EDDYSTONE MUNITIONS

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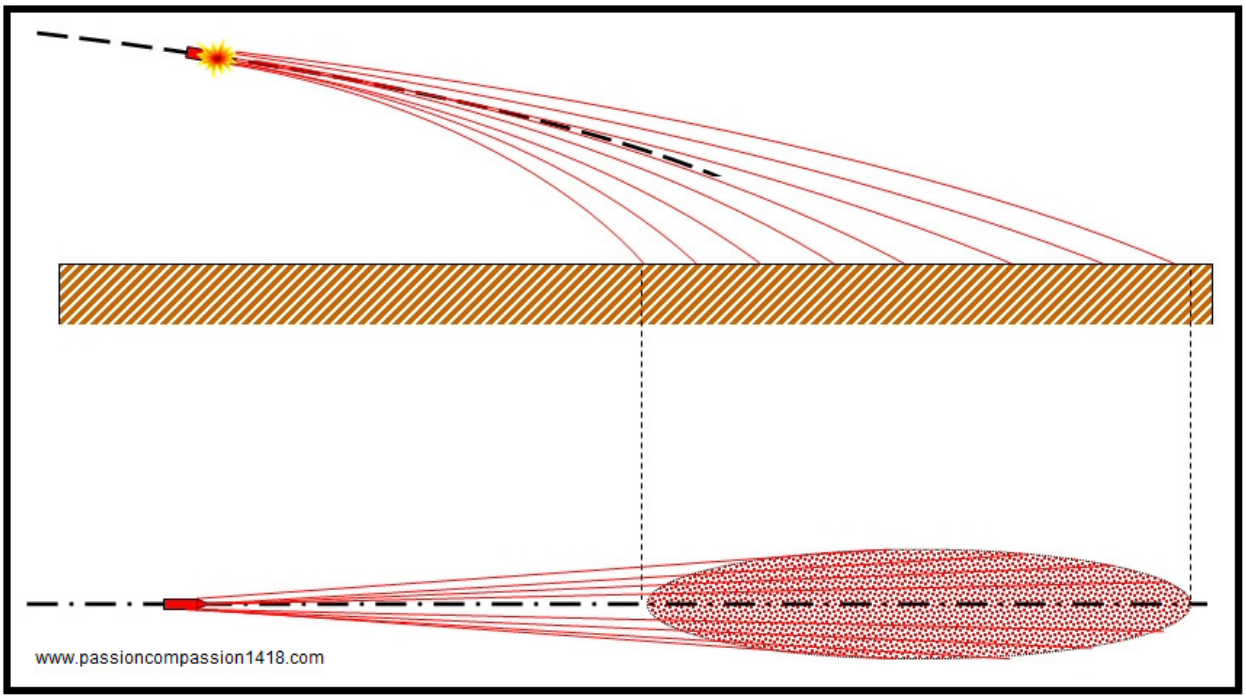
The manufacture of artillery ammunition in Eddystone, Pennsylvania during World War I is forever associated with the fatal explosion of April 10, 1917. Numerous articles have been written on this tragedy.[1] Less known are details of the ammunition plant itself and its subsequent role during the war.

The Baldwin Locomotive Works created the Eddystone Ammunition Corporation to produce 76.2mm (3 inch) shrapnel shells for Russia under a contract with Britain.[2] Construction of a factory began in 1915. The contract for 2.5 million shells was to be completed in December 1916, but was extended because of delays in acquiring machinery. The contract was completed in August 1917.[3] In September, 1917, the U.S. government bought the machinery and equipment of the of the Eddystone Ammunition Corporation. The plant continued to be operated by Baldwin.[4] Baldwin formed a new corporation, the Eddystone Munitions Company, to produce 75mm shrapnel and high explosive shells. This was the ammunition used in the famed "French 75" Model 1897 field gun. That gun was the most numerous artillery piece used by U.S. forces.[5]

Shrapnel shells are antipersonnel munitions. Using a fuze timed for an airburst, a black powder charge disperses over 250 lead or steel balls (i.e., shrapnel) in an elliptical pattern onto the ground below.[6] This is in contrast to high explosive shells which rely on blast and fragmentation and are loaded with TNT or a similar explosive. Although widely used in World War I, shrapnel was deemed far less effective and was little used thereafter.[7]

