THE EVOLUTION OF THE AMERICAN

MODERN LIGHT FIELD GUN

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CHAPTER I

INTRODUCTION

The object of this thesis is to trace the development of the American modern light field gun, also known as the light divisional gun, from its rudimentary beginnings after the American Civil War through the time the gun was phased out of the Army inventory in the early stages of World War II. The era of the modern light field gun encompasses a period of changing tactical doctrine, profound improvements in ordnance technology and the development of radical new weapons and materiel. The technology used in the development of this gun resulted in the modernization of all field artillery, and many of the basic design characteristics are still in use today.

The modern light field gun was characterized by its relatively small caliber, high mobility and capacity to fire as many as twenty rounds of ammunition per minute at long ranges. It was a flat-trajectory weapon capable of being used in either direct fire or indirect fire. Throughout the period of its use, it continued to have one tactical purpose: to provide direct support to attacking or defending infantry in the form of firepower as a component of combined arms.[1]

In the early era of the modern light gun, the guns closely accompanied the supported infantry and attacked enemy personnel and artillery

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[1]The term "direct support" has a special meaning to field artillery. It is a mission of providing dedicated support to one designated infantry unit to assist that infantry unit in accomplishing its mission.

by means of direct fire; that is, the gun was aimed directly at the target by the gunner. Improvements in methods of fire control and adoption of indirect fire techniques allowed the guns to be placed in defilade behind the supported infantry. By taking advantage of terrain and concealment, the guns could be hidden from enemy artillery fire and long range small arms fire. As communications and fire control procedures and equipment improved, artillery tactics were modified, but the primary mission remained the same for the light field guns: support the infantry. In this role, the light field guns were always associated with the most active part of the battlefield.

Because of the importance of having the best possible weapon for the support of the infantry, the evolution of the modern light field gun was dynamic and reflected the complex processes underlying the evolution of modern battlefield capabilities. This same dynamic process had also occurred in the evolution of the early light gun when it was first employed.

Light field guns originated during the fifteenth century when small cannon were mounted on wheeled carriages to provide tactical mobility. These early guns were made of bronze, brass or cast iron and fired round stones or iron projectiles. The maximum range of the early guns with round shot was about 1,500 yards and the maximum effective range (that range which gave any reasonable assurance of accuracy) was about 500 yards. Because these guns were smooth bored, they could also fire grape shot and cannister (collections of shot packed respectively into bags or thin metal containers) which were very effective against personnel out to about 300 yards.[2]

The early field guns were used to protect infantry against attacking cavalry and infantry formations, and were relagated to a lesser role than cavalry or infantry in combat. Gustavus Adolphus changed that tactical philosophy in the early seventeenth century. Until that time, formations of pikemen and musketeers had dominated the battlefield. Gustavus Adolphus developed a light mobile field gun which could keep pace with his infantry and was responsive to the tactical situation. He used his mobile field guns to attack and break up the heavy infantry formations while his cavalry simultaneously attacked the less mobile enemy artillery. When the enemy formations had been properly demoralized and disorganized by being raked by round shot and grape shot at close range, the infantry successfully attacked.[3]

These tactics were soon adopted throughout Europe by other commanders. Frederick the Great, for example, carried the tactical use of field guns even further than had Gustavus Adolphus by massing the guns in front of his advancing infantry to create gaps in enemy formations. When a break in the enemy lines was created by the artillery fire, Frederick exploited the advantage with a cavalry charge followed by infantry.[4]

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[2]John M. Patrick, Artillery and Warfare During the Thirteenth and Fourteenth Centuries, (Logan, Utah: Utah State University Press, 1961), passim; see also Henry W. L. Hime, The Origin of Artillery, (London: Longmans, Green and Co., 1915), passim. The technical methods of manufacturing cannon in the early sixteenth century are described in detail in Vanoccio Biringuccio, The Pirotechnia of Vanoccio Biringuccio, Trans. Cyril Stanley Smith and Martha Gnudi, (New York: The American Institute of Mining and Metallurgical Engineers, 1943).

[3]Michael Roberts, The Military Revolution, (Belfast: Majory Boyd, 1956), passim; see also Henry W. L. Hime, Stray Military Papers, (London: Longmans, Green and Co., 1897), pp. 106-11.

[4]Jay Luvaas, (ed. and trans.), Frederick the Great on the Art of War, (New York: The Free Press, 1966), pp. 159-63 and 176-200.

Improvements continued to be made in the tactical use of artillery. Jean Baptiste Gribeauval, for example, reorganized the French artillery to make it more responsive to the commander, and incorporated the use of the horse with light field guns in action to provide speed and mobility. He also made some changes in the design of French guns, but he made no technological advances. His changes in design emphasized lightness, mobility, and rapid responsive support on the battlefield.[5] Napoleon Bonaparte used Gribeauval's reforms and added his own innovations to make his field artillery the most effective arm of his army. He used the advantages of speed and mobility to attack the enemy at close range with field guns and exploited the success of firepower with cavalry and infantry attacks.[6]

Throughout this 300 year period, however, the light field gun remained virtually unchanged.[7] The famous twelve pound field gun, which was called the "Napoleon" after its designer, Louis Napoleon, and used by many European countries and the United States, is a typical example of the field guns used throughout this period. The gun tube was made of either brass or cast iron, had a smooth bore, and was about 4.6 inches in caliber.[8]

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[5]David G. Chandler, The Campaigns of Napoleon, (New York: The MacMillian Co., 1966), p. 138; see also H. C. B. Rogers, A History of Artillery, (Secaucus, N J: The Citadel Press, 1975), p. 58.

[6]Chandler, Ibid., pp. 356-63; see also Theodore A. Dodge, Napoleon, (New York: Houghton, Mifflin and Co., 1904), pp. 13-18.

[7]Field Marshal Viscount Montgomery of Alamein, A History of Warfare (New York: The World Publishing Co., 1968), p. 227; see also J. R. Hale, "International Relations in the West: Diplomacy and War", The Renaissance, 1493-1520, Vol. I, The New Cambridge Modern History, G. R. Potter, Ed. (Cambridge: The University Press, 1971), p. 278.

[8]The caliber of a gun is stated either by the measured diameter of the bore, or by the weight of the projectile.

The gun tube was six feet long, and when made of cast iron, weighed about 1,200 pounds. It was mounted on a heavy, wrought-iron reinforced wooden carriage, about six feet wide. The carriage had two large-diameter, iron-rimmed wheels with wooden spokes. The carriage was supported to the rear by a wooden trail. In the travel configuration, the trail was hooked to a limber pulled by horses.

In action the gun could fire solid shot or explosive shells to a maximum range of about 1,600 yards, or canister shot to a maximum effective range of about 400 yards. The gun was a muzzle loader, and in loading, a charge of two pounds of gun powder was pushed from the muzzle down the bore to the breech, followed by wadding, then the projectile was loaded and rammed, followed by more wadding to hold it in place. The gun was aimed by open sights above the gun tube. Elevation was adjusted by turning a hand-screw which raised or lowered the breech. Traverse was accomplished by manually shifting the trail laterally with hand spikes. When the gun fired, it rolled back in recoil and had to be pushed back into position, or "battery". It was also necessary to swab the bore with a wet sponge on the rammer staff between rounds to extinguish any sparks before loading, and to clean the powder residue out of the bore. In spite of all the activity required to service the gun between rounds, a well trained section of cannoneers could fire about two aimed shots per minute.[9]

Early in the nineteenth century, field guns began to lose their dominance in the offensive role because of improvements in small arms. Rifling and other improvements in small arms began to increase the effective

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[9]Curt Johnson, Artillery (London: Octopus Books Limited, 1975), pp. 10-11; see also Harold L. Peterson, Round Shot and Rammers (Harrisburg, PA: Stackpole Books, 1969), p. 119.

range of infantry fire power beyond 200 yards, and when the Minie bullet was introduced in 1848, the effective range of the rifled musket was increased to 500 yards. With this increased range in small arms, cannoneers were subjected to enemy fire before they could bring their guns into action at effective artillery range. In order for the field artillery to maintain a supporting role as a part of combined arms tactics, it was necessary to increase the effective range of the field guns beyond small arms fire. These increased ranges and other vital materiel improvements were soon forthcoming with the phenomenal growth in ordnance technology in the last half of the nineteenth century. These improvements were manifest in the development of the first modern light field gun, the French Model 1897 quick-firing 75 millimeter gun.

CHAPTER II

THE FIRST MODERN LIGHT ARTILLERY SYSTEM: THE FRENCH 75 MILLIMETER PUTEAUX FIELD GUN, MODEL 1897

The period between the Franco-Prussian War (1870) and the hostilities of World War I (1914) was one which produced many changes in artillery weapons and ammunition. Due to advances in weapon technology, the development of modern artillery was almost inevitable; it was only a question of which country would successfully piece together the developments into one system. France was the first country to accomplish this, and one of the most important reasons for this accomplishment was the humiliating defeat she suffered in the Franco-Prussian War.

During this war, the French artillery was hopelessly outclassed by Prussian breech loading rifled artillery, but it still gave a good account of itself by tactical mobility. However, the French learned an enduring lesson about the lethality of massed artillery in the battle of Sedan (1 September 1870), in which the Prussians trapped MacMahon's army in a valley surrounded by hills offering superb tactical advantage to the Prussians. In order to maximize the effects of artillery fire, the Prussians massed their artillery on the overlooking hills and began to fire on the French army. Each time the French tried to break out of this entrapment, their formations were torn by devastating artillery fire. Eventually, the Prussians had about 600 guns in action. The French had no choice but to surrender an army of over 100,000 men to the Prussians.[1] The devastating

[1]Michael Howard, The Franco-Prussian War (London: Rupert Hart-Davis, 1962), pp. 203-23; see also A. Borbstaedt and F. Dwyer, The Franco-German War (London: Asher and Co., 1873), pp. 578-652.

effect of massed artillery fire left a lasting impression on the French military mind.

At the end of the Franco-Prussian War, most of the French artillery had been captured or confiscated as war reprisals. This was a blessing in disguise, for it forced the French to manufacture new artillery, using the latest technology in metals and artillery developments. Because of this, and an aggressive rearmament program, by 1897 France was in a position of leadership in artillery. At this time, France produced the first modern artillery system, the French 75 millimeter quick-firing field gun, Model 1897. This gun became the model for the light field gun for most western armies, including the United States. But it was France who first brought the significant developments in ordnance technology together to produce the modern light field gun.

PREREQUISITE TECHNOLOGICAL DEVELOPMENTS

In considering the development of the modern light field gun, five primary areas of progress must be discussed: the development of smokeless powder as propellants, the perfection of breech loading systems, rifling and improvement in cannon tubes, development of fixed ammunition, and development of recoil systems. Although each of these technological developments will be addressed individually, it is important to recognize that they were all concurrent, interrelated and interdependent. When combined into a complete weapon system, a dramatic new advance in artillery was accomplished.

Development of Smokeless Powder Propellants

From its very beginnings, artillery was characterized by noise, flash and smoke. Of these three, smoke inherently caused many problems for cannoneers, especially as mobility and counterbattery tactics developed. Persistent smoke often obscured the battlefield and targets from the gunners. Smoke also prevented the gunner from seeing the effects of his shot, making the adjustment of fire difficult. There were attempts in the late eighteenth century to correct this problem by adding ingredients to the gunpowder, but none were successful.[2]

Nineteenth century chemistry, like contemporary disciplines, began to expand with new discoveries, one of which was the nitrogen-based explosives. This development began when Braconnot of Nancy, France, discovered in 1832 that wood or plant fibers treated with nitric acid produced rapidly combustible compounds. From that time through 1886, many unsuccessful attempts were made to adopt nitrogen-based compounds to use as artillery propellants, because these compounds were more powerful than gunpowder and produced little smoke. Progress toward smokeless powder continued with the work of a French chemist, Paul Vieille, who developed the first dependable nitrocellulose propellant for military use. In 1886, he developed a manufacturing method which made the compound stable and predictable in the burning process.[3]

Alfred Nobel soon capitalized on the process developed by Vieille, and carried the process even further by adding nitroglycerine to the product, producing what is known as a double based propellant. Nobel patented this compound in 1888 as a smokeless powder called "Ballistite". By 1894, almost every European army was using smokeless powder in small arms and as artillery propellants.[4] The significant factors of smokeless propellants

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[2]Oscar Guttman, The Manufacture of Explosives, I (London: Whittaker and Co., 1895), pp. 17-18.

[3]Ibid., p. 22.

[4]Ibid., pp. 22-23.

were that they eliminated smoke, significant residue, and more importantly, their burning characteristics allowed the re-design of artillery tubes to make them lighter yet capable of greater ranges than with gunpowder.

The burning rate of gunpowder (also known as "black powder") is very rapid, achieving a peak pressure in the gun bore shortly after the initial inertia of the projectile has been overcome and it begins to move down the bore. Because the burning rate was so fast and accompanied by high breech pressures, there was only a certain time that the projectile would be accelerated by the burning gases, consequently, short, heavy-breeched gun tubes were designed around the burning characteristics of gunpowder. With the advent of smokeless powders, it was found that by forming the powder granules into certain shapes, the burning rate could be controlled. By slowing the burning rate of the powder, a relatively consistent force by the propellant gases efficiently accelerated the projectile through the cannon bore, resulting in higher muzzle velocities and greater ranges of the projectile. The smokeless powders required only about half as much volume as gunpowder in the breech to achieve the same ballistics, consequently the breech size was reduced in tubes designed for smokeless powders. The overall result was a lighter, longer tube which gave better firing capabilities.[5]

Development of Breech Loading Systems

Although muzzle loading cannon were used almost exclusively from the fifteenth century to the mid-nineteenth century, most artillerymen

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[5]F. W. Barker, "Modern Gunpowder and Cordite", Minutes of Proceedings of the Royal Artillery Institution, XX (Woolwich: The Royal Artillery Institution, 1893), pp. 269-91; see also Theodore C. Ohart, Elements of Ammunition (New York: John Wiley and Sons, Inc., 1946), pp. 21-29.

realized that safer guns with increased rates of fire could be made if breech loading were perfected, but experiments continued to prove that it was beyond the technology of the time.[6]

In 1845, Cavalli of Italy developed a moderately successful breech loading gun. His success was soon followed by Wahrendorff of Sweden, who produced a breech loading gun in 1846.[7] In 1854, William G. Armstrong of England produced a gun which combined the best features of the Cavalli gun and the Wahrendorff gun. After testing the Armstrong gun, the British army adopted nine pound and twelve pound versions of this gun.[8]

At the time that Armstrong was perfecting his gun, Krupp Industries of Germany began developing a breech loading cannon. Basically, Krupp used a solid block of steel which slid horizontally through a mortised hole in the breech of the tube. As with the Armstrong breech, the Krupp breech had problems with rearward obturation since the breech parts wore through use.[9] As long as gun powder continued in use, small gas leakage at the breech did not present great problems. A small amount of leakage could be tolerated because of the relatively low pressures generated by gun powder and the large volume of powder required to move the projectile. Breech obturation

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[6]There was an inherent problem with muzzle loading weapons with respect to safety. In the excitement of battle, a second charge could be loaded on top of a previously loaded, unfired charge. This was called "double charging" and the gun usually blew up when fired. Breech loading prevented "double charging".

[7]James P. Kelly, Field Artillery Materiel (Columbia, MO: University Co-operative Store, University of Missouri, 1920), p. 21.

[8]H. C. B. Rogers, A History of Artillery (Secaucus, NJ: The Citadel Press, 1975), p. 96; the British army classified smaller artillery by projectile weight rather than by diameter size.

[9]Ian Hogg and John Batchelor, Artillery (New York: Charles Scribner's Sons, 1972), p. 11; Obturation is a term meaning the effective sealing of propellant gases within an artillery tube until the projectile leaves the bore.

was especially important with the use of smokeless propellants because they generated higher pressures over a longer period than did gunpowder, and required only half as much chamber volume to give the same velocity to the projectile. The leakage of propellant gases also eroded the metal around the leak, making it progressively larger. The loss of pressure from the leak caused unacceptable range deviation. This leakage, loss of pressure, and erosion of metal was a significant obstacle to the perfection of breech loading artillery.

