in diameter. Both of the cylinder configurations were shown on Frankford Arsenal drawing FB 57308 dated 23 April 1970 (Fig. 448).

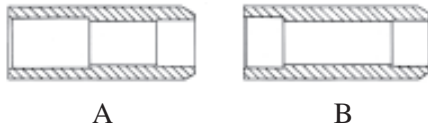


FIG. 448. 5.56mm Propellant Cylinders (from Dwg. FB 57308, 23 Apr. 1970). (A) Duo primer; (B) Single primer.

Diam. .370 \pm .005 Length .966 \pm .007

The cartridge drawing of the case with the Duo primer was FB 57309 dated 29 April 1970 (Fig. 449), and the drawing of the single-primer case was FB 57320 dated 24 August, 1972. Both rounds used the standard M193 ball bullet and had a nominal propellant weight of 20 to 22 grs.

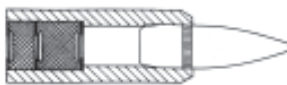


FIG. 449. 5.56mm Caseless Cartridge with Duo Primer (from Dwg. FB 57309, 29 Apr. 70).

During 1970, a short, molded case design was also fabricated at Frankford Arsenal using both IMR and Hercules molded propellants (Fig. 450). Testing of this configuration extended into 1971.

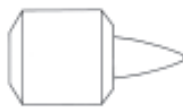


FIG. 450. 5.56mm Frankford Arsenal Caseless Cartridge with Hercules Molded Propellant Case, 1970 (from specimen).

Diam. .490 Bullet diam. .223 Length .526 OAL .896

Fabrication of these rounds was under the personal direction of Joseph B. Quinlan, a senior Frankford Arsenal engineer who had earlier established a caseless cartridge development laboratory and hand-line in the Bldg. 240 area of the Arsenal.

During the initial development of the 5.56mm caseless cartridge, a considerable effort was directed at a suitable ignition system for the propellant cylinder. Combustible primers were first experimented with, using a conventional cup and anvil formed from solid propellant, but these were often not completely consumed when fired. This led to an anvil-less primer design using a more sensitive primer mixture that could be initiated by the strike of the firing pin. However, the bolt face was exposed to the abrasive action of the primer flame, and various methods of reducing this effect were tried. Duo primers and other ignition methods that moved a portion of the primer mixture forward into the case and away from the bolt face were also tried. Experiments were also made using a single-primer cartridge with a plastic support tube added inside the case (Fig. 451).

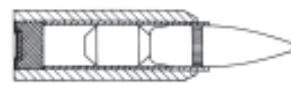


FIG. 451. 5.56mm Caseless Cartridge with Propellant Support Tube (Fig. 36, FA-TR-75040).

Ignition boosters were also developed for both the Duo and single primers, with varying degrees of success (Fig. 452).

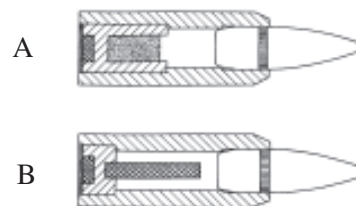
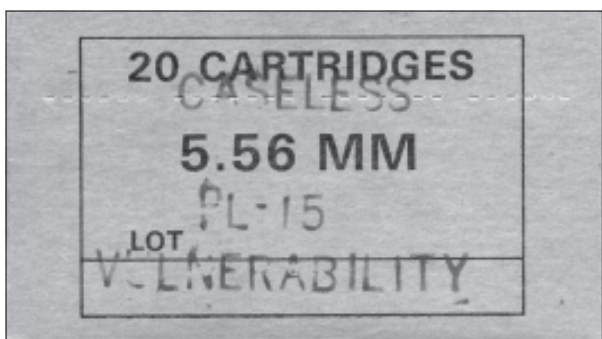


FIG. 452. 5.56mm Caseless Cartridges with Ignition Boosters (from sketches in FA-TR-75040, May 75). (A) Deep Pocket Duo Primer, (B) Axial Igniter Booster.

Some of these developments were incorporated in the project to reduce the vulnerability of the caseless cartridge to cook-off and round-to-round flame propagation discussed next (FA Rept. R-1967, Jun. 1970). Undoubtedly, the greatest challenge facing Frankford Arsenal during the development of the caseless cartridge was making the case less vulnerable to heat and flame transfer. This was particularly of concern because of cook-off in a hot weapon chamber and the possibility of accidental ignition in the weapon's feed system or while being carried by the user in combat. The first approach was to develop high-temperature-stable propellants, and both Picatinny Arsenal and Hercules Powder Co. developed a number of different types, but none were completely successful.



However, a Hercules HMX propellant designated HES 8028 did show promise, particularly when used with binders and an outer protective coating. This was molded into propellant cylinders and sent to Frankford Arsenal for loading and testing.

A contract was also let to Thiokol Corp. for the development of a caseless propellant made of energetic crystals in various inert binders. After numerous experiments, one composition consisting of HMX and polyurethane showed promise. This program was called HITP/SEAP for High Ignition Temperature Propellants which were also Self-Extinguishing at Atmospheric Pressure. This propellant was extruded by Thiokol into cylinders for use in 5.56mm caseless rounds. Most of these cases can be identified by off-white HMX granules imbedded in the outer surface (Thiokol Rept. TWK 5839, TP 5-28-5-2, Dec. 1971). Frankford Arsenal identified these by a series of white dots put on the case to distinguish different case compositions.