The base of the shrapnel shell was filled with a black powder charge topped by shrapnel suspended in resin. The powder charge was separated from the shrapnel by a diaphragm. Upon detonation of the powder charge, the diaphragm served to expel the shrapnel forward. The booster tube containing the ignition powder ran down the center of the shell and was attached to the diaphragm. A mechanical time fuze was inserted into the nose of the projectile. The time fuze activated the ignition powder in the booster tube which, in turn, detonated the main charge in the base of the shell expelling the shrapnel. The main charge in a 75mm shell was 2.43 pounds of powder.[8]



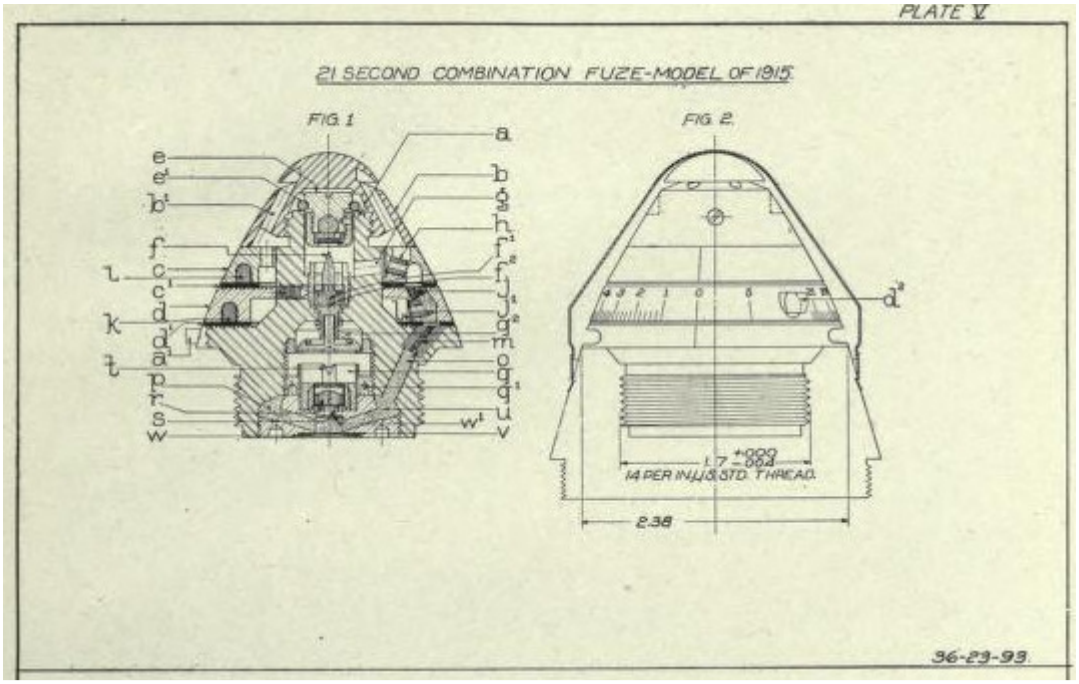
Time fuze triggers an airburst - the charge in base of shell propels a diaphragm which, in turn, propels the shrapnel forward striking the ground in an elliptical pattern

Based on calculations of range/ time of flight, gunners set the time fuze to explode the shell over a selected target. The time fuze in the nose of the shell was a relatively complex mechanical device. If the time fuze failed, a secondary fuze function exploded the shrapnel round on contact with the ground or any other surface.

The Model 1915 fuze was used with U.S.-made 75mm shrapnel rounds.[9] These fuzes, developed by Frankford Arsenal in Philadelphia, were the equal, if not superior, to the French pattern.[10]

French 75mm Shrapnel Shell

This battlefield relic failed to explode. Brass fuze in the nose section is the 22/37 Mle. 1897. This fuze could be set for detonation in time increments up to 24 seconds or upon impact. Large quantities of unexploded ordnance are still unearthed every year on World War I battlefields in France and Belgium. Even after a century they remain an explosive hazard.