One solution to the problems of breech loading was found to be the use of cartridge cases for the propellant. Krupp Industries began to use brass cartridge-encased propellants in their guns. The cartridge canister contained the precussion primer to ignite the propellant. Upon firing, the propellant gases expanded the brass cartridge against the wall of the tube and breech and made a gas-tight seal.[10]

The French approached the breech loading problem with a system different than the sliding breech used by Krupp. The French breech block used the principle of a screw-plug to seal the breech, called an interrupted, slotted screw breech. In essence, the breech block was a screw with threads cut away in slots corresponding to threads within the breech. The block was mounted on a hinge so that it could be swung open or closed, and when closed and rotated one-quarter of a turn, engaged the threads of the breech, and sealed the breech with great strength.[11] This system was designed to use either cloth-bagged powder or the cartridge case. When bagged powder was used, an obturator system with expandable pads or rings was used with the breech block. By 1885, most European countries had developed breech

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[10] Ibid.

[11] A. B. Dyer, Handbook for Light Artillery (New York: John Wiley and Sons, 1896), pp. 72-88.

loading artillery by using variations of either the sliding breech or the slotted screw breech. Both types are used on current artillery.

Improvements in Cannon Tubes

There were two major improvements in cannon tubes which were necessary for the development of modern artillery: the use of rifling, and the stress reinforcement of steel tubes for strength and lightness.

Rifling. The origin of the idea of rifling is unknown but there are records of rifling being used in small arms in Switzerland in the seventeenth century.[12] It was known that when spin was imparted to a projectile, better accuracy was achieved. Even with this knowledge, rifling in artillery was not attempted until the middle of the nineteenth century because of the mechanical difficulties involved. Therefore, as long as artillery remained smooth bore, the only projectile that could be used was spherical in shape. Spherical projectiles, or round shot, were inaccurate and ballistically inefficient. A tolerance between the projectile diameter and the tube bore was required to facilitate loading from the muzzle. This tolerance, or "windage", allowed considerable gas leakage in firing, reducing the velocity and the range of the projectile. This tolerance also caused unequal contact between the projectile and the bore during firing, and often imparted inconsistent spinning to the projectile which made it inaccurate.[13] Loss of range also occurred because air resistance on the round shot was greater than that of an elongated projectile of the same weight, but smaller in diameter.

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[12]Carl P. Russell, Guns on the Early Frontiers (New York: Bonanza Books, 1957), p. 101.

[13]C. H. Owen, Modern Artillery (London: John Murray, 1873), pp. 8-9.

The first recorded successful use of rifling in artillery was in 1846 with Cavalli's breech loading gun. The gun had two spiral grooves in the bore. The projectile had corresponding lugs which engaged the grooves when loaded, and the gun demonstrated good range and accuracy.[14] With these advantages, however, the Cavalli gun was still deficient in one aspect of rifling: it did not provide obturation around the projectile.

Wahrendorff, of Sweden, also used rifling in his breech loading gun, but he refined the process to provide obturation around the projectile which increased the efficiency of the propellant. The rifling that Wahrendorff used in his gun consisted of a series of fine grooves spiraling through the bore. The projectile was coated with a thin layer of lead, which engaged the rifling, imparted spin to the projectile, and sealed the gases behind the projectile. The gun was not successful because the lead tended to accumulate in the tube.[15]

Other inventors tried to perfect rifling in artillery. In England, Joseph Whitworth produced a gun in 1855 which had a hexagonal bore with a spiral twist to impart spin to a corresponding hexagonal projectile. It was moderately successful but was difficult to produce because of the machining process of making the hexagonal bore.[16]

In 1855, the United States Army experimented with rifled artillery in the form of a grooved gun. The experiments indicated potential for

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[14]Frank E. Comparato, Age of Great Guns (Harrisburg, PA: The Stackpole Co., 1965), p. 18.

[15]*Ibid.*

[16]E. W. Lloyd and A. G. Hadcock, Artillery: Its Progress and Present Position (Portsmouth: J. Griffin and Co., 1893), pp. 35-36.

rifling, and in 1860, a board of officers was appointed to study the experiments and make recommendations. The board recommended that at least half of the guns in the inventory be rifled to enable the firing of a heavier, elongated projectile. The project proved to be a failure, because the new projectile was heavier than the round shot, and the increased strain of firing ripped out the rifling and ruined a number of guns. The soft bronze used in these particular guns would not adapt to rifling.[17] With the advent of the Civil War, light rifled artillery gained importance. A wrought iron rifled gun was developed by the Ordnance Department and was known as the 3-inch Ordnance rifle. Another rifled gun design which became popular was the Parrot rifled gun. The Parrot design used a wrought iron band shrunk over the breech of a cast iron gun to reinforce it at the point where the propellant gas pressure was greatest. Both the Ordnance rifle and the Parrot rifle were accurate at long range and could engage targets as far as 2,000 yards, which made them effective counterbattery weapons.[18]

In England, the successful Armstrong breech loading gun also incorporated rifling and other improvements into the design. The rifling was the polygroove type which had a large number of shallow grooves around the bore, as in modern artillery. The projectile was iron and coated with lead to engage the rifling for spin and to provide obturation.[19] However, even in this type of rifling, the lead still tended to accumulate in the bore, which required frequent cleaning. Experimentation in rifling continued

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[17]William E. Birkhimer, Historical Sketches of the Artillery, United States Army (Washington: Thomas McGill and Co., 1884), pp. 284-86.

[18]Ibid.; see also Harold L. Peterson, Round Shot and Rammers (Harrisburg, PA: Stackpole Books, 1969), pp. 92-95.

[19]Lloyd and Hadcock, Op. cit., pp. 36-39.

for two more decades before a satisfactory solution to the obturation problem was found. It was found that if a soft copper band were substituted for the lead jacket on the projectile, the copper would not accumulate in the rifling as the lead did, and copper provided excellent obturation.[20] The Armstrong gun was the most advanced gun of its time in that it had a successful breech loading system, it used rifling and an obturating projectile, and was unique in another aspect: it was the first gun to be made with a reinforced steel tube. This was a significant improvement in gun tube design.

Stress Reinforcement in Cannon Tubes. The Armstrong gun made the first practical use of steel in a gun tube. The steel tube was not strong enough to withstand the pressures of the propellant and required reinforcement. This reinforcement consisted of a built up process in which an outer jacket of wrought iron was heated and cooled around the steel tube to make it stronger.[21] This built up process followed the stress reinforcing theory developed by Thomas J. Rodman, of the United States, but used component parts over a steel tube instead of the casting-cooling technique.

One of the earliest successful attempts at improving gun tubes was accomplished by Rodman in 1845. He developed the theory that while casting an iron gun, if the tube were cooled from the inside, or the bore, the contraction stresses of cooling would make the gun stronger. In practice, his theory was proven. Eventually a twenty inch smooth bore gun was made

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[20]Ibid., pp. 44-45.

[21]Ibid., pp. 36-39.

in 1864 which fired a 1,080 pound projectile, attesting to the strength of the gun. The Rodman process placed the United States in a position of temporary leadership in artillery technology until the steel tube came into use.[22]

Another method of reinforcing artillery tubes was the wire wound process which was developed after Armstrong used the built up process on his guns. In the wire wound process, a steel gun tube was prepared by anchoring one end of a flat, high tensile-strength ribbon of steel to the gun tube, and the steel wire was slowly and uniformly wound on the gun tube under constant heavy tension. As the winding continued, the compression on the gun tube induced by the constant tension of the wire had the same effect as the stresses induced by the cooling of a heated jacket forced on the gun tube in the built up process, or the internal cooling of cast iron guns by Rodman. The wire wound process often used miles of wire on larger guns. When the winding procedure was complete, a steel jacket was heat-shrunk over the windings to protect them.[23]

Of the three processes used to strengthen artillery tubes, the built up process came into general use in the United States and the continent of Europe, while the British seemed to prefer the wire wound process. The Rodman process of internally cooling cast iron guns became obsolete with the use of reinforced steel tubes. The built up process offered the advantages of simplicity and added longitudinal strength as well as circumferential strength to the gun tube, and was later used in almost all

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[22]Birkhimer, Op. cit., pp. 283-87; see also Peterson, Op. cit., pp. 101-04.

[23]Lloyd and Hadcock, Op. cit., pp. 76-77; for detailed study of wire wound processes, see Golden L'H. Ruggles, Stresses in Wire-Wrapped Guns and in Gun Carriages (New York: John Wiley and Sons, Inc., 1916).

light field guns. The wire wound process was not as popular in use because the process was complex and time consuming and did not provide longitudinal strength to the tube.[24]

Development of Fixed Ammunition

In 1525, the French began to make gun powder by a process called "corning", in which the powder is produced in a stable, granulated form. This process made possible the packaging of pre-measured powder charges into bags which made loading a cannon faster and easier. Gustavus Adolphus is credited with the first combination of gun powder and projectile into one unit. The powder was placed in a flannel bag, and the projectile was tied to the top of the bag. The fixed charges were transported in weatherproof wooden boxes.[25]

The use of bagged powder charges continued through the nineteenth century and is currently used today in separate loading modern artillery.[26]

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[24]Current field artillery tubes are strengthened by a process called auto-frettage which came into use in the United States shortly after World War I, and will be discussed later.

[25]Rogers, Op. cit., pp. 39-41.

[26]Artillery ammunition is classified by the loading configuration of the components. Separate loading ammunition is loaded by first ramming the projectile into the breech, then the propellant charge is loaded behind it. Next, the breech is closed and a percussion primer is inserted into the firing mechanism in the breech, which completes the loading of the weapon. This type of ammunition is generally used in medium and larger classes of artillery. Semi-fixed ammunition is that class which utilizes a metallic cartridge case containing a variable charge of propellant increments and has the percussion primer fixed to the cartridge base. The projectile fits loosely into the cartridge and can be removed to adjust the propellant charge. Semi-fixed ammunition is usually loaded as one unit in one simple operation. Semi-fixed ammunition is used in light artillery, primarily howitzers. Fixed ammunition uses a cartridge as in the semi-fixed class, but the propellant is not adjustable and the projectile is fixed rigidly to the cartridge. It is also loaded in one operation and is used in quick firing guns where fast loading is required.

The subdividing of the powder charge came into general use with the rifled muzzle loading guns used by the British until about 1885. Subdividing the charges for large guns facilitated loading as well as providing a means to vary ranges.[27]

By 1860, small arms ammunition had progressed to the use of metallic cartridges which incorporated the percussion primer, gunpowder and projectile into one unit. The metallic cartridge greatly increased the rate of fire for small arms by reducing the loading operation to one simple step. Artillerymen began to consider the use of this principle for artillery. By 1870, the French were using fairly large metallic cartridges in the Montigny mitrailleuse, a multi-barreled machinegun.[28] When smokeless powders caused obturation problems in the Krupp breech loading guns, Krupp adopted the metallic cartridge case to seal the breech. The next logical progression was to combine the cartridge case and projectile into a fixed unit to simplify loading operations. The French accomplished this when they developed the first quick firing gun in 1897.

Development of Recoil Mechanisms

Newton's third law of motion states that for every action, there is an equal and opposite reaction. Recoil in artillery is caused by the reaction of the mass of the projectile and propellant gases as they leave the cannon bore at a given velocity. Recoil has been a problem to cannoneers since cannon were first mounted on carriages. Recoil of the weapon with

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[27] Lloyd and Hadcock, Op. cit., pp. 213-15.

[28] Howard, Op. cit., p. 36.

each round required the cannoneers to re-emplace the cannon and "relay", or re-sight it on the target, a time consuming process and a source of errors. In the nineteenth century, solving the problems of recoil did not progress as rapidly as other technological advances. Until late in the nineteenth century, all field artillery cannon were allowed to roll back in recoil, usually for a distance from twelve to eighteen feet, then the cannoneers had to push the cannon forward again to be relaid. Any attempt to block the carriage from recoiling resulted in wrecked carriages because the carriage then absorbed the full force of recoil. Large platform guns, such as fortress and naval armament had been developed with various devices which absorbed recoil. The most successful of these recoil systems employed hydraulics, where the force of recoil was directed against a fluid and absorbed by movement of the fluid. These recoil systems were massive, but with permanent mountings, weight and size was not a limiting factor. This was not the case with the field artillery carriage which was limited by weight and size. Early attempts were made to check recoil in field artillery cannon by attaching cables to the carriage wheels and then to an arrangement of springs attached to the trail so that when the wheels rolled back in recoil, the springs were compressed. At the end of recoil, the springs moved the cannon forward. This was a clumsy arrangement which did not last.[29]

In 1873, Krupp began developing a combination of springs and hydraulic cylinders to absorb recoil. Instead of mounting the cannon directly on the carriage, a sliding cradle was used to allow the cannon to move

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[29]Rogers, Op. cit., p. 119.

rearward. It was coupled to the hydraulic cylinder and spring by a recoil rod. The recoil rod was attached to a piston with orifices so arranged that when the cannon moved in recoil, the piston was pulled through oil in the cylinder, forcing oil through the orifices, and thus absorbed the recoil. The action also compressed the springs of the system so that when recoil motion had stopped, the force of the springs returned the gun to the firing position (also called the "in battery" position). The system was called a short recoil system because movement was limited to about eighteen inches.[30] This system, although somewhat successful, still allowed the cannon to move out of lay, but this movement was minor compared to cannon without recoil systems. The French and British were experimenting with combinations of springs and buffers with moderate success at this time.[31] The major problem which prevented the development of successful hydraulic recoil systems on field artillery was that technology was not sufficiently advanced to perfect a reliable high pressure seal required for the rods and cylinders. By 1890, most European weapon manufacturers were trying to perfect a hydraulic recoil system for field artillery. The French succeeded in this project in 1897 with a long recoil system for their new 75 millimeter

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[30]The early short recoil systems were not as efficient as the long recoil systems developed after 1897. The short recoil systems placed more force of recoil on the carriage by stopping the movement of recoil in a short distance. The long recoil systems allowed more of the recoil force to be absorbed by the recoil oil over a longer distance and time, making the carriage more stable during recoil and return to battery. An analogy with an automobile may be used for comparison, in that much more braking force is required to stop the automobile in a short distance than a longer distance at a given velocity.

[31]Comparato, <u>Op. cit</u>., pp. 34-35.

light field gun. They considered the design of this recoil system a defense secret for over twenty years.[32] This secret will be discussed in Chapter 4.

DEVELOPMENT OF THE FRENCH 75 MILLIMETER GUN

Two tacticians correctly predicted the development of a light, quick-firing field gun. In 1891, General Wille of Germany in a book entitled, "The Field Gun of the Future", predicted revolutionary changes in artillery, to include quick-firing guns, recoil mechanisms, and improvements in ammunition.[33] In 1892, Colonel Langlois of France published a book with a similar prophesy.[34] In his book, "Field Artillery in Combination With Other Arms", Langlois used the term "rafale" (squall) for a sudden, intense, devastating artillery fire which he believed would give a decided tactical advantage on the battlefield.[35] To fire such a concentration of fire as Langlois described required a light, highly mobile gun which remained laid on target during firing and capable of firing a large number of rounds in a very short time. The only problem that prevented the development of such a weapon was the precise control of recoil during firing so that the

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[32]William J. Snow, Signposts of Experience (Washington: U.S. Field Artillery Assn., 1941), pp. 216, n. 2, and 239.

[33]Wilmot E. Ellis, "The Development of the Modern Field Guns", Journal of the United States Artillery, XVI, 2, (September-October, 1901), pp. 122-33.

[34]U.S. Army Field Artillery School, History of the Development of Field Artillery Materiel (Fort Sill, OK: Field Artillery School, 1940), p. 50.