Some of these were sized for the "standard" case length of 0.966 in. and diameter of 0.370 in., and other loadings used a larger 0.635-in.-diameter case. Multiple layer cases were also developed with the HITP/SEAP propellant tube as the outer layer and a core of molded IMR propellant. This work was done under contract with both Thiokol and the Rocketdyne Division of North American Rockwell Corp. During 1971-1972, the outer case of HITP/SEAP propellant was also coated and wrapped with various compounds and filament materials in an attempt to provide greater protection (Fig. 453). However, for the most part, these were not successful (Rept. R-8931 Mar. 1972. Rocketdyne Div., No. American Rockwell Corp.).



FIG. 453. 5.56mm Caseless Cartridge with Filament-Wound Case (from specimen with gold-colored primer).

Body diam. .356 Bullet diam. .221 OAL 1.481

Three basic configurations of caseless rounds were tested with HITP/SEAP propellant. The first used the standard case configuration as shown on Frankford Arsenal drawing FB 57309 with Duo primer, the IMR molded propellant being replaced by a cylinder of PPL 6090 HITP/SEAP propellant. This round was called the Mono Round. The second type also used the Duo primer, but had an inner core of IMR propellant and an outer cylinder of HITP/SEAP HES 8602 propellant. This round was designated Inner Core Intermediate (ICI) (Fig. 454).

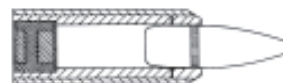


FIG. 454. 5.56mm HITP/SEAP Caseless Inner Core Intermediate (ICI) Cartridge (Fig. 48 from Rept. FA-TR-75040, May 1975).

Body Diam. .400 max. Body Length 1.000 max.

The third type was similar in design to the Intermediate, except the case had a complete protective envelope of PPL 6090 propellant and was called the Internal Core Encapsulated (ICE). Both the Intermediate and Encapsulated rounds can be identified by their yellow-white to gray case color. Concern over firing a caseless round with an unprotected case in an automatic weapon prompted the development of a case sleeve and shoulder cap to prevent cook-off in a hot chamber. About 300 rounds were assembled for cook-off testing in a special Rock Island Arsenal fixture which simulated short bursts of automatic fire.

The shoulder cap was made from cellulose acetate 0.020-in. thick and the case sleeve from a heat-shrinkable Mylar tube 0.002 in. thick (Fig. 455). When assembled, the cap and sleeve completely covered the case body which was visible underneath. The tests of this protective covering were successful in reducing chamber heating and cook-off but did not offer adequate moisture protection. Further development included applying various coatings and sealing methods to the cap and sleeve. The most promising of these was a metal foil cover which Frankford Arsenal tested with some success.



FIG. 455. 5.56mm Caseless Cartridge with Protective Cap and Sleeve (from specimen).

Diam. .372 Bullet diam. .223 Length .937 OAL 1.417

The final design in providing a protective cover was the use of a complete cartridge encapsulation with polyethylene film, including the entire base and primer. To further protect the case and provide a case-mouth-to-bullet seal, a Mylar shoulder sleeve was added to the forward portion of the case body (Fig. 456). Testing of this cartridge design was very successful, both from moisture sealing and cook-off prevention standpoints. In addition, the polyethylene film was readily applied by vacuum forming, with further sealing around the bullet and

forward part of the case being accomplished with adhesives. Over 2,000 rounds of this design were made at Frankford Arsenal on the Bldg. 240 area hand-line and sent to Rock Island Arsenal for testing in 1972-1973.



FIG. 456. 5.56mm Caseless Encapsulated Cartridge (from specimen).

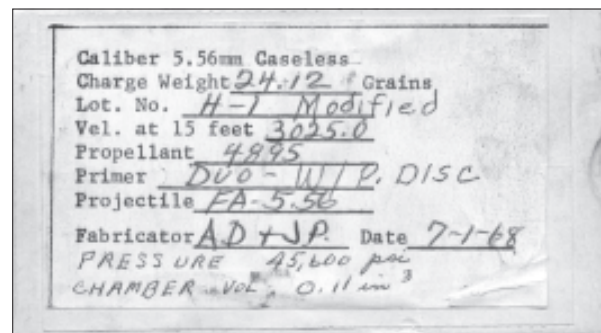
Diam. .362 Bullet diam. .223 Length 1.016 OAL 1.499

AAI also developed a 5.56mm caseless cartridge using a cylindrical propellant tube with a mouth bevel. A round from Lot H-1 Modified, loaded during July 1968, has a M193 ball bullet, 24.12-gr. charge of molded IMR 4895 powder, and Frankford Arsenal Duo-primer. During ballistic test at the Arsenal this lot obtained a chamber pressure of 45,600 psi and velocity of 3,025 fps. A round examined has a case diameter of 0.362 in., length of 1.004 in., and cartridge overall length of 1.466 in. The case is dark gray-black in color and the primer has a reddish-orange seal (Fig. 457).



FIG. 457. 5.56mm Caseless (from AAI specimen, Lot H-1 Modified).

Diam. .362 Bullet diam. .223 Length 1.004 OAL 1.466



A caseless round with 4.32mm bullet contained in a 5.56mm sabot has been examined that probably came from Frankford Arsenal. The case is made from a black molded cylindrical propellant grain 0.778 in. long with a diameter of 0.383 in. The primer pocket is empty and has a diameter of 0.245 in. A 4.32mm bullet with FMJ is assembled in a clear plastic 5.56mm segmented sabot to give a cartridge overall length of 1.287 in. (Fig. 458). No Arsenal R&D project file or firing record could be located on this type of round and it is possible this design did not reach the completed cartridge stage of development before being cancelled.



FIG. 458. 4.32mm/5.56mm Experimental Caseless Cartridge (from specimen).