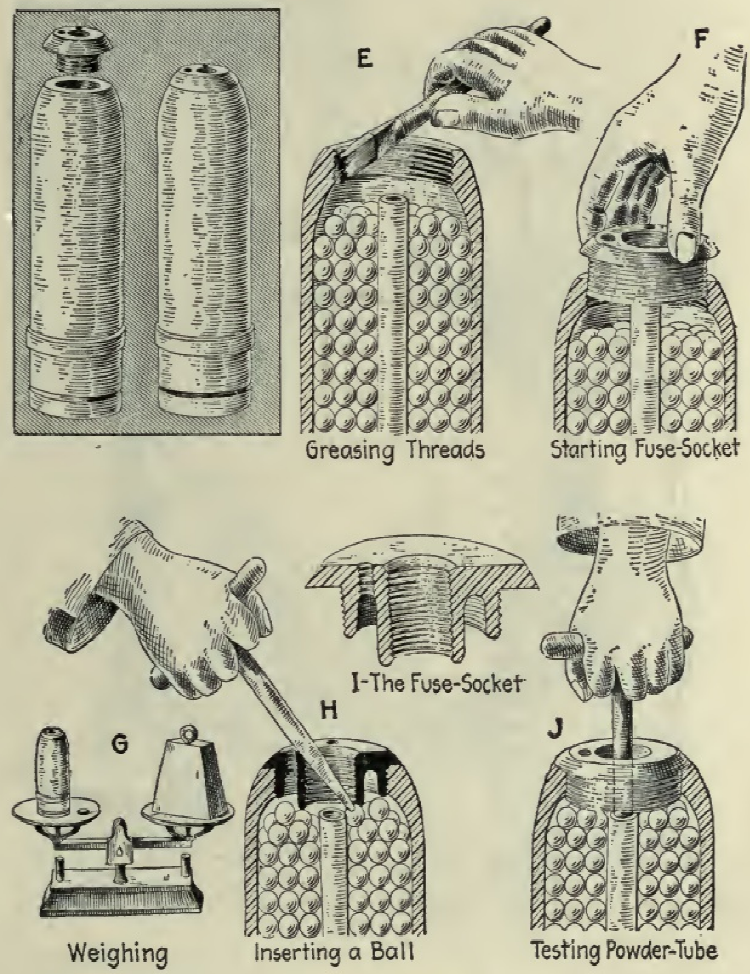
U.S. Model 1915 Fuze

This combination time/impact fuze was used on U.S-made 75mm ammunition

U.S. Ordnance Dept. Handbook of the 2.95-Inch Mountain Gun, p.22

fuze from the Eddystone plant

This is a U.S. pattern fuze used on Russian shells made at Eddystone. Note Cyrillic lettering on the foremost index lines. Not visible are the "E.A.C." and "1917" date markings on the base. E.A.C. denotes Eddystone Ammunition Corporation.



OPERATION 18. START FUSE SOCKET AND MAKE WEIGHT

Machines Used—Hand operations.

Special Fixtures and Tools—Brush E for smearing grease in threads; drift H for inserting balls.

Gages—Scales G for weight; rod J for testing powder tube.

Production—Three men take care of 250 shells per hour.

Note—Weight at this operation is held to 13 lb. 5.6 oz. plus or minus the weight of one of the small lead balls.

A stage in manufacture of the Russian 3 inch (7.62mm) shrapnel shell

The fatal explosion at Eddystone on 4/10/1917 occurred while making this type shell.

from Alford p.101

The 75mm round is "fixed" ammunition meaning the shell case containing the primer and propellant is attached to the shell.[11] A complete 75mm round contained 68 parts.[12] Unlike most other manufacturers, Eddystone produced all of the component parts, including time fuzes, and assembled complete rounds of shrapnel ammunition. Other plants assembled ammunition from parts from as many as 35-40 contractors.[13]

Projectiles were made either by forging or machining from bar stock. Both processes were used at Eddystone. About forty machining operations were used to finish a forged projectile.[14] The nose of the projectile was drilled to accept the threaded adaptor for the fuze. Adaptors permitted a variety of fuzes to be later inserted. Finally, a copper driving band, necessary to fit the rifling of the gun, was hydraulically pressed around the circumference of the projectile near its base.