[35]As cited in Gabriel Rouquerol, The Tactical Employment of Quick-Firing Field Artillery, Trans. P. De B. Radcliffe (London: Hugh Rees, Ltd., 1903), pp. 30-34; see also R. S. Ballagh, Jr., "The Seventy-Five, 1897-1914: Revolutionary Change in the French Field Artillery" (paper presented at the Tactics Conference/Inter-University Seminar Regional Meeting, 30 March 1978, Fort Leavenworth, Kansas).

gun remained laid on target from one round to the next. An answer to the problem originated in Germany.

In 1888, Konrad Haussner, a Krupp engineer, proposed the use of a long recoil system to Krupp. Haussner's idea was to extend the length of recoil to about forty inches to reduce the stress of recoil on the carriage. His proposals were rejected and he was subsequently dismissed. In 1891, he received a patent for his idea and he actually built a small gun for testing. During field trials in 1892, he encountered trail spade problems in hard ground and the gun failed the test. As a result, the German Army completely rejected the long recoil principle.[36]

The French soon received information about the long recoil tests in Germany and decided that this principle had possibilities in building a quick-firing gun as described by Langlois. Colonel Albert Deport was given responsibility for developing the gun. The development of the gun was based on the perfection of the long recoil system, which proved to be a major problem. Initially, bronze was used for the recoil cylinders, but the porous metal proved to be unsatisfactory. Steel recoil cylinders, which were much harder to machine, were substituted. Finally a workable gun was produced, but it had excessive movement in recoil. Work on the recoil system began again, this time under the direction of a noted hydraulic engineer, Sainte-Claire Deville. Deville completed the gun in 1897.[37]

The final product of the French effort made most other guns obsolete. The recoil mechanism was the feature that made the gun unique. It was a

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[36]Curt Johnson, Artillery (London: Octopus Books, Limited, 1975), p. 51.

[37]Comparato, Op. cit., pp. 36-38.

long recoil type, with the recoil mechanism housed inside the cradle. The recoil system consisted of two cylinders, parallel to each other, and interconnected at the breech end by a series of valves and a diaphragm. In the upper cylinder was a piston attached to a recoil rod. In the lower cylinder was a floating piston which separated the fluid from air which was pressurized at about 1,800 pounds per square inch. During recoil, the recoil rod pulled the piston of the upper cylinder rearward, forcing the fluid through the valves and diaphragm, imparting a braking action to the recoil. The fluid movement into the lower cylinder further compressed the air. At the end of recoil, the compressed air forced the fluid back into the upper cylinder, moving the piston and the gun back into battery.[38]

The gun tube was of the built up type, with a central steel tube reinforced at the breech with a steel hoop. The central part of the tube was covered with a bronze jacket. The gun tube was supported in the cradle by bronze slides which rested on the cradle and recoil mechanism. Rollers were attached in such a way that when recoil began, the slides moved back on the cradle a short way, and then the rollers raised the gun tube and carried it through recoil, providing smooth movement of the tube through the recoil cycle. The breech block was the Nordenfeld type, cylindrical in shape, threaded on the outside, and screwed into the breech ring. A large notch was cut through the breech block which was mounted off-center. The mechanism opened by turning the handle 120 degrees which exposed the

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[38]U.S. War Department, Office of the Chief of Ordnance, Handbook of Artillery (Washington: Government Printing Office, 1920), pp. 86-90; see also American Expeditionary Forces Booklet No. 1402, Samur Artillery School, France, Manual of Artillery, II, and supplement, "The 75 mm Gun 1897 Model (French)" (Paris: Imprimerie Nationale, 1918).

breech for loading. A cartridge of fixed ammunition was inserted into the breech and a reverse motion closed the breech block. Loading could be accomplished by a skilled crew in about two seconds.[39]

The gun carriage was stabilized in a three point suspension system using the wheels and trail spade. Each wheel had a brake which could be moved down to ground level and used as a chock. The emplacement operation, called "abatage", required the cannoneers to lift the trail to shoulder height and then drop the wheel brakes to ground level. Then the trail was dropped to dig in the sharp-pointed trail spade. The first round fired seated the spade into the ground, making the carriage very stable. The carriage was one of the first to employ on carriage traverse. It could be traversed through six degrees, which was significant for that period.[40] Older weapons required manually shifting the trail to traverse the gun.

The French army now had a field gun which could fire the "rafale" envisioned by Langlois on future battlefields. The gun was light weight, highly mobile and capable of both direct and indirect fire. French tactical doctrine was modified to maximize the capabilities and employment of this weapon, which they considered a decisive factor in combat. They envisioned a highly mobile battlefield dominated by quick-firing field guns and characterized by swift, violent combat of short duration.[41]

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[39] Ibid.

[40] Ibid., p. 83.

[41] Frederick Georges Herr, "Field Artillery: Past, Present and Future", Field Artillery Journal, XVII, 3, (May-June, 1927), pp. 222-28; During World War I, General Herr was named the Inspector General of the French Artillery. After the war, General Herr was president of a commission which reconsidered the role and functions of the French artillery. (Much like the Westerveldt Board in the United States in 1919, see Chapter 5); see also Ballagh, Op. cit.

This was the successful gun envisioned by Wille and Langlois, and it set the standards for world artillery. It also had a profound influence on the development of the American modern light field gun.

CHAPTER III

DEVELOPMENT OF LIGHT FIELD GUNS IN THE UNITED STATES FROM 1865 TO 1916

During the American Civil War, development of war materiel had proceeded at an intense rate, but rapidly declined as the war ended. In the post war period, most materiel appropriations went to the Navy or the emerging coast artillery because the seas and coast were considered the strategic first line of defense.[1] Less importance was placed on field equipment because of the large quantities of this materiel left over from the war.

In the years following the war, there was much disagreement over the recent improvements in artillery. In 1861, Robert Parrot devised a method to produce a rifled muzzle loading gun. He used the Rodman process of strengthening the cast iron tube by internal cooling, and then added a wrought-iron jacket to the breech for reinforcing, as used in the early built-up process. The gun fired an elongated projectile and was more accurate at longer ranges than the smooth bore guns. The Ordnance Department also produced a cast-iron rifled gun of 3-inch caliber which was accurate at long range.[2] Many of the old-school artillerymen felt that smooth bore guns were better because they were almost as accurate as rifled artillery at shorter ranges where most of the action occurred, and they could be

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[1]U.S. War Department, Report of the Chief of Ordnance, (Washington: Government Printing Office, 1873), pp. 6-7.

[2]William E. Birkhimer, Historical Sketch of the Artillery, U.S. Army, (Washington: Thomas McGill and Co., 1884), pp. 285-86.

loaded faster than the rifled guns. The results of the Franco-Prussian war, however, changed this line of thought and ended much of the debate.

The defeat of France in the Franco-Prussian War startled the United States, for much of its tactical doctrine and military equipment had been influenced by French ideas. German tactical doctrine and materiel soon became the model followed by many countries, and greatly influenced military thought in the United States. The Germans had very successfully used Krupp breech loading rifled artillery in the war, and the War Department became interested in artillery of this type. Experiments were begun in 1872, but progress was slow because of limited funds. The experimentation consisted of converting a Civil War 3-inch ordnance rifle to a breech loader by cutting off the solid breech of the tube and fitting a new breech mechanism to it. The new breech was the Krupp-type sliding wedge breech. The bore of the gun also had to be re-rifled so that the latest type of breech loading projectile could be used in it. As a result, the bore diameter increased from 3 inches to 3.18 inches. To handle the increased stresses of firing and mobility, a new steel carriage was designed for the converted gun. The conversion was completed in 1879, and the gun was found to be satisfactory by ordnance tests.[3] The gun was designated the 3.18-inch Breech Loading Chambered Rifle. Five more guns were converted during the period from 1880 to 1881, and the guns were redesignated as the 3.2-inch Breech Loading Rifle (Converted). After being thoroughly tested by ordnance

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[3]U.S. War Department, "Progress Report on the 3-Inch Breech Loading Rifle", Report of the Chief of Ordnance, 1879, (Washington: Government Printing Office, 1879), p. 179.

officers, these weapons were found to be sound and dependable, and were subsequently issued to the Field Artillery.[4]

During this time, the Army was also investigating the European built-up tube manufacturing process. In 1882, the Army recommended the development of an entirely new gun using a steel built up tube. Because the Krupp-type breech did not provide good obturation, ordnance officers decided to use the French-type screw plug breech which gave better obturation. The Army also decided to keep the caliber of the new gun at 3.2 inches in spite of proposals to increase the caliber to 3.5 inches to increase projectile weight. The abundance of 3.2-inch ammunition governed this decision. In 1883, two experimental 3.2-inch breech loading field guns were built. Each gun had a different breech; one used the DeBange obturator, the other gun used the Freyre type.[5] Both guns were placed on

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[4]U.S. War Department, "Report of the Trial of the 3.18-Inch Breech Loading Chambered Rifle No. 774 With Experimental Field Carriage", Report of the Chief of Ordnance, 1880, (Washington: Government Printing Office, 1880), p. 249; see also "Construction Report of 3.20-Inch Breech Loading Chambered Rifles", and "Construction of Field Carriage for 3.20-Inch Breech Loading Rifle With Description of Englehardt Carriage", Report of the Chief of Ordnance, 1881, (Washington: Government Printing Office, 1881), pp. 409-33.

[5]The DeBange obturator used a mushroom-shaped spindle which extended through the breech block into the chamber. The head of the spindle was on the inner face of the breech block. Between the head of the spindle and the breech block was an asbestos pad which was impregnated with tallow and paraffin. The shaft of the spindle was drilled through to provide an ignition channel into the chamber. When the breech was closed, a percussion primer was inserted into the spindle shaft and fired by a firing mechanism, sending an ignition flame into the propellant in the closed chamber. As the propellant ignited and generated gases, pressure forced the spindle head back into the asbestos pad which expanded laterally against the walls of the chamber, making a good, gas-tight seal.

The Freyre obturator worked essentially the same way. The difference was in the shape of the spindle head, which was flat with a chamfer on the back side, which fit into an expandable metal ring. When the propellant gases pressed on the spindle, it moved back slightly, causing the metal ring to expand outward, pressing against the chamber walls, also making a good seal. (For details and diagrams, see A. B. Dyer, Handbook for Light Artillery, (New York: John Wiley and Sons, 1896), pp. 72-88.

an improved steel carriage much like the older wooden carriages, but much stronger. Extensive tests were conducted on the guns in 1884, and the tests concluded that both prototypes were as good or better than any European gun at that time.[6] Consequently, in 1885, the Army ordered five guns from Watertown Arsenal with the Freyre obturator, and twenty guns from West Point Foundry with the DeBange obturator.[7] The twenty five guns were delivered by the end of 1887, tested, and with minor modifications, were issued to the Field Artillery. The gun proved to be good in service. It fired three types of projectile: explosive shell, cannister (filled with lead balls) and shrapnel (which combined lead balls with an explosive charge and time fuse, improving the antipersonnel effects). It had a maximum range of 6,631 yards with shell, and a maximum range of 4,500 yards with shrapnel. The elevation limits were from minus five degrees to plus twenty degrees. The muzzle velocity was 1,685 feet per second with the shell projectile, which was good at that time. The propellant was 3.75 pounds of bagged black powder.[8]

After the gun had been in service a short while, the Army ordered another seventy five guns from Watervliet Arsenal, all to be equipped with the DeBange obturator. The Freyre obturator had proven unsatisfactory in

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[6] U.S. War Department, "Partial Trial of a 3.2-Inch Steel Field Gun and Steel Gun Carriage by the Ordnance Board", and "Report of Manufacture of 3.2-Inch Breech Loading Steel Rifle at Watertown Arsenal", Report of the Chief of Ordnance, 1884, (Washington: Government Printing Office, 1884), pp. 141-42 and 509-37.

[7] U.S. War Department, Report of the Chief of Ordnance, 1885, (Washington: Government Printing Office, 1885), pp. xxii-xxiv.

[8] Dyer, Op cit., pp. 89-107; see characteristics and data at Appendix B.

service because the squared edge of the spindle was easily damaged while the breech was operated.[9] By 1890, there were 100 of the 3.2-inch Field Guns, Model 1885 in service.[10]

In 1890, the Army began to experiment with the tube of the gun to strengthen it to permit the use of smokeless powder, which was beginning to be used in Europe. A successful prototype tube was developed and designated the model 1890.[11] The new tube differed from the Model 1885 in that it was shorter in length, 7.31 feet as compared to 7.56 feet, and lighter, 794 pounds compared to 829 pounds. The jacket of the new tube was formed from one piece instead of four components of the jacket of the Model 1885. Internally, the chamber was not cut as deeply into the tube, and the sides of the chamber were made straight, for the future use of metallic cartridge cased ammunition.[12]

Studies were conducted by the Ordnance Department to determine the feasibility of using metallic cartridge cases, and they concluded that the configuration of the breech mechanism would not readily adapt to this ammunition without extensive redesign and modification. Concurrent studies of smokeless powders which were to be used in the cartridge ammunition found that the powder deteriorated rapidly in storage. Based on these findings,

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[9]U.S. War Department, Report of the Chief of Ordnance, 1889, (Washington: Government Printing Office, 1889), p. 24.

[10]U.S. War Department, Report of the Chief of Ordnance, 1890, (Washington: Government Printing Office, 1890), pp. 30 and 140.

[11]U.S. War Department, Report of the Chief of Ordnance, 1891, (Washington: Government Printing Office, 1891), pp. 16-17.

[12]Dyer, Op. cit., pp. 89-91.

the work toward smokeless powder and cartridge ammunition was dropped.[13] The inventory of 100 of the Model 1885 3.2-inch field guns was considered adequate for the Army's need. The occasional hostilities with the Indians had ended, and field artillery units stationed about the country had little to do but conduct training.

In 1898, with the advent of the Spanish-American War, the Army ordered 262 field guns of the improved Model 1890, none of which were delivered until after the end of the war. Four batteries of the 3.2-inch Model 1885 were shipped to Cuba, and saw action there. The only serious complaint against the guns in actual combat was that the black powder propellant produced so much smoke that the cannoneers had to wait a considerable time until the smoke cleared enough to relay the gun. This seriously impaired the combat efficiency of the artillery, and the enemy gunners could concentrate firepower on the guns as soon as their smoke was seen.[14]

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[13]U.S. War Department, Report of the Chief of Ordnance, 1897, (Washington: Government Printing Office, 1897), pp. 42-44; Although there were no references as to the reasons for redesign of the breech blocks to adopt metallic cartridges, there is a strong probability that the problem was a matter of safety. The breech block could have been adopted to the cartridge by removing the obturator spindle and replacing it with a firing mechanism having a firing pin to strike the primer in the cartridge base. There is an inherent danger in this type of breech, in that the firing pin is in alignment with the primer even when the breech is not locked by rotation. If the breech were closed with force, inertia of the firing pin could cause it to strike the primer and cause an accidental firing of the propellant, resulting in a blown-apart breech and possibly injured personnel. The problem was solved with eccentric breech blocks such as the Stockett and the Gerdom types which will be discussed later.

[14]U.S. Army Field Artillery School, History of the Development of Field Artillery Materiel, (Fort Sill, OK: Field Artillery School, 1940), pp. 51-52; see also C. D. Parkhurst, "The Artillery at Santiago", Journal of the United States Artillery, XI, 2, March-April, 1899, pp. 149-49, for a discussion on the tactical employment and organization of units using these guns, see U.S. Army, Light Artillery Drill Regulations, (Washington: Government Printing Office, 1891), passim.