Diam. .383 Sabot diam. .223 Length .778 OAL 1.287

A round labeled “Ignition Test Blank” has also been examined with a round-nosed opaque white plastic bullet. The case is black molded IMR propellant with mouth taper and cartridge overall length of 1.436 in. (Fig. 459). This round came from Frankford Arsenal, but further details are not available.



FIG. 459. 5.56mm Caseless “Ignition Test Blank” Cartridge (from specimen).

Diam. .360 Bullet diam. .218 Length .969 OAL 1.436

Dummy and inert rounds were also assembled for display, test, and setup purposes. These have been examined in many types and variations, depending upon the round they simulate or their intended use. Black plastic cylinders were often used to simulate the propellant charge. A number of these have been

examined assembled with M193 ball bullets and base closures in place of primers. Case lengths vary from 0.780 to 1.010 in. and cartridge overall lengths from 1.365 to 1.467 in. Some of these have a blackened inert primer and others a solid disc base closure. An unusually long type has a case length of 1.580 in. and a cartridge overall length of 2.086 in. It appears to be a display dummy.

Additional case variants include a short 0.962-in. black plastic case (Fig. 460-A), a solid aluminum case with gray finish (also black plastic) (Fig. 460-B), a solid brown plastic with small primer pocket (Fig. 460-C), an opaque plastic case with pink adhesive on bullet and primer (Fig. 460-D), a one-piece solid aluminum case and bullet (Fig. 460-E), and a solid wood case with base indent (Fig. 460-F). This last one said to have been made by Calspan Corp. to test weapons magazines.

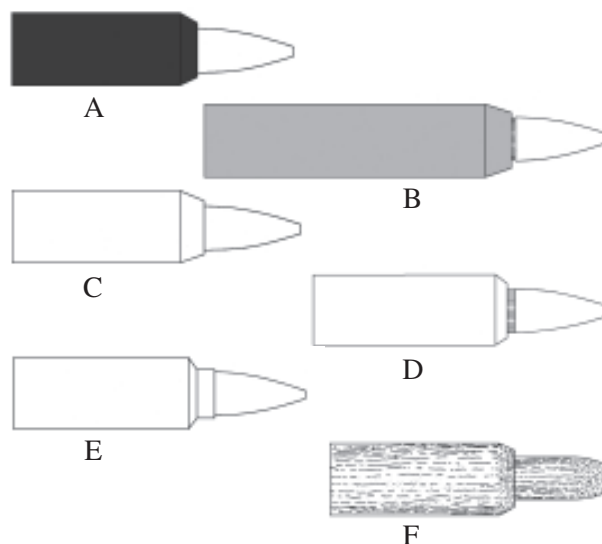


FIG. 460. 5.56mm Caseless Dummy Cartridges (from specimens). (A) Short black plastic, (B) Solid aluminum, (C) Solid brown plastic, (D) Opaque plastic with pink adhesive, (E) Solid aluminum, (F) Solid wood.

	A	B	C	D	E	F
Case Diam.	.365	.364	.368	.367	.371	.354
Case Length	.962	1.580	.997	.965	1.038	.961
Bullet Diam.	.223	.223	.223	.223	.223	.223
OAL	1.457	2.086	1.500	1.515	1.508	1.457

A number of dummy rounds have also been noted with various shades of a brown plastic material making up the case. These have both solid and recessed bases and were assembled at Frankford Arsenal using M193 ball bullets. Case lengths are about 0.975 in. with a cartridge overall length of 1.469 in.

Solid dummy rounds have been examined made from machined or formed aluminum, some with a bare finish and others painted various colors including gray, yellow, and olive-drab. Solid plastic cases assembled with M193 ball bullets have also been noted. These include clear, opaque and translucent material with and without base closures. One example, assembled at Frankford Arsenal during June 1969, uses a pink adhesive to secure the primer and bullet; another has a clear plastic case with recessed inert primer sealed with red lacquer. Two other dummy rounds have been examined. The first has a yellow plastic tube to simulate the case, no primer, and a M193 ball bullet. The second has a black plastic case 0.864 in long with an extractor groove at the base, two holes in the body, one hole in the base, and a M193 ball bullet (Fig. 461).



FIG. 461. 5.56mm Caseless Dummy Cartridge with Extractor Groove (from specimen).

Rim diam. .354 Case length .864 Body diam. .375
Bullet diam. .223 OAL 1.459

Frankford Arsenal also developed a caseless tracer round using the standard M196 tracer bullet loaded into a 0.966-in.-long propellant tube with beveled mouth. For identification, two orange rings were painted around the case body. Both single and Duo combustible primers were tested successfully with this bullet.

Besides the conventional straight case design, 5.56mm caseless rounds were also developed under

contract and by Frankford Arsenal with the bullet located inside the propellant cylinder. When the bullet was completely enclosed, this design was called "fully telescoped." The initial development of this design was carried out during 1967 by Hughes Tool Co. Hughes designated this the HTC-AD. The propellant cylinders used were molded by both Frankford Arsenal and Hercules Powder Co. The FMJ, 55 gr., Cal. .223 bullets were purchased from local sources, and the metallic primers were made by CCI.

Duco cement was used to bond the primer and bullet inside the tube. The diameter of the tube was about 0.364 in. and the overall length was just over 1.00 in. (Fig. 462). These have been examined with greenish, tan and yellow primers (Hughes Tool Co. Rept. HTC-AD68-18, Mar. 1968). A variant round with a diameter of 0.393 in. and overall length of 0.974 in. and a beveled case mouth has also been noted.



FIG. 462. 5.56mm Caseless Telescoped Cartridge, Hughes Tool Co. (from specimen).

Diam. .364 Length 1.002

Frankford Arsenal also developed a telescoped caseless round in this caliber during 1969. This round had a maximum overall length of 1.00 in. and a case diameter of about 0.400 in. (Fig. 463).