Over eighty dimensions of a completed shell required gauging to insure uniformity and over 500 gauges were needed during various stages of manufacture. To this number must be added the 200 gauges used by government inspectors.[15] American-made shells were manufactured by a different metallurgical practice than the French shells, but retained the French dimensions to insure ballistic uniformity. French and American 75mm and 155mm ammunition was interchangeable.[16]

Eddystone manufactured the projectiles, shrapnel, diaphragms, booster tubes and adaptors for the fuzes. After the shell was lacquer painted, these components were assembled. Resin was injected after the shrapnel was placed in the shell. The shell was then loaded with the black powder bursting charge and a booster charge. The booster/ignition charges were made of black powder pellets wrapped in paraffin paper which was inserted into the booster tube.

The brass shell cases were also made at Eddystone. Starting with a brass disk, a case was formed from a series of drawing and annealing operations, then tapered and the head machined.[17] The Eddystone cartridge case shop manufactured over 60,000 cases a week.[18] A primer was inserted into the completed case. The primers were also made at Eddystone.

The final stage of assembly was loading the primed case with 1.56 pounds of smokeless powder propellant, mating it to the 11 pound shell and inserting the time fuze.[19] Time fuzes required specialized manufacture. Whereas many ammunition makers received their fuzes from outside sources, Eddystone manufactured their own.