The 262 new 3.2-inch guns, Model 1890, were delivered some months after the war had ended. By the end of 1899, the field artillery was equipped with the new gun, which could use smokeless powder. This solved the smoke problem encountered in Cuba.[15]

Even with the improvements in the 3.2-inch field gun, it was now an obsolete weapon. This was especially obvious when the American soldiers compared this gun to the modern Krupp guns that the Spanish had used against them in Cuba.[16] It was well known that European technology was concentrating on the use of hydraulic buffers and springs to absorb recoil and allow the carriage to remain in place as the weapon fired. Most light European guns were using metallic cartridge case ammunition which greatly increased the rate of fire. The old 3.2-inch field gun had to be re-emplaced and laid after each round, it could not be adapted to metallic cartridge cases and in all aspects was now inferior to European artillery. No one doubted that a modern replacement was needed for the 3.2-inch field gun.

After the Spanish-American War studies were conducted by a board of field artillery officers to determine artillery needs, which concluded that the size of artillery should be based on multiples of weight of the projectile. The lightest weight should be fifteen pounds, then thirty pounds, sixty pounds and finally one hundred and twenty pounds. The calibers of guns to fire these projectiles were recommended as 3 inches, 3.8 inches, 4.7 inches and 6 inches respectively.[17]

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[15] U.S. War Department, Report of the Chief of Ordnance, 1899, (Washington: Government Printing Office, 1899), p. 17.

[16] Parkhurst, Op. cit., pp. 173-175.

[17] Harry G. Bishop, Elements of Modern Field Artillery, 2d ed., (Menasha, WI: George Banta Publishing Co., 1917), p. 16.

In accordance with these studies, work began on the basic 3-inch gun in 1899. The Ordnance Board tested two new tube types. One was a built up tube, while the other was made from a single forging, which after being machined, was heat treated and then cooled from the inside to stress the tube, as in the Rodman process. Muzzle velocity was about 1,700 feet per second using smokeless powder. An improved shrapnel round was also developed for the gun. After the tube had been developed, a new type of carriage and recoil system were to be designed for the gun.[18]

The responsibility for designing the new 3-inch gun carriage was assigned to Captain Charles B. Wheeler, an ordnance engineer, in 1899.[19] The design, development and construction of the gun were all accomplished at Army facilities, with many of the rough-cast parts made by commercial manufacturers, and machined to fit at Ordnance facilities. Although the principle of the hydraulic buffer and spring recoil system of European guns was well known in the United States, there was no manufacturing expertise to rely upon, and progress was made on a trial and error basis. The basic design ideas were patterned after the field guns built by Schneider Industries in France. The first step in the project was to design an experimental short recoil carriage, designated the Model 1900. The short recoil system absorbed most of the gun's recoil, but still had sufficient movement to require it to be relaid after each round. It also had a very

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[18] Report of the Chief of Ordnance, 1899, Op. cit., pp. 17-18.

[19] U.S. War Department, "Report on Test of the Experimental 3-Inch Field Carriage Manufactured at the Rock Island Arsenal", Report of the Chief of Ordnance, 1901, (Washington: Government Printing Office, 1901), pp. 417-23; Captain Wheeler, later Brigadier General Wheeler, served as Acting Chief of Ordnance from December 1917 to April 1918.

limited on-carriage traverse of less than three degrees, which was hardly better than the Model 1885, in which the trail was shifted for traverse. This carriage became a test carriage for tubes, breech mechanisms and ammunition.[20]

Before work was completed on the Model 1900 carriage, Captain Wheeler began work on a design for an entirely new gun.[21] The experience gained in designing the Model 1900 and much of the engineering data computed for the gun were applied to the new design. The new gun, designated the 3-Inch Field Gun, Model 1902, was modern in every aspect. It employed an on-carriage long recoil system which absorbed all of the recoil shock of firing. The system used a hydraulic buffer cylinder to absorb the recoil, and an arrangement of coiled springs to return the gun to battery position. The gun had adequate traverse of eight degrees. The design also included the use of shields to protect the gun section from small arms fire. The development tests of the new field gun took place at Sandy Hook Proving Ground, New York, and at Rock Island Arsenal in 1903. The tests of the Model 1902 carriage were completely successful and the carriage was fully accepted; however, the tube design was rejected. Two more tubes were tested, one with a Gerdom breech mechanism and one with a Stockett breech mechanism.

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[20]Ibid.

[21]Although no research source could be found which gave reference to the change in design to long recoil, it is probable that the success of the French Model 1897 field gun had a great influence in this decision. The French gun, which used the long recoil principle, was beginning to be widely acclaimed about this time.

In late 1903, the test board recommended that the Gerdom breech be used with the gun.[22]

The initial requirement for the 3-inch field guns was for twenty six batteries (four guns per battery) for the Regular Army and six and one-half batteries for the National Guard, for a total of 130 complete guns and equipment sets. By the end of 1904, eighty four guns and equipment sets had been issued to the Regular Army and the remaining guns and equipment were issued in July, 1905.[23] The guns proved to be effective and satisfactory weapons in the hands of the soldiers.[24]

The gun fired a fifteen pound shrapnel projectile or an explosive shell with a muzzle velocity of 1,700 feet per second to a maximum range of 8,500 yards. However it had a maximum effective range of 6,500 yards because the single trail directly beneath the cradle prevented higher elevations that would give maximum range.[25] Ranges beyond 6,500 yards

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[22]Both of these breeches are screw-plug types, but designed for safety in use with metallic cartridge cases. This is accomplished by mounting the breech mechanism eccentric to the tube; that is, the breech mechanism is mounted so that its center is off-center to the axis of the bore of the tube. In the Gerdom breech, the breech block is eccentric to the bore and the firing mechanism fits into an eccentric cylinder centrally located in the breech block. The object of the design is to ensure that the firing pin is aligned with the cartridge primer only when the breech is closed and securely locked. The locking process turns the central firing mechanism into alignment with the primer. The Stockett design used only the eccentricity of the breech block to align the centrally located firing pin with the primer. This safety feature prevented accidental discharge of the cartridge. (See footnote 13.) For a complete report of the test and a technical description of the breeches, see U.S. War Department, "Report of Ordnance Board on Test of Field Materiel", Report of the Chief of Ordnance, 1904, (Washington: Government Printing Office, 1904), pp. 183-206.

[23]U.S. War Department, Report of the Chief of Ordnance, 1905, (Washington: Government Printing Office, 1905), pp. 30-31.

[24]William J. Snow, Signposts of Experience, (Washington: U.S. Field Artillery Association, 1941), p. 245.

[25]U.S. War Department, Office of the Chief of Ordnance, Handbook of Artillery, (Washington: Government Printing Office, 1920), pp. 118-120.

could be achieved by digging a hole for the end of the trail to sink into, which allowed a higher elevation to be fired, but this was dependent upon time available in action and the condition of the ground.

After 181 guns were made on the original design of the Model 1902, the slotted sections of the interrupted screw breech were increased from two to four, which made it easier to manufacture. This became known as the Model 1904. After forty more guns had been manufactured, experiments proved that better ballistics could be achieved by changing the twist of the rifling to the tube. The original rifling had a gain (increasing) twist from one turn in fifty calibers at the breech to one turn in twenty five calibers at the muzzle. The new rifling went from no twist at the chamber to one turn in twenty five calibers at the muzzle. This was known as the Model 1905 tube; it continued to be used until the gun was phased out of service. All three of the models were considered extremely serviceable weapons and were all commonly referred to as the Model 1902, since there were no changes in the carriage.[26]

Perhaps the most significant factor in the development of the Model 1902 field gun was that it was wholly an American product, inspired by the French, but not copied from their weapons. This fact alone did much for the morale and pride of the American artillerymen. The United States Army had a successful quick-firing field gun of its own that was equivalent to European artillery. Like the French Model 1897 field gun which was considered the best field gun in the world, the Model 1902 could be fired as quickly as the cannoneers could operate the breech and load the gun. With

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[26] Ibid., pp. 120-29.

a skilled crew, this could be as many as twenty rounds per minute.[27] The ranges of the two guns were comparable, although the French gun could be elevated four degrees higher than the Model 1902, which gave a slight advantage, but the Model 1902 had about two and one-half more degrees of traverse than the French gun. The major advantage that the French gun had over the Model 1902 was in the hydropneumatic recoil system, which had no steel springs to weaken in use.

Shortly after the development of the Model 1902 gun, events occurred which would make the gun obsolete by 1916. There was a problem with the field gun carriage design at this time, not only with the Model 1902 gun, but with European field guns as well. Almost all field guns used the traditional single trail on the carriage which limited the elevation of the gun to the space between the gun cradle and the trail. Because of this limitation, the gun could not be used to its full range capabilities. This single trail carriage also limited the traverse of the gun to about ten degrees or less, because of the vector angle of force on the trail during recoil. If the angle between the axis of the gun and the axis of the trail exceeded five degrees, the resultant force caused the carriage to shift, knocking the gun out of lay on the target.

In France, Albert Deport, who had worked on the French Model 1897 gun, developed a carriage which solved these problems of elevation and

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[27]For discussions on the tactical employment of this gun, see U.S. Army Infantry and Cavalry School, Tenny Ross, "Characteristics of the Three Arms", Course in Organization and Tactics, Lectures, (Fort Leavenworth, KS: Staff College Press, 1904), pp. 15-24; see also U.S. Army Infantry and Cavalry School, R. H. C. Kelton, "Artillery in Attack", Course in Organization and Tactics, Lectures, (Fort Leavenworth, KS: Staff College Press, 1904); and U.S. Army Infantry and Cavalry School, O. L. Spaulding, "Artillery in Defense", Course in Organization and Tactics, Lectures, (Fort Leavenworth, KS: Staff College Press, 1904).

traverse on field guns. It was called a split trail carriage because of the two trail beams which pivoted from the center of the axle and spread upon unlimbering the gun. These trails allowed the gun to be elevated to achieve its maximum range potential, and allowed a wide angle of traverse with stability during firing. The French Army, however, did not accept the carriage because of economy, so Deport sold the carriage to the Italians. The Italian Army tested the carriage and found it to be an excellent piece of equipment, and recommended the carriage highly to the United States Army. As a result of this recommendation, the Army brought the Deport carriage to this country for testing in 1913. Although there was controversy over the complexity of the split trail carriage, it was found favorable in Field Artillery Board tests and Ordnance Board experiments conducted between 1913 and 1916. The Field Artillery Board concluded that the advantages of high elevation and wide traverse were more significant than the disadvantage of a complex carriage. By 1916, a prototype carriage had been designed which provided forty five degrees of traverse and a maximum elevation of fifty three degrees. Also in 1916, a strong possibility existed that the United States would become involved in the war in Europe, and the Ordnance Department began to increase orders for war materiel. Included in this materiel build up was an order for 300 of these new split trail guns, to be designated the Model 1916 3-Inch Field Gun.[28] This order, in effect, put an end to the period of the Model 1902 field gun.

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[28]Oliver J. Spaulding, Notes on Field Artillery, 4th ed., (Leavenworth KS: U.S. Cavalry Association, 1918), p. 8 and pp. 74-75; see also Arthur R. Wilson, Field Artillery Manual, I, (Menasha, WI: George Banta Publishing Co., 1925), Chpt. XLVIII, p. 2; for a technical description of the Model 1916 gun, see Handbook of Artillery, Op. cit., pp. 65-76.

Although it was a good gun, the only occasion of hostilities involving the use of the Model 1902 gun was the American Punitive Expedition into Mexico in 1916. The Model 1902 gun was taken on the Expedition, but the elusiveness of Pancho Villa's forces never gave General Pershing occasion to use his artillery. When World War I began, the Model 1902 gun was used for training, but was never actually used in the war. After the war ended, the Model 1902 was taken out of the Army inventory. This ended the life cycle of the United States Army's first modern artillery weapon.

CHAPTER IV

THE PROBLEMS OF AMERICAN LIGHT ARTILLERY DURING WORLD WAR I

As World War I intensified in Europe, the possibility of United States involvement prompted Congress to pass the National Defense Act on 3 June 1916, which provided for the build up of the armed forces to a strength of about one million men, to be accomplished over a five year period.[1] To provide artillery for the build up of the Army, the Ordnance Department placed an order for 300 Model 1916 field guns although the new split trail carriage had not been thoroughly tested. The Ordnance Department assumed that any major design problems could be solved during initial production of the carriage.[2] This assumption was wrong, and the Ordnance Department later suffered much criticism because of it.

The initial order for the 300 Model 1916 guns was divided between Bethlehem Steel Company for ninety six weapons and Rock Island Arsenal, where the remainder were to be produced. Before production could begin, the tools, dies, and machinery had to be designed and manufactured. There were not many items at that time that were more complex in design than the

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[1]For a discussion and background of this mobilization, see Department of the Army Pamphlet 20-212, Marvin A. Kreidberg and Merton G. Henry, History of Military Mobilization in the United States Army 1775-1945, (Washington: Government Printing Office, 1955), pp 189-95.

[2]William J. Snow, Signposts of Experience, U.S. Field Artillery Association, Washington, D.C., 1941, pp. 208-09. This assumption was analogical to a general belief at that time that the industrial base of the United States could satisfy the demands of a national emergency in a short time.

Model 1916 gun carriage and there was no engineering experience in the production of such weapons. Production facilities had to be built, and production personnel trained to use the equipment, all of which required time. In May, 1917, after the United States had entered the war, 340 more guns were ordered from Bethlehem Steel Company, before any of the original ninety six guns were produced. Then in June, 1917, the French Military Mission advised the War Department to change the caliber of the light field gun from 3 inches to 75 millimeters to facilitate ammunition interchangeability. This was the first of many changes ordered by the Ordnance Department during the production of this gun, resulting in many delays and difficulties in the manufacturing process.[3]

One of the major problems in the manufacturing process of the Model 1916 gun was the requirement to design a new recoil system, or recuperator. Unlike the Model 1902 field gun which had a maximum elevation of 15 degrees, the Model 1916 gun could be elevated to 53 degrees to take advantage of the full range capabilities of the gun. With the long recoil system (which moved about 44 inches), the breech of the gun could strike the ground and damage the mechanism while recoiling at the higher evaluations. To solve this problem, a variable length recoil system was needed which would begin to progressively shorten the length of recoil as elevation increased, until the length was about twenty eight inches at maximum elevation.[4] The variable

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[3]Ibid.; Major General William J. Snow was the first Chief of Field Artillery appointed since the Civil War, and he held the position from 1918 to 1927. His personal efforts contributed much to the war effort, and he made many needed improvements in the status of personnel, training and materiel.

[4]Leslie E. Babcock, Elements of Field Artillery, (Princeton, NJ: Princeton University Press, 1925), pp. 192-94; see also James P. Kelly, Field Artillery Materiel, (Columbia, MO: The University Co-operative Store, University of Missouri, 1920), pp. 120-26.

length recoil system was then in use on the 6-inch howitzer, and it was assumed to be a simple matter of applying the same design to the Model 1916 recuperator. After the variable length recoil mechanism was developed, a major problem was encountered with the counter-recoil springs which returned the gun tube to battery position. Even after several design changes, the recuperator would not return the gun to battery at high elevation because the short recoil and the weight of the tube did not allow enough momentum to develop during counter-recoil. The state of metalurgical technology and engineering experience did not permit the production of a highly reliable spring that could be fitted into the recuperator.[5]

The problem of the recuperator soon became a major bottleneck in the production of the Model 1916 gun. The Ordnance Department had no expertise in this type of design, and the contractors had never been required to produce such a complex hydraulic component. Consequently, numerous design changes were issued after the original orders were placed, which required redesign of production equipment resulting in production delays.