FIG. 463. 5.56mm Caseless Telescoped Cartridge, Frankford Arsenal (from Fig. 91, FA-TR-75040).

Diam. .400 max. Length 1.000 max.

With the M193 ball bullet, the cartridge total weight was 89 grs. The base of the case was closed by a

0.25-in.-diameter combustible primer. A velocity of 3,250 fps was obtained by this round during firing tests. A partially telescoped variant of the cartridge has also been examined with the bullet protruding slightly from the case mouth. The case diameter is 0.363 in. and cartridge overall length is 0.973 in. (Fig. 464).



FIG. 464. 5.56mm Caseless Partially Telescoped Cartridge, Frankford, Arsenal (from specimen).

Case diam. .363 Case length .934 OAL .973

A dummy version of this round with a slightly shorter case (0.889 in.) has been noted on a Frankford Arsenal display board.

An unusual partially telescoped round has been noted with a beveled base, black propellant tube, and dark brown primer. The case diameter is 0.350 in. and cartridge overall length is 1.138 in. (Fig. 465).



FIG. 465. 5.56mm Caseless Partially Telescoped Cartridge with Beveled Base (from specimen).

Case diam. .350 Case length .995 OAL 1.138

A similar round has a slightly shorter overall length and a cream colored primer. Finally, in 1971, Frankford Arsenal developed a so-called "improved" partially telescoped round with an internal plastic sleeve. The case length was 0.921 in. and cartridge overall length was 1.230 in. with the M193 ball bullet.

During 1969, Frankford Arsenal developed a 5.56mm caseless flechette cartridge under an advanced R&D program for a new rifle concept.

Rounds from Frankford Arsenal are assembled with a green-Teflon-coated sabot and have both dark gray and off-white primers. Examples vary in case length from 0.940 to 1.455 in. and cartridge overall length from 1.562 to 1.861 in., all with a case diameter of 0.350 to 0.362 in. (Fig. 466).



FIG. 466. 5.56mm Caseless Flechette Cartridge, Frankford Arsenal (from specimen).

Diam. .360 Sabot diam. .223 Case Length 1.455
OAL 1.861

A variant round is assembled with a dark tan Honeywell sabot, and has a cartridge overall length of 1.235 in. A dummy round which came from Frankford Arsenal has a green-Teflon-coated sabot inserted in a plastic tube with blackened primer. The case is 1.29 in. long, the diameter is 0.328 in., and the cartridge overall length is 1.730 in. (Fig. 467).



FIG. 467. 5.56mm Caseless Flechette Cartridge, Frankford Arsenal (from specimen).

Diam. .328 Sabot diam. .223 Case Length 1.29
OAL 1.730

A display board dummy cartridge has a black molded propellant cylinder with a white sabot holding a single flechette, the tip of which protrudes from the sabot. The case length is about 1.42 in. with a diameter of 0.315 in. Cartridge overall length is 1.86 in. including the protruding tip of the flechette.

AAI, Inc. also developed caseless flechette rounds, but it is not known if this was under contract or an internal project. A cartridge examined from a display

board entitled "AAI 5.56mm Caseless Flechette Ammunition" has a black cylindrical case assembled with an enlarged, segmented, dark-gray plastic sabot holding a single flechette. An unusual band or obturator is included on the sabot at the case mouth with another around the tail end of the sabot. Case length is 1.703 in. with a diameter of 0.409 in. and a cartridge overall length of 1.937 in. (Fig. 468).

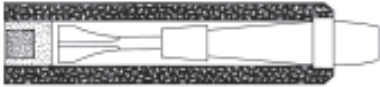


FIG. 468. 5.56mm Caseless Flechette Cartridge (from AAI display board).

Diam. .409 Sabot diam. .225 Length 1.703 OAL 1.937

Another round reported to be an AAI development has a case length of 1.543 in., diameter of 0.315 in., and cartridge overall length of 1.757 in. (Fig. 469).



FIG. 469. 5.56mm Caseless Flechette Cartridge, AAI (from specimen).

Diam. .315 Sabot diam. .223 Case Length 1.543
OAL 1.757

Another caseless flechette round developed by AAI was loaded using the green-Teflon-coated sabot-flechette assembly used in the 5.77mm XM645 cartridge. The case was made from a molded black propellant tube with a length of 1.968 in. and a cartridge overall length of 2.176 in. The combustible primer is sealed with red lacquer. A similar round has a slightly shorter case length of 1.90 in. and an overall length of 2.050 in.

Cal. .30 Caseless Cartridge

During the summer of 1945, a British intelligence team found two 8mm consumable-case cartridges

at the Polte Werke in Magdeburg, Germany. In 1946, based on the report describing these rounds, the Office, Chief of Ordnance let an exploratory development contract to Remington Arms Co. to determine the feasibility of a combustible-cased cartridge. (W-19-059-ORD-3428, Aug. 1946).

Remington's initial testing was done in a special fixture chambered for a commercial .410 shotshell attached to a Cal. .30 barrel. The paper body of the shell was replaced with three layers of photographic film wound into a cylinder and attached to the primed .410 head. Various types of propellant were loaded into this case and a standard Cal. .30 M2 ball bullet was seated in the barrel forward of the case. Separate loading allowed the testing of different propellant charges and primers without fabricating complete test cartridges. With a charge of 30 grs. of 1301 powder and a 35-gr. consumable case made from photo film, a chamber pressure of 27,000 psi was achieved, which completely consumed the case. At least two primers were used, the No. 55 primer with mixture 5054 and the No. 55 with a more powerful composition called TX-2. Hercules Ballistite 5085 molded into a single grain was also tried, replacing the photo film case, and this gave better results (Fig. 470).