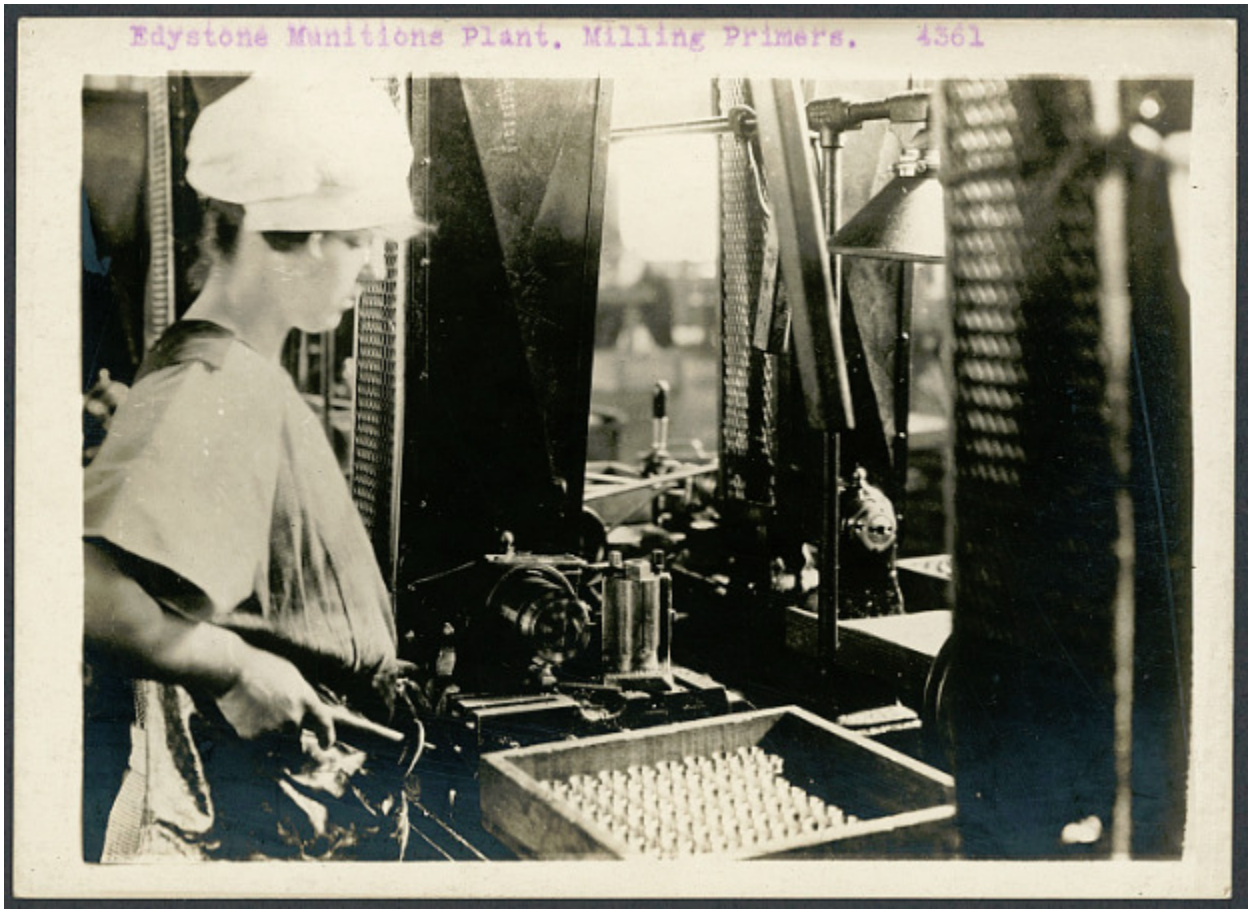
French 75 mm Round

Note the rifling marks on the copper driving band. These marks would not appear on an unfired projectile. The shell and casing have been mated for illustration purposes.

Unlike shrapnel shells, all high explosive projectiles were shipped to one of thirteen explosive filling plants. At the filling plant the explosive was inserted and the complete round of ammunition was assembled.[20] Shrapnel ammunition was issued with the time fuzes already inserted. Fuzes for high explosive ammunition were packaged separately and shipped with the shells.[21] Artillerymen in the field removed shipping plugs and inserted the fuzes.

Manufacture was ongoing 20-24 hours a day with workers employed in two or three shifts.[22] The number of Eddystone employees averaged 4,213 with a high of 6,583.[23] Labor turnover was very high in the heavily industrialized Philadelphia/ Delaware River region. At Eddystone, the turnover was primarily due to a housing shortage, but competition for skilled workers also played a role. During the influenza epidemic in the fall of 1918, illness struck many employees, many fatally, including the munitions corporation's vice president.[24] Despite the labor challenges, the Eddystone plant managed an impressive rate of production.