In June 1917, the Ordnance Department placed an order for 400 Model 1916 guns with New York Air Brake Company, to be built without recuperators. Evidently, the thought behind this order was to have the gun completed and apply the recuperators to them as soon as the design problems were solved and mass production had begun. As late as December, 1917, with the recuperator problem still unsolved, another order for 2,927 Model 1916 guns, less recuperator, was placed with the Willis-Overland Company. As the

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[5]William Crozier, Ordnance and the World War, (New York: Charles Scribler's Sons, 1920), p. 236, Major General William Crozier was Chief of Ordnance in this period and held the position until December, 1917.

contractors began production of the carriage, more and more design problems became apparent. Some components could not be manufactured as specified. The original axle pintle was to be an elaborate forging, but this proved to be technically impossible. Castings were substituted, which proved unsatisfactory because the axle arms broke. Redesign of the pintle required redesign of related parts. The sight mechanism had so much loose motion that acceptable accuracy was impossible. The breech was changed to a vertical sliding wedge, and the trails required redesigning.[6]

The frustration of repeated failures in the design of the hydro-spring recuperator caused the Ordnance Department to step out of diplomatic channels and contact Albert Deport, originator of the Puteaux recuperator used on the French 75 millimeter gun. A contract was set up with Deport to design a hydropneumatic recuperator similar to the Puteaux design, for a sum of 60,000 dollars. The recuperator was to be designated the St. Chamond, to differentiate it from the Puteaux recuperator. The first St. Chamond recuperator was ready for testing in early 1918, and a Model 1916 carriage was sent to France for trials with the recuperator. By June, 1918, it was determined that the St. Chamond recuperator could withstand the firing tests, but in road tests, the Model 1916 carriage was torn to pieces. The Ordnance officers conducting the test requested sixty more carriages for testing, yet at that time industry had been able to produce only nineteen carriages.[7] Although the St. Chamond recuperator worked with the Model 1916 carriage, it was not an immediate solution to the problem because it had to be mass produced in sufficient quantities to complete the 3,967 guns which had been ordered.

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[6]Snow, _Op. cit._, p. 220.

[7]_Ibid._, pp. 238-41.

Production of the St. Chamond recuperator proved to be a manufacturing problem in itself. First, the original recuperator was handmade to the most exacting tolerances with a floating piston to prevent the mixing of the compressed air and hydraulic oil. The interior of the cylinder had to be polished mirror smooth. Secondly, because it was hand made, there could be no interchangeability of parts, precluding assembly line production. The Ordnance Department had to redesign the floating piston with seals allowing manufacturing tolerances instead of the close metal-to-metal fit of the original design. In addition to designing production equipment, it was also necessary to build a dustless factory at Rock Island Arsenal with filtered air and constant temperature and humidity. It was not until November, 1918 that the first recuperator was produced, almost concurrently with the Armistice.[8]

Meanwhile, the Ordnance Department realized that the St. Chamond recuperator was not going to be available within the immediate future, and an order was given to proceed with the manufacture of 3,000 hydrospring recuperators and then replace them with the superior St. Chamond recuperators when mass production occurred.[9]

The time between the initial Ordnance Department order for 300 Model 1916 guns and the time the first gun was actually produced in February, 1918, there were at least six major design changes to the carriage. Consideration was even given to changing the designation to Model 1918. Even after production had begun on the guns, the output was low, and none of these guns were shipped overseas for the war. As of 31 December 1918, six

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[8] Ibid.; see also U.S. War Department, "The Chief of Ordnance," War Department Annual Reports, 1919, I (Washington: Government Printing Office, 1920), p. 3912.

[9] Ibid., p. 222.

weeks after the war had ended, there had been only 249 of the Model 1916 guns produced out of the 3,967 guns ordered, and the majority of the unfilled orders were cancelled. These guns had all been produced with a marginal hydrospring recuperator which was later replaced by the St. Chamond recuperator and the gun was redesignated the Model 1916M1.[10]

Even with the hydropneumatic recuperator, the Model 1916 gun was far from satisfactory. Parts of the carriage often fell off during firing, and there was so much slack in the sights, elevating and traversing mechanism that the gun was unsafe to fire over the heads of troops.[11]

Although the Model 1916 was not a good gun, and the Ordnance Department received much criticism for its haphazard development, the principle behind the gun was good. Because of its capability of high elevation, it could achieve a range of 12,360 yards, almost double the range of the Model 1902 field gun, and almost 5,000 yards beyond the range of the French 75 millimeter gun. It could traverse through 45 degrees, and had a maximum elevation of 53 degrees.[12] In principle, its design was to be all-American, and with high elevation and wide traverse, it would have been tactically superior to any field gun at that time. This is one of the major reasons its development was so adamantly pushed by the Ordnance Department. With all its faults, the Model 1916 proved to be valuable because it proved, in principle, that the split trail carriage was feasible if properly developed. The Ordnance Department and industry gained valuable engineering and technological expertise in the manufacture of artillery in the development of this weapon. It also caused the Ordnance Department to develop procedures

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[10]U.S. War Department, Office of the Chief of Ordnance, Handbook of Artillery, Washington, Government Printing Office, 1920, p. 78.

[11]Snow, Op. cit., p. 238.

[12]Handbook of Artillery, Op. cit., pp. 69-70; see also Kelly, Op. cit., pp. 105-53 for a complete technical description and drawing of this gun.

and facilities to mass produce hydropneumatic recuperators, an important step in the improvement of all future United States artillery.

When the United States entered World War I in 1917, there were about 560 Model 1902 field guns in the Army inventory. With only 300 of the Model 1916 field guns ordered, and no estimate of delivery within a year, the United States was in a precarious position with respect to field artillery. To solve this problem, the United States bought 600 of the French 75 millimeter field guns from France to equip General Pershing's forces until the Model 1916 gun went into production. It was during this period that so many design problems with the Model 1916 became apparent, which cast serious doubts on its availability within a suitable time frame. When the recuperator problem became critical to the production of the Model 1916 gun, Colonel E. S. Hughes, Chief of Artillery Section, Ordnance Department Procurement Division, submitted a memorandum recommending cancellation of the contract with Willis-Overland Company for the 2,927 Model 1916 gun. He proposed that a contract be negotiated with that firm to produce the same number of French 75 millimeter guns, also without recuperators. The rationale behind the recommendation was that the French gun was a proven design, adaptable to production in the United States, and that it would be quicker and cheaper to produce than the Model 1916 gun. Meetings were held to discuss this recommendation and on 18 February 1918, the Willis-Overland Company was informed of the decision to manufacture the French gun.[13] When the Field Artillery School learned of the decision to produce the French 75 millimeter gun in the United States, they sent a memorandum to Major General William J. Snow, who had just been appointed Chief of Field Artillery.

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[13]Snow, Op. cit., pp. 225-228.

The School's position was that if a choice had to be made on production of an existing gun, then the choice should clearly be the American Model 1902 field gun equipped with a 75 millimeter tube. The School stated that in use, the Model 1902 had proven equal to, and in some aspects, superior to the French gun. They felt that the sighting system of the Model 1902 was superior to the French gun, and that at ranges greater than 4,000 yards it was more accurate. They also felt that the carriage was sturdier. The Ordnance Department opposed the use of the Model 1902 gun on the basis that the range of the gun was not as great as the French 75 millimeter gun and could be out-ranged in a counter-battery duel.[14] Work continued towards production of the French 75 millimeter gun.

With the initial purchase of the 600 French guns, the Ordnance Department had received drawings of the gun and recuperator from France to study the problems of maintenance and replacement parts. However the drawings were faulty and corrected drawings were not received until early 1918, when the decision was made to produce the French gun. It was not until then that a detailed study could be made of the manufacturing requirements.[15] To compound the problem, the French considered the Puteaux recuperator design a French defense secret. Not even their artillery officers knew the interior

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[14]Ibid., pp. 197-200. General Snow concluded after the war that one of the biggest mistakes made in gun procurement was the failure to put the Model 1902 back into production. See p. 245. No reference source could be found to indicate that an impartial comparison test had been conducted to determine the superiority of either gun. Undoubtedly, the French gun had the better recoil system and greater range capability. The School also made an assumption that changing the caliber of the Model 1902 gun from three inches to 75 millimeters would not have changed the firing characteristics of the gun. It is probable that the School was being parochial in its defense of the Model 1902 gun.

[15]Crozier, Op. cit., pp. 232-33.

design of the recuperator. An agreement between France and the United States assured the French that the details of the recuperator would remain classified secret. The degree to which the French guarded this secret can be exemplified by an incident which occurred at the Field Artillery School. One of the French guns which had been sent there to familiarize students with the gun burst during firing. The School decided to use the wrecked gun as a training aid to demonstrate the principle of recoil, and cut the recuperator lengthwise to demonstrate the mechanism. Upon learning of this, the French protested violently to the War Department about this breech of secrecy.[16]

Even with the corrected French drawings of the Puteaux recuperator, the Ordnance Department had problems in trying to determine manufacturing tolerances and types of material to use for producing the recuperator. A solution appeared from an unexpected source. To support the military efforts, Yale University had purchased four worn out French 75 millimeter guns from France to use in their military training program. The Ordnance Department learned of the purchase of these guns and traded Yale some British 75 millimeter guns which were being manufactured in this country for the French guns, and took the recuperators of the French guns to Washington for detailed analysis. Upon close examination, the secret of the Puteaux recuperator was revealed. Each one was hand made to an indescribably close tolerance with precision nearing perfection. These extremely close-fitting parts and highly machined surfaces could not be adapted to assembly line production needed to quickly produce guns. This is the reason the British elected not to use hydropneumatic recuperators until 1918 when they developed

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[16]Snow, Op. cit., p. 239; see also "The Chief of Ordnance," War Department Annual Reports, 1919, Loc. cit..

proper manufacturing techniques. The Germans never attempted to produce the recuperator during the war after examination of captured French guns.[17] The exacting construction of the recuperator also posed a significant problem to the Ordnance Department after the decision was made to produce the French gun.

On 26 March 1918, the Singer Manufacturing Company took a contract for 1,000 of the Puteaux recuperators, to be produced at a rate of seventeen per day. The first recuperator was not produced until one year later, after the war was over.[18]

On 16 April 1918, Rock Island Arsenal was also given a contract for 1,000 of the Puteaux recuperators. The arsenal encountered the same problems with the Puteaux recuperator as they were having with the St. Chamond recuperators for the Model 1916 gun, since the recuperators were very similar in design. The same dustless, air conditioned assembly building was used for the assembly of both recuperators. The exacting tolerances of the Puteaux design were relaxed to allow interchangeability of parts and new piston seals were designed. A new type of hydraulic oil which was not temperature sensitive had to be formulated. It was a tribute to the dedication of the arsenal personnel that these problems were overcome and production began six months after the contract was placed. The first recuperator was finished about the time the Armistice was signed.[19] Consequently, no American-made

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[17] Crozier, Op. cit., p. 231; see also "The Chief of Ordnance," War Department Annual Reports, 1919, Loc. cit.

[18] Snow, Op. cit., p. 203.

[19] Ibid., p. 203 and p. 241; see also "The Chief of Ordnance," War Department Annual Reports, 1919, Op. cit., p. 3927.

French guns were used in World War I.[20] The gun did become a standard item of Army equipment after the war and remained in active service until they were replaced with the split trail carriages in the 1935 to 1938 time frame.

Although the Ordnance Department was not successful in providing American-made artillery for American forces in Europe before the war ended, there was some American-made British artillery that was used in the War. Before the United States entered the war, the British had contracted with Bethlehem Steel Company to manufacture the Model 1917 British light gun. This gun was of 3.3 inch caliber and is referred to as the eighteen pounder because of the weight of the projectile. Bethlehem Steel Company produced these guns for the British Army throughout the war.[21]

In April 1918, the Army had an urgent need for guns for training forces to be sent to Europe. The 600 Model 1902 field guns on hand met only part of this training requirement.[22] In May 1918, the Ordnance Department ordered 268 of the readily available British guns from Bethlehem Steel Company, with the tubes to be made in 3 inch caliber. Shortly afterwards, when the decision was made to adopt the 75 millimeter caliber as standard for the war, the order was changed to this caliber, which caused several

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[20]Department of the Army, United States Army in the World War 1917 - 1919: Reports of Commander-In-Chief, A. E. F., Staff Sections and Services, XII (Washington: Government Printing Office, 1948), 5, 59 and 76; see also Department of the Army, United States Army in the World War 1917 -1919: Reports of Commander-In-Chief, A. E. F., Staff Sections and Services, XV (Washington: Government Printing Office, 1948), 187. There were 109 American-made French 75 millimeter guns shipped to Europe, but they arrived after the Armistice was signed.

[21]Snow, Op. cit., pp. 243-50.

[22]U.S. War Department, "The Chief of Field Artillery," War Department Annual Reports, 1919, I (Washington: Government Printing Office, 1920), p. 5102.

months delay in production. The first guns began to arrive in January 1918, with steady increases in monthly production. By June 1918, 300 of the guns had been delivered, and by the time the war ended, there were 800 guns in the inventory. The gun had a wire-wound reinforced tube instead of a built-up tube, and because of this, never received the favorable consideration given the French gun. However, cannoneers liked the gun because of the rugged carriage, reliable mechanical features, and because it used the same panoramic sights as the Model 1902 gun. The gun was equipped with a hydrospring recuperator which was reliable as long as the oil level was checked. The British adopted a hydropneumatic recuperator for the Model 1917 gun in the summer of 1918, and this change caused the Ordnance Department to attempt to halt production of the American version of the Model 1917 until a hydropneumatic recuperator could be installed. The Field Artillery Department violently objected to this proposal, based on the delays experienced in the production of the other recuperators for the Model 1916 gun and the French gun. The Field Artillery Department needed guns for training and the possibility of delays could not be accepted. As a result, production continued and all the British guns produced for the Army had hydrospring recuperators.[23]

In September and October of 1918, plans were made for a massive Allied campaign against the Germans during the spring of 1919. When it became apparent that production delays would preclude the availability of sufficient American-made French guns for this offensive, serious consideration was given to the use of the British gun in the campaign. It was felt that sufficient numbers of the gun could be manufactured to support the effort. A study of this alternative led to an order for 1,500 of the British

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[23] Ibid.

guns from Bethlehem Steel Company.[24] The Armistice in November 1918 caused the contract to be cancelled. It also reduced the urgent need to solve the dilemma of field artillery production.

CONCLUSIONS

World War I had a great effect on the evolution of American light field artillery, and there were a number of important lessons to be learned in the production of artillery.

First, before the war, there was an assumption by the government and the general populace that the United States could quickly mobilize a large army for national defense because of the large national industrial base. This assumption proved to be a complete fallacy. Weapons technology was reaching new heights, and artillery was one of the most complex items to manufacture because of the carriage components and the recoil mechanism. Additionally, with respect to light artillery, a weight restriction of 3,900 pounds was placed on the gun, ammunition and limber. This represented the sustained pulling weight for a section of horses. In gun design, careful consideration had to be given to component weight. Undoubtedly, the recuperator problems with the Model 1916 gun could have been solved by building a larger recuperator with heavier springs, but the weight of other components would have been reduced to the point of structural weakness. Complex weapons production, with which the industrial base had had little or no manufacturing experience required a long lead time until production began.

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[24]Ibid.

Secondly, shortly after the war had ended, Congress, the Ordnance Department and the civilian contractors suffered severe public criticism for the lack of war materiel when the war began and the inability to provide materiel rapidly during the war.[25] Congress was blamed for failure to appropriate funds for materiel before the war. The Ordnance Department was blamed for a lack of foresight, planning and judgment in procuring war materiel. Civilian contractors were blamed for not putting their full resources into the production effort, causing excessive production time.

These criticisms must be placed in proper perspective. Most of the criticism arose because the European countries were able to fight a war and still produce great quantities of war materiel, while it seemed that the United States could not meet its commitments to the war effort in materiel. It should be remembered that the United States had not been engaged in a major war since 1865, and that the nation's industry was geared to a peace-time economy. Even the Spanish-American War did little to disrupt that status. In contrast, the European countries had been involved in numerous wars from 1865 to 1914. Even when the European countries were at peace, they engaged in an active arms trade around the world which sustained such weapon industries as Krupp of Germany and Schneider of France. Had World War I lasted a year longer, American industrial experience and capacity would have produced significant results; materiel production was just beginning as the war ended.[26] The evident lesson was that weapons

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[25]Crozier, Op. cit., passim; see also Department of the Army Pamphlet 20-212, Op. cit., pp. 318-23.