FIG. 470. Cal. .30 Separate Loading Test Cartridge (from RAC Rept. AB-47-10, Mar. 14, 1947).

No measurements given

A second test device was designed to test an improved combustible case and primer with a Cal. .30 M2 bullet attached to the propellant grain by a stud. This device had a self-sealing chamber which eliminated the need for the .410 shotshell head. However, only ignition tests were carried out with this design, and no loaded cartridges are known to have been made (RAC Rept. AB-47-10, Mar. 14, 1947).

7.62mm Caseless Cartridges

In 1958, Frankford Arsenal started the development of a 7.62mm caseless round using a “stub” base (also called a primer holder) to provide weapon chamber obturation. The initial experimental rounds used cut-off Cal. .30 brass case heads about 0.513 in. long headstamped DEN 43. (A 7.62 NATO case headstamped ⊕ WCC 64 that came from a display board made later has also been examined.) The case was made of molded propellant to form the upper case body, shoulder, and neck and was about 1.75 in. long. The first test rounds used commercial soft-point bullets, and both the base stub and bullet were attached to the propellant by adhesive cement. The cartridge overall length was about 2.753 in. (Fig. 471).



FIG. 471. 7.62mm “Stub” Caseless Cartridge (from specimen headstamped ⊕ WCC 64).

Rim diam. .470 Case length 1.750 Head diam. .465
Bullet diam. .308 OAL 2.753

During this development period, numerous types of base stubs were tried, including those made from brass, steel, and aluminum. The length of the stub also varied from 0.336 to 0.520 in. Case lengths were from 1.69 to 1.75 in., and have been examined colored black, blue, green, orange, yellow, and silver, probably indicating different types or loadings. Depending upon the bullet used, cartridge overall lengths range from 2.68 to 2.75 in. Both M59 and M80 ball bullets were used in these loadings and one Arsenal report indicates that when the M59 bullet was used, it was identified with a red tip (FA Rept. R-1643, Jun. 62). However, rounds examined headstamped ⊕ FA 58 with the M59 bullet have a plain tip and green colored case and with the M80 bullet, headstamped ⊕ FA 60, a plain tip and yellow-colored case, this latter identified as a “50% Reduced Propellant” loading. Work on the stub caseless round was suspended in 1960 after

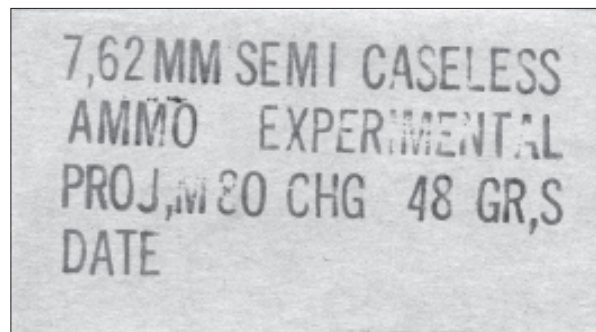
the brass stubs failed during firing tests, but was resumed in June 1962 using both steel and anodized aluminum stubs. An example of a steel stub round from this period has a case length of 1.648 in. including the 0.334-in.-long stub (Fig. 472).



FIG. 472. 7.62mm Steel Stub Caseless Cartridge (from specimen without headstamp).

Rim diam. .470 Case length 1.648 Head diam. .465
Bullet diam. .308 OAL 2.736

Cartridge overall lengths vary because of different bullet seating depths. Rounds with this case have been noted with blue, orange, and silver-colored case bodies, with the orange also having an orange bullet tip; although it is a ball bullet, not a tracer. This design was also assembled as a dummy cartridge, probably for display purposes. Dummy rounds have been examined with the stub and case painted silver and an indented brass primer. Another almost identical round has a black plastic case and a blackened stub.



A semi-caseless round with a REM-UMC 222 REM headstamp has also been examined. It has a commercial case shortened to 1.128 in., a 0.305-in.-diameter propellant cylinder 1.733 in. long, and an M59 ball bullet (Fig. 473, next page). These components were found loose at Frankford Arsenal, and it is assumed they were loaded separately in a test device. It is not known if this was an Arsenal

project or done under contract, possibly by Remington.



FIG. 473. 7.62mm *Semi-Caseless Cartridge* (from specimen with REM-UMC 222 REM headstamp).

Rim diam. .376 Bullet diam. .308 Head diam. .374
Case-propellant length 2.031 Propellant diam. .305
OAL 3.296

During 1964, Frankford Arsenal developed a test device called the “Bulpin” to investigate an improved method of obturation for caseless ammunition. Later, U.S. Patent 3,169,333 dated Feb. 16, 1965, was granted to inventor John J. Scanlon, Jr. for this device (Fig. 474).



FIG. 474. 7.62mm “Bulpin” *Test Device Cartridge Assembly* (from Fig. 4, FA Rept. R-1750, Jan. 1965 and specimens).

Bullet diameter .308 Propellant diameter .312
Bullet length 1.178 OAL 6.24

Basically, a caseless propellant charge is inserted between two bullets, and when the device is fired, the device’s firing pin strikes the rear bullet’s striker head which strikes the primer of the caseless charge, which propels the forward bullet down the bore. The next round, consisting of a propellant charge with a bullet at the base, is fed into the chamber, pushing the original rear bullet forward into firing position and the cycle is repeated.

Two “O” rings on the bullet act as gas seals, first as an obturator in the rear position, then as an obturator/rotating band when fired in the forward position (FA Rept R-1750, Jan. 1965).