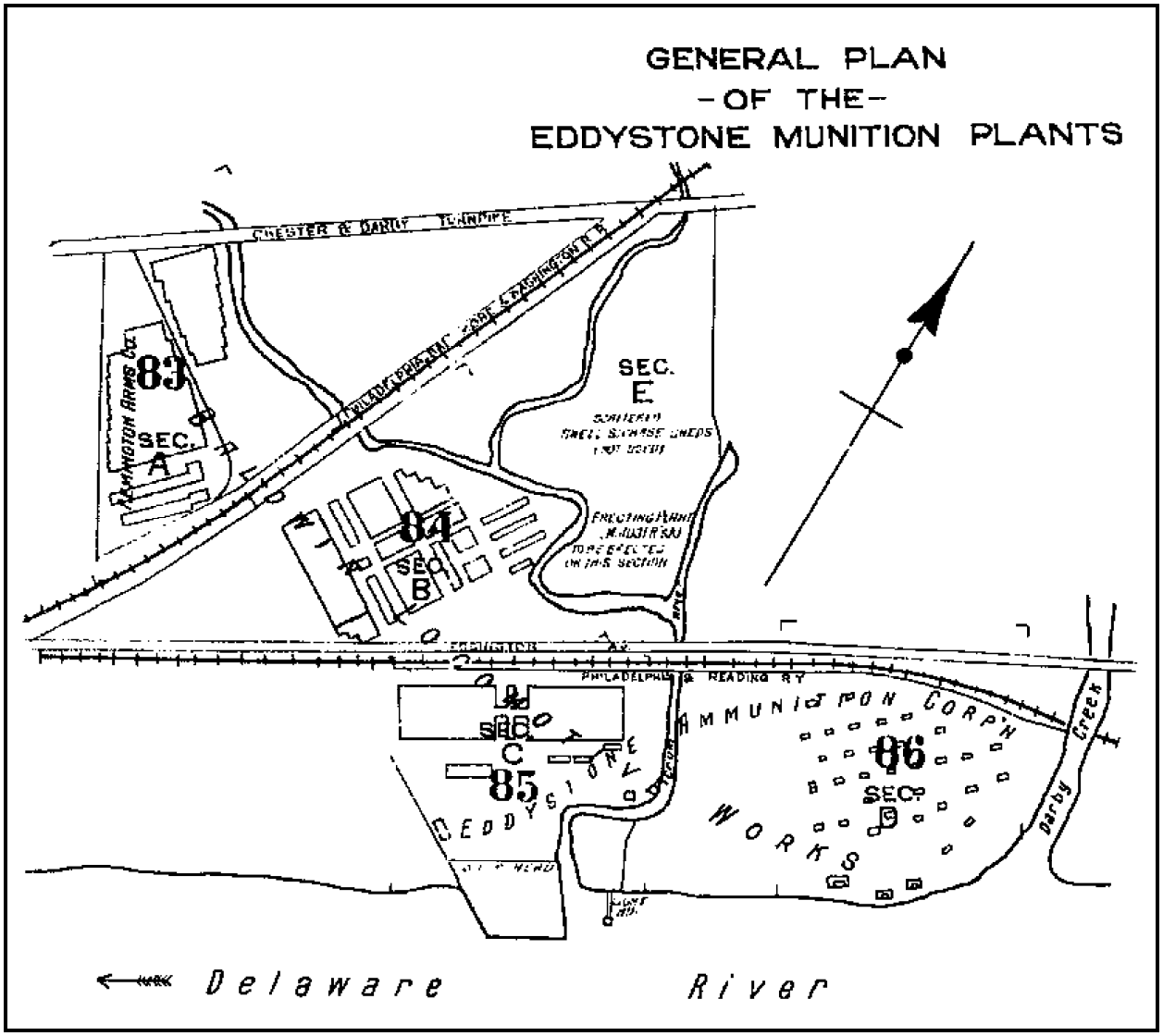
By the end of the war, Eddystone had completed its orders for 75mm shrapnel shells having forged 769,961 and machined another 750,000. It had also machined 190,000 high explosive shells out of an order for one million which was cancelled at war's end.[25] Eddystone also filled contracts for large quantities of ammunition components and made 475,000 6 inch high explosive shells for Britain.[26] All production ceased on December 31, 1918.[27]