[26]"The Chief of Ordnance," War Department Annual Reports, 1919, Op. cit., pp. 3872-77; discussion of production and charts for comparison of war-time production.

producing capability must be maintained during peace-time to assure adequate materiel during a war. New weapon technologies must be integrated into this capacity.

Third, attempts were made to produce an advanced light artillery carriage without an adequate testing program to discover design faults and weaknesses before a final design was approved for production. The Model 1916 was still in the experimental stage when the threat of war prompted production of the gun. Then numerous design faults necessitated many changes and delays in production. The result was a superior idea built into an unsatisfactory gun. Weapon development could not be carried into the production line.

Finally, foreign influence on American artillery during the war was profound. The caliber of light artillery was changed to 75 millimeter for interchangeability of ammunition with the French gun. The French-designed recuperator was adapted for American artillery and improved upon by the Ordnance Department. The DePort carriage influenced the design of the Model 1916 carriage which was the prototype of later towed artillery carriages.

At the end of World War I, the United States Army was equipped with four different light field guns; the Model 1902 3-inch gun, the Model 1916 gun, the French Model 1897 gun, and the British Model 1917 gun. This wide assortment of light field guns left the Army in a bewildering situation as to the future of light artillery. The choice of which weapon, or combination of weapons to be used as the standard light field gun was a problem but it was only one of the many problems created or left unanswered by the war.

CHAPTER V

PROGRESS OF THE LIGHT FIELD GUN IN THE UNITED STATES ARMY BETWEEN WORLD WARS

At the end of World War I, the Army found itself with a wide variety of artillery ranging from 37 millimeter field guns to 16 inch coast artillery. During the war, a dependence upon the Allies for artillery had upset the accepted prewar standards for artillery, and changes in tactics and technology had required reorganization of missions and materiel. Major General William J. Snow, the Chief of Field Artillery, recognized the seriousness of these problems. In early December, 1918, he sent a memorandum to General March, the Chief of Staff of the Army, recommending the formation of a board of officers to study the requirements for artillery to support the future Army. He also recommended that Brigadier General William I. Westervelt, a prominent artilleryman, chair the board. The Chief of Staff approved the memorandum.[1]

War Department Special Orders Number 289-0, December 11, 1918, appointed a board of officers to meet at Chaumout, France, with the charter to conduct a study of the armaments, calibers and types of materiel, kinds and proportion of ammunition and methods of transport of the artillery to be assigned to a field army. The board was thereafter popularly known as

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[1]William J. Snow, Signposts of Experience (Washington: U.S. Field Artillery Association, 1941), pp. 299-305.

the Caliber Board and sometimes as the Westervelt Board, because of its chairman, General Westervelt. Other Board members were Brigadier General Robert E. Callan, Brigadier General William P. Ennis, Colonel James B. Dillard, Colonel Ralph M. Pennell, Lieutenant Colonel Walter P. Boatwright, and Lieutenant Colonel Webster A. Capron. At its initial meeting, it was organized and soon began accumulating data in France. The Board conducted numerous interviews with both American and French artillery officers, and began visiting artillery manufacturing plants. After sufficient data had been gathered in France, the Board went to Italy and collected additional data. Board members visited the Italian Great Headquarters and the Italian technical facilities where they interviewed both artillery officers and ordnance officers. A similar visit was made to the British headquarters in France and Great Britain. The Board also had conferences with commanders of the major American occupation units in Europe.[2]

In April, 1919, the Board returned to the United States, and in Washington, it sifted through the mass of information which had been collected in Europe. During this period, the Board was also in close communication with the Chiefs of Field Artillery, Coast Artillery, Ordnance, and the Chemical Warfare Service. This ensured inclusion of the current doctrinal and technical aspects into the Board's report. The Board's completed report was forwarded to the Chief of Staff of the Army and approved on May 23, 1919.[3]

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[2]William I. Westervelt, "A Challenge to American Engineers", Army Ordnance, I, 2 (September-October, 1920), 59-64.

[3]Ibid.

The subjects covered by the Board's report were numerous and reflected a realistic view of artillery in future wars. In determining the types and calibers of artillery that should be used by a field army, the Board divided tactical artillery into three general classes. The first class was divisional, or light artillery composed of the 75 millimeter gun and the 105 millimeter howitzer. The next class was the corps, or medium artillery consisting of the 4.7-inch gun and the 155 millimeter howitzer. Finally, the army, or heavy artillery was the 155 millimeter gun, the 8-inch howitzer and the 240 millimeter howitzer.[4]

In assigning the classes of artillery, the Board set forth ideal specifications for weapons in each general class. These standards and specifications represented goals to be achieved in the research and development programs for each weapon, to include ranges, weights, ammunition, traverse and elevation requirements and other data considered essential to accomplish artillery missions of the future. From data based on the World War I experience, the Board concluded that motorized vehicles were superior to horses in moving artillery. that it was feasible to motorize all artillery except railway guns, and that some form of motorized, self-propelled artillery was the trend of the future.[5]

The Board's report was one of the most significant studies to come from the war experience, since it set the objectives for the development of

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[4]U.S. War Department, "Study of the Armament and Types of Artillery Materiel to be Assigned to a Field Army", Field Artillery Journal, IX, 3 (July-August, 1919), 289-347;(Hereafter referred to as the Caliber Board Report.)

[5]Ibid.; By motorizing the artillery, the Board meant that a truck or tractor would be used instead of horses as a prime mover of towed artillery. The motorized self-propelled artillery was a special category of artillery in which the gun mount and cradle were attached to the chassis of a tractor-type vehicle, and the gun was fired from the vehicle.

artillery in the peace-time period between World War I and World War II. Because of the research and development program stimulated by the Board's report, even within a limited budget, the United States was in a much higher state of military readiness when it became involved in World War II than it had been in April, 1917.

One of the major conclusions of the Caliber Board was that the divisional artillery had to have the mobility to permit it to keep pace with the infantry, but at the same time it had to have the maximum power commensurate with that mobility. The primary target of division artillery was the infantry of the opposing force. The division artillery had to have accuracy and flexibility to quickly change targets and it had to have great range because of echelonment in depth. The offensive missions of division artillery included cutting barbed wire barriers, destroying machinegun nests, gassing enemy areas, firing on enemy infantry positions, and firing the deep barrage that preceded infantry attacks. The defensive missions of division artillery included counter-offensive fires to break up enemy formations, firing on the main attack with annihilating fires and barrage, and close-range shrapnel fire on attacking forces.[6] It was the consensus of the Board that the 75 millimeter gun firing a fifteen pound projectile and having a range of not less than 11,000 yards was a satisfactory weapon for division artillery.[7]

In considering the ideal light artillery gun for division artillery, the Board recommended:

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[6] Ibid., p. 294.

[7] Ibid., p. 299.

"a gun of about 3-inch caliber on a carriage permitting a vertical arc of fire from minus 5 degrees to plus 80 degrees; a projectile weighing not over 20 pounds, shrapnel and high explosive shell of satisfactory man-killing characteristics with a maximum range of 15,000 yards; fixed ammunition; smokeless, flashless propelling charge; time fuse for shrapnel; bore-safe, super-quick and selective delay fuses for shell... Two propelling charges should be furnished, a normal charge for about 11,000 yards range and a super charge for maximum range. The proportion should be 90 percent of the former and 10 percent of the latter... A maximum rate of fire of 20 rounds per minute is deemed sufficient."

Until a weapon with performance characteristics approaching those of the ideal gun could be developed, the Board recommended arming half of the light artillery units with the 75 millimeter Model 1916 field gun and the other half with the 75 millimeter Model 1897 French gun.[8]

For transport, the Board stated that "mechanical transport is the prime mover of the future". It recommended extensive development work in this area and predicted radical changes encompassing future self-propelled artillery. At that time, the Board felt that twelve miles per hour was sufficient for a motorized prime mover. From a practical point of view, the Board recommended that four light field artillery regiments be motorized and that the horse should remain in service as a mover until the tractor demonstrated a clear superiority over horses as artillery prime movers.[9]

In 1919, using the characteristics of the Caliber Board's ideal light gun and the experience gained in producing the Model 1916 field gun, the Ordnance Department began a development program for the light division gun. After some of the basic design faults were corrected on the Model 1916 split trail carriage, it had been a fairly good carriage. The Ordnance

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[8]Ibid., pp. 309-10.

[9]Ibid., pp. 310-11.

Department developed a new carriage designated the Model 1920, using the basic design of the Model 1916 but with significant improvements. Following the Caliber Board's recommendation, the new carriage was designed for use with either the 75 millimeter gun or a light divisional howitzer. The Ordnance Department worked quickly on the project, and by December, 1920, the first improved gun, made at Watervliet Arsenal was assembled and test fired on a split trail carriage, Model 1920, made at Rock Island Arsenal.[10]

Also under development by the Ordnance Department at this time was a box trail carriage, to be designated the Model 1921.[11] Because there was no agreement of opinion as to the superiority of either type of carriage, the Ordnance Department decided to manufacture a small quantity of both types and conduct a comparison test to determine which was best. The split trail carriage was heavier and more complicated than the box trail carriage, but it allowed much wider limits of traverse and elevation.[12] As testing continued at Rock Island Arsenal, the Model 1920 gun demonstrated good potential, achieving some of the desired characteristics of the ideal gun as specified by the Caliber Board. The gun could be elevated from minus 4½ degrees to plus 80 degrees and had a total traverse of 30

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[10]"Artillery Division Notes", Army Ordnance, I, 4 (January-March, 1921), 220.

[11]The box trail carriage was a modification of the older single trail carriage. It used two rails to form a narrow triangle, with a trail spade at the apex and the carriage axle at the base. The space between the trail allowed the gun cradle to be elevated through the space to fire at elevations up to about 55 degrees, which was a marked improvement over the single trail carriage. However, it still allowed only a narrow angle of traverse.

[12]"Artillery Division Notes", Army Ordnance, I, 4 (January-March, 1921), 220.

degrees. (Although the Caliber Board had recommended 360 degrees of traverse, the Ordnance Department had concluded that this would require a pivot mount, which seemed impractical at that time with horse drawn artillery. The weight of such a carriage would exceed 3,900 pounds, the maximum sustained pulling load for a section of six horses.) The new carriage was well balanced and could be unlimbered by two men, but it was very heavy. The weight of the gun and carriage was 3,660 pounds and the limber weighed 1,150 pounds, totaling 4,810 pounds. Both the carriage and limber were equipped with rubber-tired wheels for motorized transport. These wheels were heavy, weighing 295 pounds each, and accounted for much of the weight of the gun. In test firing under proving ground conditions, the gun worked well.[13] However, actual field tests were not favorable.

In late 1922, one of the two Model 1920 guns was sent by the Ordnance Department to Camp Bragg, North Carolina for testing by the Field Artillery Board. Although the idea of wide traverse and high elevation appealed to the Field Artillery Board, they concluded that the carriage was too heavy and complicated for acceptance.[14] In addition to the heavy wheels, another reason for the weight of the Model 1920 was excessive was that the new gun tube, (which had been developed to meet the Caliber Board's range specifications) was about two feet longer than the older 75 millimeter guns and was about 240 pounds heavier. This weight, combined with the weight of the variable length recoil mechanism and cradle was 1,925 pounds, which was 600 pounds heavier than the Model 1916 gun or the Model 1897 gun.

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[13] Ibid., p. 225.

[14] "Annual Report of the Chief of Field Artillery", Field Artillery Journal, XII, 6 (November-December, 1922), 470-71.

However, the new gun could achieve the 15,000 yard range requirement of the Caliber Board.[15]

After the initial tests of the Model 1920 gun by the Field Artillery Board, the Ordnance Department decided that the light howitzer on this carriage would also be too heavy and the idea of a dual-purpose split trail carriage was dropped at this time. Plans were made to redesign the split trail carriage and eliminate about 500 pounds of weight.[16]

While the Model 1920 gun was being tested, the Ordnance Department was also developing the Model 1921 box trail carriage for a comparison test using the same model gun as used on the Model 1920 carriage. The box trail limited the elevation to 45 degrees and required no variable length recoil mechanism, which simplified the cradle and reduced the weight. Because of this, the total weight of the gun and limber was 4,000 pounds.[17]

The advantages of lighter weight and simplicity of the Model 1921 gun were somewhat offset by the narrow eight degree limit of traverse of the gun. Tacticians were beginning to realize the importance of being able to shift artillery fires laterally to mass firepower at decisive points on the battlefield. A wide angle of traverse on gun carriages facilitated the shifting of fires over a wide area without having to relay the gun. Because of this, the narrow traverse of the Model 1921 carriage was looked upon somewhat unfavorably, but the Artillery Board did not reject the carriage. It was temporarily adopted for use with the light

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[15]D. A. Gurney, "Seventy-Five vs. Soixante-Quinze", Army Ordnance, I, 6 (May-June, 1921), 325-26.

[16]Ibid.

[17]Ibid.

howitzer (which was still in the development stages) with the provision that the elevation capacity be increased to 65 degrees.[18]

Based on the recommendations of the Field Artillery Board and the basic design characteristics of the Model 1920 gun, another split trail carriage was developed by the Ordnance Department. Unlike the Model 1920, it was designed specifically for the 75 millimeter gun. This new carriage, designated the Model 1923, was designed for weight reduction and was much simpler than the Model 1920 carriage. The weight of the Model 1920 gun tube was reduced by shortening it by six inches and using a lighter drop-block sliding breech with a simplified firing mechanism.[19] Another significant feature of the gun was that it was one of the first cold-worked tubes; that is, it was strengthened by the auto-frettage method. Auto-frettage was a new process by which the tube was formed from a single casting and then pre-stressed internally under tremendous hydraulic pressure, allowing higher propellant pressures without the danger of bursting. This process is similar in theory to the Rodman process and the built up process of strengthening gun tubes but resulted in a stronger tube because it was formed from one piece, and was of the same material throughout.[20] The carriage was futher simplified by changing the cradle to allow the gun tube to recoil on slides in place of rollers, which had been used on previous guns and required frequent maintenance. Because the Model 1923 gun had a maximum elevation of just over 45 degrees, there was no danger

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[18]"Annual Report of the Chief of Field Artillery", Field Artillery Journal, XIV, 2 (March-April, 1924), 119.

[19]Ibid., p. 110.

[20]For a definitive explanation of the auto-frettage process, see Albert E. Guy, "Auto-frettage", Army Ordnance, I, 3 (November-December, 1920), 126-29.

of the breech striking the ground in recoil, which eliminated the need for a variable length recoil system. A simpler, lighter, fixed length recoil system was used, and this helped reduce the weight of the gun. The 45 degree elevation allowed a maximum range of 14,880 yards even with a slightly shorter tube than the Model 1920 gun. The carriage also allowed a wide traverse of 45 degrees, more than any other carriage developed at that time. The Model 1923 also used steel-tired wheels, in place of the heavy rubber-tired wheels used on the Model 1920, and this made the gun lighter. The gun underwent extensive tests by the Field Artillery Board beginning in 1924. It was a satisfactory system and was acceptable to the field artillery. The gun was accepted as standard in 1926 and redesignated the 75 millimeter Field Gun, M1.[21]

Although the 75 millimeter Field Gun, M1 was classified as standard and would have been put into production in the event of war, few of these guns were actually purchased. There were still a large number of the World War vintage field guns on hand, and Congress would not authorize procurement of new guns. The Army had to continue to use the Model 1916, Model 1917 (British) and the Model 1897 (French) guns that were in service.[22] These guns were becoming obsolete and there was little hope of procurement of improved guns in the near future, but the Ordnance Department continued an active research and development program toward improved guns.

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[21]H.G. Bishop, Field Artillery, King of Battles (New York: Houghton Mifflin, Co., 1935), pp. 46-48; Major General Bishop was Chief of Field Artillery from 1929 to 1934.