Starting about 1965, Frankford Arsenal began the development of a fully combustible caseless 7.62mm cartridge. Very little is known about this early effort except that the case length was about 1.31 in. with a diameter of 0.448 in., using molded IMR propellant and the M59 ball bullet.

A dummy round believed to simulate the original prototype design has a translucent plastic case and cartridge overall length of 2.12 in. Development of a molded IMR case assembled with the M59 ball bullet continued through 1965-1967 using a case length of about 1.86 in. and a cartridge overall length of 2.81 in. (Fig. 475).



FIG. 475. 7.62mm *Caseless Cartridge with Molded IMR Propellant and M59 Ball Bullet* (from specimen).

Diam. .468 Bullet diam. .308 Case Length 1.860
OAL 2.813

A variation using a 49-gr. molded IMR propellant case has a case length of 1.650 in. and a cartridge overall length of 2.650 in. This was tested in a modified M1903 rifle in 1965 (FA Rept. R-1750, Jan. 1965). This basic design was covered by U.S. Patent 3,212,440 dated Oct. 19, 1965, with Joseph B. Quinlan, Marvin E. Levy, and Earl F. Artsdalen as inventors, assigned to the U.S. Army (FA Rept R-1971, Jul. 1970). This early development used combustible primers usually colored off-white, silver, or various shades of brown to yellow. Further refinement of this design resulted in a shorter case and cartridge overall length.

A typical example has a molded propellant charge 1.247 in. long and an overall length of 2.150 in. with the M59 ball bullet. The primer is colored dark brown and the bullet has a red tip to identify the M59 ball bullet. Later, the case length was increased to about 1.562 in. (variations measuring from 1.638 to 1.763 in. have also been noted) with a cartridge

overall length between 2.314 and 2.566 in. This intermediate length also has numerous variations in case diameter and primer type.

These rounds have also been examined with the entire bullet colored both red and blue, and primers colored both yellow and gold. A dummy of this type has been noted with an orange-colored case. Some of the molded charges also have visible propellant grains in the outer surface. A case length of 1.99 in. has also been noted, with primers colored black, orange, red, and salmon in a cup insert; and yellow without an insert. Also, larger-diameter primers colored both light brown and red, some taking up almost the entire base of the case, have been noted in this longer case. During 1960, Frankford Arsenal also experimented with various primer protectors to prevent premature ignition during sustained firing, the most successful being a mica disc placed over the primer.

During 1965, Frankford Arsenal loaded a 540-round lot of special caseless cartridges called "Minni Rounds" for testing in a modified M73 machine gun. These were loaded with M59 ball, M61 armor-piercing, and M62 tracer bullets for ballistic evaluation. With the M59 ball bullet, these rounds had an overall length of 2.160 in. The molded propellant charge had a tapered mouth and a length of 1.28 in. Since the test weapon was link-belt fed, a 0.125-in. hole was drilled in the case body about 0.125 from the base to accept the M13 link tab (FA Rept. R-1797, Jan. 1966) (Fig. 476).

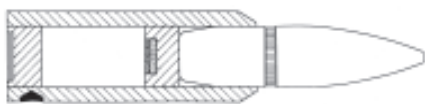


FIG. 476. 7.62mm "Minni Round" (from Fig. 3, FA Rept. R-1797).

Propellant diam. .450 Bullet diam. .308
Propellant length 1.28 OAL 2.160

In early 1967, the Jet & Ordnance Division of TRW, Inc. submitted two proposed cartridge designs, a modified Frankford Arsenal telescoped round and

a sabot bullet cartridge concept, in response to a Request for Proposal from Rock Island Arsenal (RFQ DAAF-01-67-Q-1602). The modified Frankford Arsenal telescoped design (Fig. 477) had plastic or metal seals placed on the rear and forward edges of the propellant cylinder to aid in obturation.

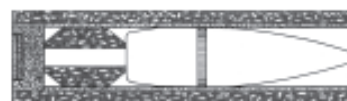


FIG. 477. 7.62mm TRW Telescoped Cartridge Concept (from TRW Proposal dated 27 March 1967).

No dimensions given

The sabot cartridge had a molded propellant case containing a flash tube and primer with a conventional FMJ bullet mounted in a sabot at the case mouth (Fig. 478). It was thought that the sabot would allow the use of a variety of projectiles, including shot and flechette, from the same bore size. It is assumed that neither of these designs proceeded beyond the study stage of development, since no record of test or fabrication could be located (TRW, Inc. Jet & Ordnance Division Proposal for the Design and Development of a Machinegun Firing 7.62mm Molded Propellant Caseless Cartridge, dated 27 March, 1967).



FIG. 478. 7.62mm TRW Saboted Bullet Concept (from TRW Proposal dated 27 March 1967).

No dimensions given

In 1967, the Armour Research Foundation, Illinois Institute of Technology Research Institute (IITRI), submitted an unsolicited proposal for a telescoped combustible cartridge 2.80 in. long and 0.468 in. in diameter to Frankford Arsenal, but no record of testing could be located (Fig. 479, next page).

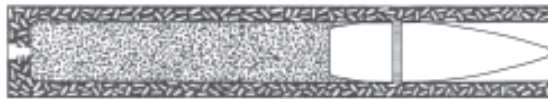


FIG. 479. 7.62mm Combustible Case IITRI Maremont Cartridge (from IITRI Proposal 68-161 K).

Diam. .468 Length 2.80

A board dummy entitled “7.62mm Combustible Case IITRI Maremont” has been examined. It has a cylindrical white plastic case and a cartridge overall length of about 2.82 in. An improved version of this round was also designed with a 0.47-in.-diameter case 1.90 in. long with a consumable primer and M80 ball bullet (Fig. 480).