Milling primers at the Eddystone munitions plant

Library of Congress

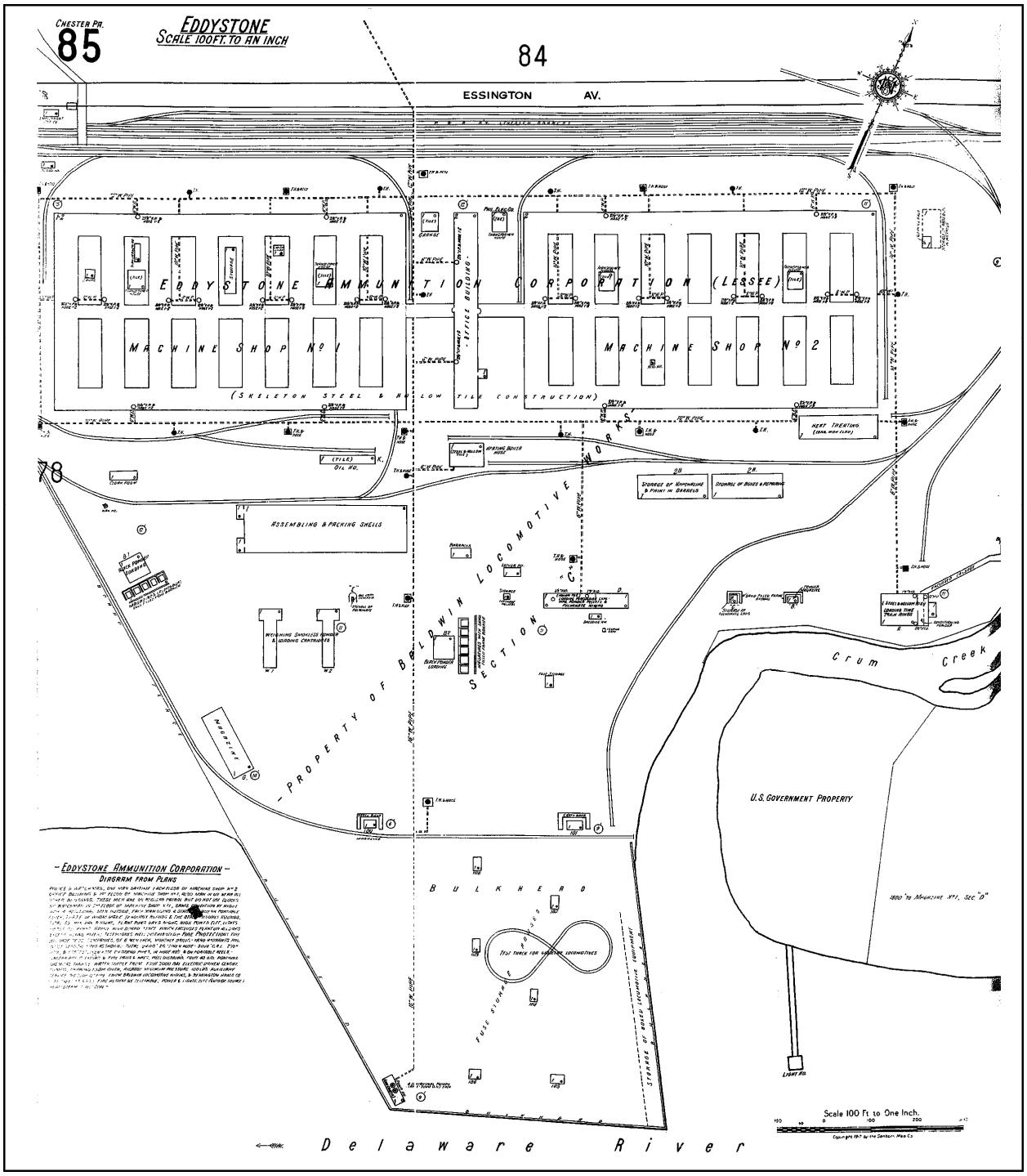
Several U.S. manufacturers combined to make a total of over 14.7 million 75mm shells. Large quantities of other calibers were made as well, but the war ended before any were used in combat. U.S. artillery units fought with French guns and ammunition. This does not mean U.S. artillery munitions had no impact on the war. Some of the U.S.-made ammunition had arrived in France and the certainty of continued supply meant allied commanders could be generous with artillery fire in the final offensives of 1918.



Eddystone Munitions Plants

All facilities were on the grounds of the Baldwin Locomotive Works - rifle factory (83), locomotive shops (84) ammunition plant (85) and ammunition storage area (86).

The Eddystone ammunition facilities were located just south of the present Hwy 291 Industrial Highway and extended to the Delaware River. The ammunition plant was on the site now occupied by an Exelon power generating plant. For safety reasons, completed shells were stored east of the plant in dispersed structures. This ammunition storage area was on the site now occupied by Boeing. A Walmart now stands in the center of the former rifle factory grounds.



Ammunition Plant, 1917 [28]

Note labeling as *Eddystone Ammunition Corporation* - plant was renamed *Eddystone Munitions Company* on Sept 27, 1917, after the government acquired its machinery.[29] The ammunition storage area to the east of Crum Creek is labeled as *U.S. Government Property*.

BIBLIOGRAPHY

Alford L.P., et al. Manufacture of Artillery Ammunition. New York: McGraw Hill, 1917.

Baldwin Locomotive Works. History of the Baldwin Locomotive Works, 1831-1920. Philadelphia: Baldwin Locomotive Works, 1920.

Crozier, William, Major Gen. Ordnance and the World War: A Contribution to the History of American Preparedness. New York: Charles Scribner's Sons, 1920.

Crowell, Benedict. America's Munitions 1917-1918: Report of Benedict Crowell ,the Assistant Secretary of War, Director of Munitions. Washington D.C.: Gov't Printing Office, 1919.

Environmental Data Resources (EDR), Inc. Fire insurance maps of Eddystone Munitions Plants,1917 (Sanborn certified). Obtained from EDR, Inc., Shelton CT, courtesy of Ron Spencer, Environmental Management Group (EMG), Edgemont PA

Hamilton, Douglas T. Shrapnel Shell Manufacture. New York: Industrial Press, 1915.