[22]S. L. Conner, "The 75 mm Gun", Army Ordnance, XIX, 114 (May-June, 1939), 347-48.

After the standardization of the M1 field gun, the Ordnance Department began to give serious thought to the ideal gun specifications set forth in the Caliber Board report. In recommending a maximum elevation of 80 degrees and a 360 degree traverse, the Board was considering the potential tactical threat of aircraft to a division, with the ideal gun as an answer to that threat.[23] In the decade following World War I, great advances had been made in aircraft and tanks, both of which were fast-moving targets and required a flexible gun mount if they were to be attacked. The Ordnance Department decided that if a gun could be designed following the Caliber Board's specifications, it would prove to be an all-purpose gun. The problem of the 360 degree traverse required a new approach to carriage design. The only way a gun could have 360 degree traverse was to mount it on a pedestal. All pedestal mounts were then stationary, as in ships or fortifications, and mounting a pedestal on a movable carriage called for radical design changes. It was also noted that the trend of the Army was toward motorized transport, and replacement of horse transport with motor vehicles was inevitable. With motor transport, weight of gun carriages had less importance, which allowed greater freedom in gun carriage design. In May, 1929, two independent studies of an all-around fire, 75 millimeter high-speed divisional gun carriage were made: one by the Office of the Chief of Ordnance, and one by Watertown Arsenal. These two studies resulted in the independent production of two different, innovative carriages, the T2 and the T3, which after full development, the Ordnance Department hoped would be an all-purpose divisional gun.[24]

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[23]Caliber Board Report, Op. Cit., p. 320.

[24]Elmer C. Goebert, "Modern Thought in Division Artillery", Army Ordnance, XI, 61 (July-August, 1930), 33-37.

The T2 carriage was the result of the study by the Office of the Chief of Ordnance. The carriage was built on the principles of simplicity, low cost and ease of operation. Basically, the carriage consisted of a cylindrical pedestal through which an axle passed. The axle was braced by struts pinned to the pedestal. Below the axle was a cylindrical lifting plate with spade blades fixed to the bottom. The top portion of the carriage consisted of the gun mount, fitted to the pedestal by a cylindrical bearing and supported by coil springs which protected the gun and fire control equipment from road shock at speeds up to 35 miles per hour. Fixed to the rear of the pedestal were two outriggers (or trails) which closed together during travel and spread apart 120 degrees during emplacement. The gun was towed by these outriggers. To emplace the gun, the outriggers were spread, the lifting plate was dropped to the ground by a quick-release pawl, and the gun was raised by two built-in jacks. The pneumatic truck-type wheels, which were quick-demountable, were removed, and the gun was dropped by the quick-release pawl, driving the lifting plate spades into the ground. In this configuration, the gun had a 120 degree traverse, as allowed by the spread of the rear outriggers. If 360 degree traverse was desired, a third outrigger, which was carried on top of the other outriggers in travel, was pinned to the front of the pedestal, giving a three point support to the gun at each 120 degrees of the circle.[25]

The T2 gun, with its fifteen-foot long outriggers required a relatively level area for emplacement. In travel configuration, the gun weighed 5,900 pounds, and had a lunette load of 653 pounds, requiring at least four men to release the gun from the prime mover.[26]

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[25] Ibid.

[26] The lunette load is comparable to trailer tongue weight exerted on a prime mover vehicle. In light artillery, this weight must be manually lifted to disengage the lunette, a ring-like device used to couple the gun to the prime mover.

The T2 carriage was designed to mount either the 75 millimeter gun developed for the M1 carriage, or the divisional light howitzer which was still under development. The T2 carriage had elevation capacity from 0 degrees to 80 degrees, which allowed for high angle fire and antiaircraft fire. The sighting and fire control devices on the carriage were designed to interface with antiaircraft detection systems then in use.[27]

The result of the Watertown Arsenal study of the high-speed divisional artillery carriage was the development of the T3 carriage, which was somewhat more complex in design than the T2 carriage. As with the T2, the pedestal gun mount was used for the major component. The T3 used four outriggers, or trails, for towing and support. In the travel-towed configuration, the two rear outriggers were attached to the pedestal, closed together, and then hooked to the prime mover. The two front outriggers were detached and latched to the outside of the rear outriggers. The pedestal was mounted on a helical-sprung, dual wheeled bogie which was detachable.[28]

The T3 carriage could be fired from three configurations; as a split trail carriage, as a 360 degree traverse mount, or from a prime mover truck chasis mount. In the split trail configuration, the rear outriggers were spread 90 degrees and the wheeled bogie was left in place. The front outriggers were then placed under the carriage and jacked tightly against the ground to protect the bogie springs and axle from the shock of firing. The gun could elevate from 0 degrees to 80 degrees, and traverse 90 degrees.[29]

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[27]Gobert, Loc. cit.; These aircraft detection systems, although primative by current standards, were sophisticated for their time. They consisted of a complex of microphones placed at known points and oriented by survey. Aircraft were detected and located by the differentials in time and direction of sound picked up by the microphones. It was one of the most complex materiel systems in the Army at that time.

[28]G. M. Barnes, "The Universal Gun and Mount, T3" Army Ordnance, XI, 63 (November-December, 1930), 187-90.

[29]Ibid.

In the 360 degree traverse configuration, the two front outriggers were used as levers to lift the carriage and remove the wheeled bogie. Then the front outriggers were attached to the front of the carriage and the gun could be fired in any direction, with outrigger support every 90 degrees around the pedestal. The T3 carriage also had to have a relatively flat area to emplace, but for slight slopes, it had an on-carriage leveling device for up to 6 degrees of slope.[30]

In the truck mounted configuration, the prime mover was equipped with a small crane which could lift the gun and pedestal from the bogie and outriggers and swing the gun into the truck bed which was equipped with a quick connect/disconnect mount. The truck bed had four corner jacks which gave the truck bed stability during firing. When it was mounted in the truck bed, the gun could be traversed 360 degrees and elevated to 80 degrees. When the gun was mounted in the truck, the outriggers were stowed on the side and the bogie was towed by the truck. The truck could travel up to 500 miles per day on good roads at speeds up to 45 miles per hour, giving a tremendous mobility advantage.[31]

Like the T2 carriage, the T3 was designed for either the 75 millimeter M1 gun or the 105 millimeter light howitzer. The T3 was also designed to interface with the available antiaircraft detection devices to provide antiaircraft capability.[32]

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[30] Ibid.

[31] Ibid.

[32] Ibid.

The Ordnance Department considered the T2 and T3 carriages as a good answer to the needs of the field artillery. Further refinements in design were achieved by combining the best features of the two carriages and reducing the weight. The resulting design was designated the T2E1 carriage, and was tested by the Field Artillery Board in 1933.[33] The results of the T2E1 test were not favorable. The Field Artillery Board concluded that the carriage was too complex when compared to the rugged simplicity of conventional carriages, and that the carriage was too heavy. The antiaircraft fire control equipment was also considered cumbersome to the point that it would interfere with the normal support operations of the battery and would degrade mobility.[34]

The intent of the Ordnance Department in developing the T2E1 carriage was to produce an all-purpose light divisional gun as visualized by the Caliber Board. However, for the field artillery to accept this weapon would have been a doctrinal acceptance of three separate tactical missions to be accomplished by one field artillery battery: direct support to the infantry, an anti-tank mission, and an antiaircraft mission. These missions were conflicting in nature and would have resulted in confusion over mission priorities. Because of this, it was apparent that an all-purpose gun would not be practical, and the Ordnance Department subsequently applied the technology and experience gained in the development of the T2E1 gun to anti-tank and antiaircraft weapons.[35]

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[33]"Field Artillery Notes, 75 mm Gun T2E1 (All Purpose) Battery", Field Artillery Journal, XXIII, 5 (September-October, 1933), 487.

[34]Conner, Loc. cit.

[35]It is interesting to note the similarities in design of the T2 and T3 guns, and the design of air defense weapons developed by the European countries, and in particular, the German 88 millimeter air defense gun. See Barnes, Loc. cit., and Goebert, Loc. cit. for pictures of the T2 and T3 guns.

Although the Ordnance Department had made important progress in weapon technology with an aggressive research and development program, the Army continued to use obsolete guns. The inventory of light field guns was still filled with World War I guns because there were so many still in depot stocks and because there was so little procurement money with which to buy new guns. By 1931, events were beginning to take place which would help modernize the light gun and also bring an end to the era of horse drawn artillery.

In the latter part of 1931, Major General Harry G. Bishop, Chief of Field Artillery, saw a demonstration at Aberdeen Proving Ground in which a light commercial truck equipped with traction devices on the wheels towed a French 75 millimeter gun with modified wheels over the difficult proving ground mobility courses. General Bishop had long been an advocate of motorized equipment, and this demonstration reinforced his belief in the truck as an artillery prime mover. He directed the Field Artillery Board to test a truck equipped with the traction devices as an artillery prime mover. The tests indicated a high potential for these trucks, even in difficult cross country movement. At General Bishop's urging, the War Department approved a test by the Field Artillery Board of a battery of truck drawn artillery. A battery of four Model 1897M1E1 75 millimeter guns were prepared for high speed travel by removing the old wooden wheels and modifying the carriage to accept ball-bearing steel wheels and pneumatic tires. The test began in May 1932 and ended in March 1933, with highly successful results. The Field Artillery Board recommended that a battalion of truck drawn artillery be tested to prove conclusively that truck transport should replace the horse as an artillery prime mover.[36] The recommended battalion test was never conducted due to a lack of funds, and the results of the battery test were accepted as evidence of the superiority of the truck as a prime mover.

In 1933, General Douglas MacArthur became Chief of Staff of the Army and instituted many changes, one of which was to motorize half of the field artillery. This presented somewhat of a problem with the light field guns. These guns were sound and dependable down to the wheels, but the old wooden wheels prevented high-speed travel. A modern high-speed wheel was required for the carriage before it could be towed by a truck. To modernize the old guns, it was necessary to modify the carriages to accept steel wheels and pneumatic tires. This was accomplished by mounting a new ball-bearing hub below the old axle. The adapter device maintained the original height of the gun and proper trail angle above the ground, even though the steel wheels were smaller in diameter than the wooden wheels they replaced. This was important to maintain the original firing characteristics of the gun. By 1938, most of the old guns had been modernized with the new wheels, which made road speeds up to 50 miles per hour possible, and greatly improved mobility.[37] The modernization of artillery carriages with high-speed wheels ended the era of light horse-drawn artillery in 1938.

The addition of modern pneumatic tires and wheels to the old 75 millimeter guns was viewed as an interim step to modernization of the light

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[36] J. H. Wallace, "Tests of the Truck-Drawn 75 mm Battery", Field Artillery Journal, XXIII, 4 (July-August, 1933), 301-19.

[37] Conner, Loc. cit.; see also E. C. Goebert, "The Weight of Gun Carriages", Army Ordnance, XIV, 80 (September-October, 1933), 86.

field gun. It was desirable to equip the field artillery with modern guns, and although the M1 75 millimeter field gun was standard, it would have been costly to put into production. There was still a large quantity of the Model 1897 guns in stock, and the gun was a proven, reliable system. A compromise decision was made by the War Department to put the Model 1897 gun and recoil mechanism on a modern carriage. The Ordnance Department used the M1 carriage design as a model, but made a number of improvements on it, one of which was a much wider angle of traverse. The traverse was increased to 85 degrees to allow coverage of artillery fire over a broad front. Other improvements were increases in elevation from minus 10 degrees to plus 45 degrees, new on-carriage fire control equipment with panoramic telescopes and cross-leveling features, direct fire equipment for fast moving targets, and high-speed towing stability. With super-charge ammunition, and an elevation of 45 degrees, the gun was capable of ranges out to 13,500 yards. A considerable savings was to be realized in the production of this gun because the gun tube, breech, and recoil mechanism were already on hand. The only required modifications to the gun tube and recoil mechanism were the removal of the rollers and the addition of slides in their place, to fit the carriage cradle.[38] Another cost reduction design was the use of a jack support under the axle to give stability in firing. Previous split trail carriages had used a complicated equalizer system to allow the trails to compensate for sloping or uneven ground. The support jack raised the axle and with the trails, allowed three point suspension for stability. The weight of the carriage, which was becoming less critical as motorized transport was used, was 3,450 pounds, slightly heavier than the older single

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[38]J. H. Wallace, "The New 75-mm Gun Carriage, M2", Field Artillery Journal, XXIV, 2 (March-April, 1936), 145.

trail, horse-drawn carriages.[39] The gun was tested by the Field Artillery Board and found to be acceptable. The gun was designated the M2 75 millimeter gun and was put into limited production in 1936. Fourteen batteries were eventually equipped with the M2 guns.[40]

The M2 gun was the successful culmination of a long period of weapon development which had begun in 1913 with the experimentation with split trail carriages. That development included all the production problems with the Model 1916 gun and the French Model 1897 gun during World War I, the development of the Model 1920 gun and the Model 1923 gun, which was finally standardized in 1926. In 1930, the developmental process digressed from the accepted standard gun carriage with the all-purpose gun, the T2E1, which the field artillery did not accept. Finally, the cycle was completed with a split trail carriage which mounted the Model 1897 French gun. With all the effort and money expended in research and development, the end result in 1936 was a gun very similar to the twenty-year-old Model 1916 field gun. The irony of the situation was that the era of the light gun ended four years later.

During the interwar period, while the continuing development and modernization of the 75 millimeter gun was in progress, another weapon was concurrently being developed which would replace the light field gun. During World War I, the static warfare of the trenches and fortifications had emphasized the need for howitzer fire with its high angle of fall and arcing trajectory to attack areas in defilade which could not be attacked by the flat-trajectory field guns. At the beginning of the war, the British

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[39]Conner, Loc. cit.

[40]Wallace, "The New 75 mm Gun Carriage, M2", Op. cit., p. 150.

and German armies had strongly favored a light howitzer as a divisional artillery weapon to complement their field guns. The French army had an unshakable faith in their Model 1897 "soixante-quinze" field gun and they felt that the need for howitzer fire could be answered with their 155 millimeter howitzers. Just before the war, the United States had begun to favor the concept of a light divisional howitzer, but was not able to develop one before or during the war.[41]

As a result of the World War I experience, the Caliber Board recommended that the 155 millimeter howitzer be taken out of the general support role at division level and placed in the corps artillery. The Board recommended a light, mobile field howitzer of about 105 millimeter caliber as a replacement for the 155 millimeter howitzer in division artillery for general support.[42] Work was soon under way to achieve this goal.

A considerable number of German 105 millimeter field howitzers had been captured during World War I, and were brought to the United States after the war. The Field Artillery Board tested the German howitzers and was favorably impressed with the weapon to the extent that it recommended the adoption of the German howitzers as standard Army equipment until a suitable American howitzer could be developed.[43] The recommendation was never acted upon because the Ordnance Department had already begun the development of a light howitzer.

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[41]Maxwell Murray, "The Place of the Light Field Howitzer in Division Artillery", Field Artillery Journal, XV, 6 (November-December, 1925), 546-47.

[42]Caliber Board Report, Op. cit., pp. 311-12.

[43]Murray, Op. cit., pp. 539-40.