However, there is no record that this round progressed beyond the conceptual stage of development (IITRI Proposal 68-161K, Dec. 1, 1967).

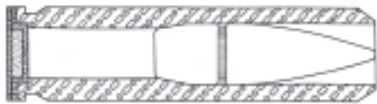


FIG. 480. 7.62mm Caseless Cartridge, IITRI Improved Concept (from Fig. 6, IITRI Proposal 68-161K).

Diam. .473 Length 1.90

The loading of what would prove to be the final design using the M80 ball bullet started at Frankford Arsenal in 1968. The initial rounds used a tapered case 1.470 in. long with a large (0.293-in. diameter) dark gray combustible primer and a cartridge overall length of about 2.50 in. Later, the cartridge overall length was reduced to a nominal 2.00 in. Experimental lots (A, B and C) loaded in 1968 for testing at Rock Island Arsenal used a 44-gr. charge of molded HG 44 propellant and the FA 961 primer. The cases were about 1.331 in. long, with a tapered mouth and a cartridge overall length of 1.978 in. (Fig. 481).

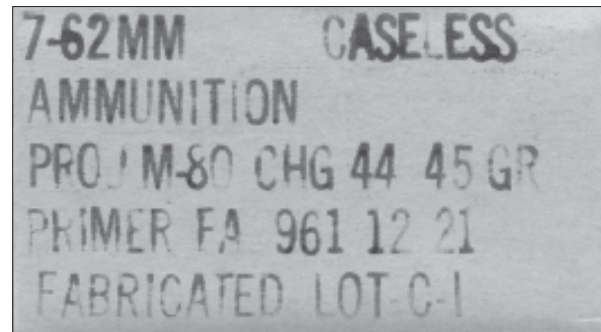


FIG. 481. 7.62mm Caseless Cartridge from Lot C-1 with M80 Ball Bullet (from specimen).

Diam..460 Bullet diam. .308 Length 1.331 OAL 1.978

Some loadings also used a molded propellant slug inside the propellant tube instead of loose powder. Later the propellant was changed to molded M8, which was originally developed by Picatinny Arsenal for use in artillery rounds.

Similar rounds from a 20-round carton marked “HIGH VEL. 3100 f.p.s.” have a black molded propellant case with both red and yellow-colored primers. The case length is 1.33 in. and cartridge overall length 1.99 in. Also noted are rounds with a dark dot on the primer and a black band around the case body. Composite and coated propellant grains were also used with this type of round and can be identified by an off-white to silver-colored case.



In summary, the Frankford Arsenal development of the 7.62mm fully combustible caseless cartridge went through at least three basic case lengths; a Short 1.25-1.49 in., an Intermediate 1.56-1.76 in., and a Long 1.86-2.0 in.

Dummy rounds with orange-colored case and both GM- and GMCS-jacketed M80 ball bullets colored blue, and with both case and bullet colored blue or orange, have also been examined. Two “cook-off” test rounds of this type have also been noted; one

has a wood plug in the primer pocket and the other has a semi-pointed wood bullet.

Contract development of 7.62mm caseless rounds was also carried out. During 1968-1969, Hercules Powder Co. developed a round with a dark gray molded case without the tapered mouth. Case length was 1.372 in. and with the M80 ball bullet, cartridge overall length was about 2.09 in. Rounds with a conventional percussion primer in a battery cup have been noted in this loading.

In 1972, under contract, Thiokol Corp. developed a similar round of the Hercules type using a tan-colored molded propellant charge. They called this round the "7.62mm Caseless Prototype" (DAA D05-71-C-0294).

Frankford Arsenal developed a 7.62mm telescoped caseless round in 1968 for use in a General Electric Co. self-powered machinegun. The molded propellant tube contained an M8 propellant sleeve and an M80 ball bullet. Cartridge overall length was a nominal 1.400 in. Tests of this round were not successful, with numerous misfires and failure to achieve sufficient chamber pressure and resultant velocity (DAA F01-68-C-0004).

5.56mm Expellable Cartridges

In December 1969, the Small Arms Systems Agency, Aberdeen Proving Ground, sponsored a research project for the development of a 5.56mm expendable or expellable case design. Most of this development was done by Remington Arms Co., which already had an internal program to develop an improved caseless cartridge. Basically, the expendable or expellable case was intended to solve the combustible case vulnerability problem by enclosing the propellant in a rimless-grooveless plastic body which was expelled through the muzzle when fired.

To ensure complete exit of the case, a special chamber was designed which had free space at the base of the case body and around the neck. Upon firing, the free space allowed the case to collapse, break up, and be blown through the muzzle of the test barrel. The case was designed with an increased

thickness of plastic in the neck and shoulder to assist in pulling the case completely out of the bore. The primer was combustible and sealed in the base of the case with epoxy and Duco cement. Remington called this concept the "XC" for Expellable Case. Three U.S. Patents were filed on the expellable case in the name of John J. Scanlon, assigned to Remington Arms Co.; Pat. 3,485,170 dated November 3, 1969; Pat. 3,527,137 dated September 8, 1970; and Pat. 4,038,923 dated August 2, 1977.

During the feasibility study phase of the project, the Remington Research and Development Dept. had concentrated on Design 7, which gave good results, but had low muzzle velocity and a too-high chamber pressure. To correct this, the case thickness was reduced and the bullet seated to a shallower depth to give greater powder space. The primer was also changed from CP27 (0.45-gr. mix) to CP34 (0.40-gr. mix). This cartridge was designated Design 7C, and over 4,000 rounds were fabricated and tested. The Design 7C was loaded with the standard M193 ball bullet, had a case length of 1.295 in., a cartridge overall length of 1.875 in., and a 32-gr. charge of IMR 8208 (Fig. 482).