Kenney, Janice E. The Organizational History of Field Artillery 1775-2003. Washington: U.S. Army Center of Military History, 2007.

New York Times, April 11,1917.
http://query.nytimes.com/mem/archivefree/pdf?res=9805E2DE153AE433A25752C1A9629C946696D6CF

"Passion & Compassion 1914-1918" website, permission was received for use of images
http://www.passioncompassion1418.com/english_plateforme.html

U.S. Ordnance Dept. Handbook of Ordnance Data, No. 1861. Washington: Government Printing Office, 1918.

_____. Handbook of the 2.95-Inch Mountain Gun and Pack Outfit, No. 1761. Washington: Government Printing Office, 1916.

_____. Handbook of the 75mm Gun Materiél, No. 1819. Washington: Government Printing Office, 1918.

Williams, William Bradford. Munitions Manufacture in the Philadelphia Ordnance District Philadelphia, Pa: A. Pomerantz & Co., Printers, 1921.

ENDNOTES

1 New York Times April 11,1917 extract provides additional details of the plant:

The loading plant consisted of three divisions, one of them the "pellet" room in which girls made the black powder fuses running through the centre (sic) of the shrapnel shells; the second being the loading room, in which the first explosion was thought to have occurred, and the third the inspection room, where the finished shells are passed on by experts.

It was the system to employ only about thirty girls in the pellet room, but about two weeks ago the force was increased to nearly a 100 (sic), so as to rush the work on a large consignment of shells, which was to be sent to Russia in a few days. Although exact figures are hard to get, it is said there 175 men in the loading room yesterday, and about 150 in the inspection room.

2 The 76.2mm (3 inch) ammunition was mainly used in the Russian M1902 field gun among a few others.

3 Baldwin, p.127

4 This arrangement was a forerunner of the GOCO (government owned, contractor operated) model used extensively in World War II.

5 The 75mm guns and French Schneider 155mm howitzers were the standard artillery pieces in a U.S. division.

6 Alford, p.119 -. The Russian 7.62mm shrapnel shells contained 250-265 balls each weighing 6 drams[.75 oz.].
U.S. Ordnance, p.44. - The French 75mm shell had 300 balls each weighing 12 grams [.42 oz.].

7 It was difficult to strike troops in trenches with shrapnel and it was practically useless against any building or fortification providing overhead cover. Shrapnel had a relatively low velocity and usually could not penetrate a steel helmet.

8 U.S. Ordnance, Data, p.174.

9 U.S. Ordnance, Data, Table 17, p.154

10 U.S. Ordnance, Mountain Gun, p.22.
U.S. Ordnance, Data, p.167, states since the existing U.S. fuze was "very satisfactory " the French pattern was not adopted
Crowell, p.121, asserts the superiority of the U.S. fuze.

11 Fixed artillery ammunition is analogous to a small arms cartridge. Larger caliber artillery uses semi-fixed cases or separate loading bag charges that allow for varying the propellant to achieve different ranges.

12 U.S. Ordnance, Data, p.140.

13 U.S. Ordnance, Data, p.140.

14 U.S. Ordnance, Data, p.140.

15 Crowell, p.124

16 Crowell, p.120.

17 Alford, 555, 557.

18 Baldwin, p.129.

19 U.S. Ordnance, Data, Table 16 facing p.138, and p.151

20 Crowell, p.122. Nearby filling plants included six in New Jersey, one in Pennsylvania, and one in Wilmington, Delaware. Eddystone's production figure for high explosive shells includes gas shells. Gas shells were filled at Edgewood Arsenal, Maryland.

21 U.S. Ordnance, 75mmm Gun, p.22.

22 U.S. Ordnance, Data, p.140.

23 Baldwin, p.130.

24 Baldwin, p.130.

25 Crowell, p.130.

26 Baldwin, p.128-129. Production of 6 inch shells reached a maximum of 4,200 shells per day.

27 Baldwin, p.130.

28 EDR fire insurance map 85. Under magnification, some specific manufacturing activities can be deduced.

29 Baldwin, p.129-130.