FIG. 482. *5.56mm Expellable Cartridge, Remington Design 7C (from specimen).*

Diam. .377 Bullet diam. .225 Length 1.297 OAL 1.883

Average ballistics were achieved, with a velocity of 3,250 fps and 55,000 psi chamber pressure. Most of the Design 7C loadings used cases made of polyphenylene oxide, although the earlier Design 7 rounds had cases made of a polycarbonate material. The Design 7C case was also loaded with the M196 tracer bullet. To accommodate the longer M196 bullet and maintain the standard overall cartridge length, the case and molded propellant charge were reduced in length by 0.145 in. This also reduced the propellant charge from 29.5 grs. to 25.5 grs. About 10 rounds were fired, and all functioned in a

satisfactory manner with normal tracer ignition (AD906989L RAC Final Rept May 72).

Rounds examined from a box marked "5.56mm EXPENDABLE CASE," loaded by Remington in 1972, have a black plastic case and primer. The bullet is the M193 ball and cartridge overall length is 1.89 in. Another, with a colorless plastic case, has a cartridge overall length of 1.80 in. (Fig. 483).

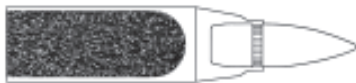
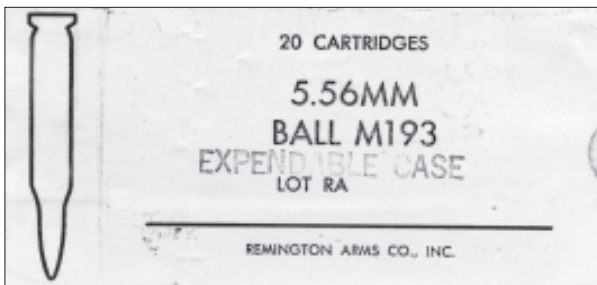


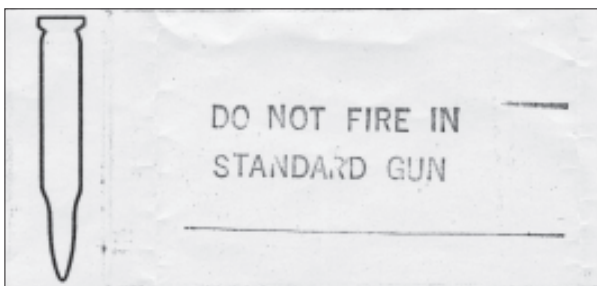
FIG. 483. 5.56mm Expendable Cartridge, Remington, 1972 (from specimen).

Diam. .376 Bullet diam. .223 Length 1.321 OAL 1.800

These were apparently loaded with different primers that were color-coded with red, yellow, green, and black sealants. Rounds have also been examined with a brownish plastic case with a shallow ring on the body about 0.17 in. wide and 0.4 in. from the case mouth, these reportedly from early Remington testing.



Front



Back

In November 1969, AAI submitted samples of their "EXPELLABLE" 5.56mm cartridge to the Small Arms Systems Agency. One has a light brown three-piece plastic case with a pinhole in the head. The case is loaded with the M193 ball bullet to an overall cartridge length of approximately 1.84 in. (Fig. 484-A). Also submitted was a silver-appearing round using a two-piece case (AD906989L, May 72) (Fig. 484-B).

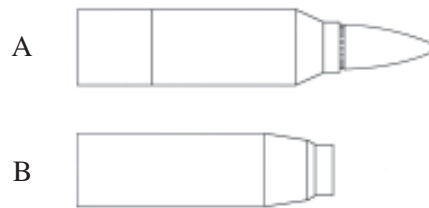
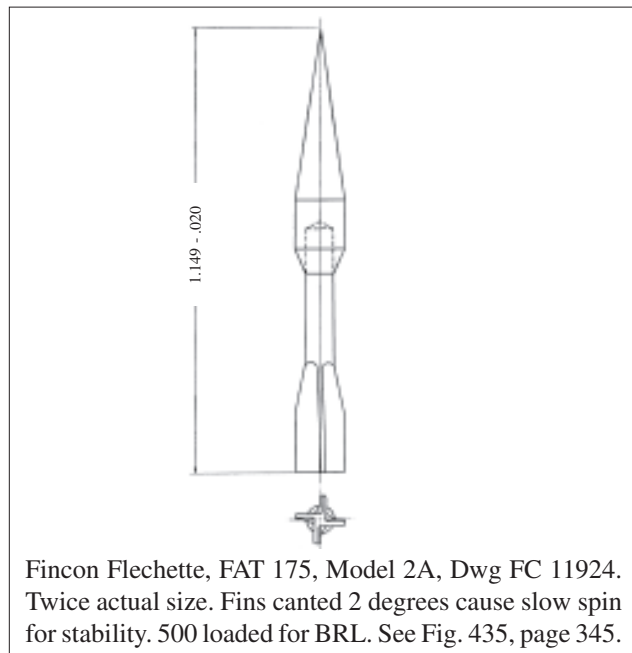


FIG. 484. 5.56mm Expellable Cartridges, Aircraft Armaments Inc. (from specimens). (A) 3-piece case, (B) 2-piece case.

	A	B
Body diam.	.386	.378
Shoulder diam.	-	.308
Neck diam	.262	.266
Bullet diam.	.226	-
Case length	1.341	1.295
OAL	1.843	-

— End of Chapter —



Fincon Flechette, FAT 175, Model 2A, Dwg FC 11924. Twice actual size. Fins canted 2 degrees cause slow spin for stability. 500 loaded for BRL. See Fig. 435, page 345.