The Ordnance Department had reacted promptly to the Caliber Board's recommendation for a light divisional howitzer, as it had with the development of the light field gun. By late 1920, a prototype 105 millimeter howitzer similar in design to the German howitzer was being prepared for testing on a split trail carriage, the Model 1920, which had also been developed for the light field gun. However, when the Model 1920 carriage with the light field gun was rejected because of weight, the howitzer was mounted on the Model 1921 box trail carriage, and underwent service tests by the Field Artillery Board. The Field Artillery Board did not reject the carriage, but stipulated that the elevation capabilities should be increased to 65 degrees (maximum elevation was 53 degrees) and that other minor improvements should be made before the carriage was fully acceptable. Another box trail carriage was built to correct the problems encountered with the Model 1921 carriage, but before it could be service tested, several split trail prototype carriages had been built for evaluation and had demonstrated good potential for use with the howitzer. One of these carriages was accepted as standard and designated the M1 in 1927. In 1930, the M1 howitzer carriage began extensive field tests at Fort Sill, Oklahoma, and when the tests were completed in 1932, the M1 carriage was found to be unsuitable for high-speed towing. The Ordnance Department redesigned the carriage to eliminate the deficiency and the carriage was service tested again by the Field Artillery Board. In 1938, the Field Artillery Board again concluded that the carriage was unsuitable.[44]

In reviewing the conclusions of the tests on the M1 carriage, the Ordnance Department decided that the deficiencies were so fundamental that

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[44]John P. Lucas, "The 105-mm Howitzer", Field Artillery Journal, XXXI, 2 (February, 1941), 69.

a new carriage design was necessary. The frustrations of the development of this carriage prompted a conference between the Ordnance officers designing the carriage and the Field Artillery officers who tested and used the carriage to resolve the sources of conflict before actual design of the carriage began.[45] The conference was a success, as evidenced by the development of a carriage which was accepted by the Field Artillery Board. The new carriage was designated the 105 millimeter howitzer carriage, M2, and was accepted as standard equipment for issue to the field artillery.[46]

Although the 105 millimeter howitzer was about to enter the inventory, the employment of the weapon was still uncertain as late as 1938. Contrary to the recommendations of the Caliber Board, the 155 millimeter howitzer was left in division artillery because the light howitzer was not available to replace it. In the 1930's, other modern armies such as Germany had begun to replace their light field guns with larger caliber light howitzers as a direct support weapon. In June, 1938, Chief of Field Artillery Robert M. Danforth directed the Field Artillery School to conduct a study of the employment of the 105 millimeter howitzer. From this study, the School concluded that the 105 millimeter howitzer was not a proper replacement for the 155 millimeter howitzer because the firepower of the larger weapon was needed in general support. It also concluded that the 105 millimeter howitzer was a suitable replacement for the light field gun,

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[45]This conference was somewhat of a milestone in the materiel acquisition process in that the ultimate users of equipment were communicating their ideas of materiel characteristics and their opinions on equipment design to the engineers and technicians who developed the equipment. For an example of Ordnance Department attitude with respect to this user-developer communication, see Conner, Loc. cit.

[46]Lucas, Loc. cit.

but it did not recommend this course of action because of economics; there was still a large number of the field guns on hand. However, the School did indicate that a combination of light guns and light howitzers was appropriate.[47]

In 1939, Congress became involved in the controversy over the replacement of the light field gun with the 105 millimeter howitzer. The War Department had requested appropriations to modernize the 75 millimeter gun with the new M2 carriage, and some Congressmen opposed this program because they felt that the 75 millimeter gun was obsolete. The appropriations were reluctantly approved only after the Chief of Field Artillery explained in congressional testimony that it would cost 87 million dollars to replace the light gun with the new howitzer. However, the controversy over the replacement of the 75 millimeter gun continued, and intensified as the 105 millimeter howitzer was approved for production in March, 1940.[48]

When Germany began the invasion of France in 1940, the Allies asked the United States for armament, and surplus materiel was shipped to them. Included in this surplus materiel was over one thousand 75 millimeter guns. By June, 1940, the European threat required an intensive rearmament program for the United States Army. Field artillery studies of practice manuevers concurred in the replacement of the light field gun with the light howitzer as the divisional direct support artillery, and tables of organization and equipment for the division were published in October 1940 which

[47]Janice McKenney, "More Bang for the Buck in the Interwar Army: The 105-mm. Howitzer", Military Affairs, XLII, 2 (April 1978), 83-84.

[48]Ibid.

reflected this change. Provisions were made to use the 75 millimeter guns until the inventory of these weapons was exhausted.[49]

Depletion of the inventory of these guns occurred sooner than anyone had expected. After the British retreat from Dunkerque, the United States transferred 895 of the 75 millimeter guns and adequate ammunition to the British Army to help replace the light artillery they had lost. The remaining 75 millimeter field guns were soon used up in action in the early phases of United States involvement in World War II, and the guns were replaced with the new 105 millimeter howitzers.[50] Thus ended the era of the light field gun--a gun which helped revolutionize tactical warfare and modernize weapons technology.

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[49] Ibid.

[50] Harry C. Thomson and Linda Mayo, The Ordnance Department: Procurement and Supply, United States in World War II, Department of the Army (Washington: Government Printing Office, 1960) p. 70.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Throughout the history of the United States, the development of military materiel has waxed and waned in cycles governed by the factors of perceived military threat, economics, changes in domestic and foreign military doctrine, and new weapons technologies.

In the decade prior to the Civil War, the United States participated in active experimentation in ordnance technology and had even advanced to temporary leadership with the Rodman process of strengthening cast iron artillery tubes by the internal cooling-stress method. One of the first uses of rifled artillery occurred in the Civil War when the 3-inch ordnance rifle and various calibers of the Parrott gun were tactically employed.

After the Civil War, development of field artillery waned to a very low level. The United States faced no military threat, the available defense money went into the coast artillery and the Navy, and attention was focused on westward expansion. This country, with an isolationist attitude, observed European tactical and materiel developments with almost passive interest. Only the Franco-Prussian War seemed to spur interest in field artillery development, which resulted in the development of the Model 1885 field gun. This was a good gun when it was developed, but weapons technology in Europe was progressing so rapidly that the gun was practically obsolete within ten years.

The European countries were engaged in competitive colonial expansion and political power struggles during the latter half of the nineteenth century. Even during periods of peace, the military threat was an incentive to maintain well-equipped standing armies. In this environment, with a ready market for improved weapons, privately-owned weapon industries, such as Krupp of Germany and Schneider of France, flourished. Competition between these industries, coupled with fundamental technological advancements resulted in rapid modernization of ordnance during this period. This trend in ordnance technology was observed by military tacticians such as Wille and Langlois, who saw the potential of this trend and visualized its application on future battlefields. These men visualized an evolution in tactics, and defined the characteristics of a field gun which would bring about this evolution. Within six years, the concurrent developments in improved ordnance brought about the production of this gun--the French Model 1897 field gun, the first modern artillery. Within five years, the United States had a comparable weapon.

The Spanish-American War in 1898 served to emphasize the need to reorganize and re-equip the Army to bring it up to modern standards of the period. The Ordnance Department studied European artillery, and in particular, the French Model 1897 field gun, which was being heralded as the best field artillery system in existence. The Ordnance Department saw the French gun as the weapon of the future, and began to develop a quick-firing field gun for the Army.

In this project, the Ordnance Department capitalized on the best features of European artillery available at that time. The final product was the American quick-firing light field gun, the Model 1902. It could fire up to 20 rounds of fixed ammunition per minute at ranges up to 6,000 yards. It was competitive with contemporary European quick-firing guns, including the renowned French gun. The Model 1902 employed a hydrospring long-recoil recuperator system, the first recoil system to be used on American field artillery, and one of the best-designed systems of this type. The modern field gun placed American field artillery on an equal status with that of Europe for the first time since the Civil War.

The impetus of having a modern field gun seemed to stimulate a willingness within the Army to investigate new and innovative ideas in field artillery. When the Italian Army recommended the DePort split trail carriage to the United States Army, it readily experimented with this radically designed carriage. The innovative thought behind the design of the carriage appealed to the Field Artillery and Ordnance officers who tested its military potential. The capability to elevate a gun tube to high elevations to achieve maximum range of the gun represented a departure in traditional artillery doctrine of direct fire at relatively short ranges. The high elevation capability facilitated the development of indirect fire procedures--a modern artillery concept. The DePort carriage also had a traverse angle much wider than conventional single trail carriages, which complemented the high elevation capabilities in indirect fire. The wide angle of traverse allowed the gunners to quickly shift fires laterally over a broad front to mass fire.

After studying the split trail carriage, the Ordnance Department designed an American version of the DePort Carriage, the Model 1916, Unfortunately, the United States was becoming involved in World War I, and the urgent need for artillery to mobilize a large army prompted the Ordnance Department to order the new carriage into production before the design could be tested. This resulted in numerous design changes and production delays during the war, and when the gun was finally produced, it had many faults. With optimistic supposition, it is probable that had the Model 1916 carriage been developed in a normal process, it would have been a sound carriage, more advanced in the state-of-the-art technology than any other carriage of the time.

Prior to World War I, the Army was equipped with only enough materiel to meet small national emergencies. The attitude of "fortress America" still prevailed in Congress, with the assumption that this country could be quickly mobilized to meet the needs of any emergency. Early in World War I, that assumption was proved a fallacy. The Ordnance Department soon became mired in the inability of industry to quickly produce war materiel, especially light field guns. The problems of design changes with the Model 1916 gun were compounded when the caliber of the gun was changed to the French standard. When the decision was made to manufacture the French field gun in the United States, the production problems were such that no American-made guns were used by American forces in World War I. The war ended before American production potential could be realized, and the lack of American-made materiel caused considerable public criticism of the Ordance Department.

In his book, Signpost of Experience, General William J. Snow was very critical of the Ordnance Department for its adamant position of continued production of the Model 1916 gun, but in retrospect, that position was defensible.[1] The tactical advantages of the split trail carriage made it a future necessity for the field artillery. Even though Congress criticized the Ordnance Department for a lack of foresight, planning and proper

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[1]William J. Snow, Signposts of Experience (Washington: U.S. Field Artillery Association, 1941), pp. 208-24.

management, some of the fault lay with Congress. In the years before the war, Congress had continually failed to respond to requests for materiel procurement funds for modern weapons.

When all the recriminations abated, the Army was faced with another problem: the employment of a bewildering variety of weapons acquired during the war. Because the Ordnance Department did not have a materiel mobilization plan of the magnitude required by World War I, it resorted to ad hoc purchases of varied weapons and materiel to meet the needs of the war. Standardization of this assortment of materiel proved to be a monumental task.

The problem was especially acute in field artillery and light guns. The Westervelt (or Caliber) Board was formed to study the problems of postwar artillery and to make recommendations for solving these problems. The Board's recommendations became the framework of field artillery organizational equipment and provided guidance for future research and development efforts during the interwar period. The Board described ideal artillery weapons, and the Ordnance Department focused its development programs on weapons having appropriate characteristics.

The Ordnance Department conducted an aggressive research and development program after World War I in spite of an acutely small budget. It developed a prototype light field gun carriage which worked well under proving ground conditions, but was judged unsatisfactory in field tests by the Field Artillery Board because of excessive complexity and weight. These test results focused on a major problem with the materiel acqusition process during the interwar period. Even though the Caliber Board had outlined firing characteristics, there was not a mutual understanding between the Ordnance Department and the Field Artillery as to the mobility and desirable characteristics of the ideal light field gun.

The problem centered around a basic lack of communication or understanding between the Ordnance technicians and the Field Artillery users as to what characteristics were needed in light field guns. There was no effective coordinating agency within the War Department to resolve these interdepartmental issues. The development of the light field gun exemplifies this problem. Had there been interdepartmental conferences to discuss the design of the gun before it was built, the problems might have been resolved.

The weight of the carriage was a major point of contention between the Ordnance developers and the Field Artillery Board. The Ordnance Department approached the development of the light gun with the idea that motorized vehicles would soon replace horses as the mode of artillery transport, and considered weight to be less important than did the Field Artillery Board. The Field Artillery Board, in testing the light gun, took a pragmatic approach to its weight. Horses were still predominantly in use for artillery transport, and with restricted procurement budgets, motor vehicles might never be available as prime movers for artillery. Accordingly, the Field Artillery Board tested the gun with horses and found it exceedingly heavy for the maximum sustained pulling load for a light artillery horse section. When the carriage was redesigned and the weight was reduced to acceptable standards, it was re-tested and accepted by the Field Artillery Board. However, because procurement funds were not available to purchase the new gun in quantity, the Army continued to use the World War I vintage guns, which were nearing obsolesence.

The lack of communication and coordination between the Ordnance Department and Field Artillery became even more pronounced when the Ordnance Department began developing an all-purpose gun, the T2E1. The Caliber Board had seen the aircraft of World War I as a tactical threat, and in developing the characteristics of the ideal light field gun, it considered high elevation and all-around traverse as essential characteristics with which to attack aircraft. The tank was also emerging in the post-war years as an important tactical weapon. The Ordnance Department decided that if a gun could be built on the guidelines of the Caliber Board's recommendations, it would be an all-purpose gun: capable of infantry support, anti-tank defense, and an antiaircraft weapon. After a three year development period, the T2E1 gun was given to the Field Artillery Board for testing. Again, the Board took a pragmatic approach to the test, and rejected the gun, but this time on grounds of doctrine and tactical missions.

In 1933, the doctrinal employment of both tanks and the aircraft remained a matter of controversy. Likewise, the doctrine of tactical defense against these weapons was uncertain. The field artillery had a mission in attacking these targets, but the priority of these targets in comparison to the primary mission of support to the infantry defied doctrinal definition. If the Field Artillery Board had concluded that the T2E1 was an acceptable gun, then the tactical doctrine and organization of the direct support units would have required drastic changes. To accept the antiaircraft mission in conjunction with the mission of direct support would have required an augmentation of the direct support batteries with antiaircraft detection devices and equipment. This would have degraded the mobility and responsiveness of the battery to the supported unit. Anti-tank fires were an inherent mission of the field artillery, but a battery in defilade several kilometers behind the supported unit could not be responsive to a tank threat requiring direct fire. The Field Artillery Board rejected the all-purpose gun concept based on the impractical doctrinal concepts it would have imposed on the field artillery direct support units. Again, there was a lack of communication between materiel developers and the materiel users as to characteristics and doctrinal employment concepts. The Army continued to use the old field guns as the primary light artillery weapon.

There was, however, a consensus on the need to modernize the old field guns to allow them to be towed with trucks, which had begun to come into the inventory in 1933. By 1938, all of the light field guns were equipped with modern wheels, and trucks were predominantly used as prime movers.

Modification of high-speed wheels on the old field gun carriages was only an interim step toward a modernized field gun. The single trail carriages still imposed limitations on elevation and traverse of the gun, and limited its use in indirect fire procedures which had seen much progress in the interwar period. The light field guns had to be modernized to keep pace with the changing tactical doctrine. This need for modern field guns, however, was constrained by the continuing lack of procurement funds. A compromise solution was developed wherein the old gun tubes and recoil systems were mounted on a new split trail carriage and designated the light field gun, M2. This procedure saved a large amount of money, since it was not necessary to develop a new gun tube and recoil system. The new gun had all the advantages of high elevation for maximum range and wide traverse for massing of fires. With the development of this gun, there seemed to be an improvement in the communications between the Ordnance developers and the Field Artillery users. After a long, arduous development period, the light field gun was modern in every detail, but the total system had become obsolete.

During World War I, the Army had realized the need for a light field howitzer to complement the field guns. The howitzer was needed for attacking targets in defilade and trenches where the arcing trajectory and steep angle of fall of the projectile was more effective than the flat trajectory of the field guns. The Caliber Board's report prescribed the ideal howitzer characteristics and the Ordnance Department began to develop the weapon. Concurrently, the Field Artillery Board began testing some of the excellent German 105 millimeter howitzers which had been captured in considerable quantity during the war and shipped back to the United States. The results of the tests were favorable, and the Field Artillery Board recommended that these howitzers be issued as standard to the field artillery batteries until an American howitzer was developed. The Ordnance Department did not concur in this recommendation because a light howitzer development program was underway which was to produce a standard howitzer in the near future. There also may have been departmental pride involved in the unwillingness to use captured enemy ordnance as standard for issue.

Communication difficulties between Ordnance and Field Artillery representitives seems to have been at least as severe for the light howitzer as they were for the light gun. There were similar problems in the testing and acceptance of the carriages. The culmination of the impasse on the characteristics of the howitzer between the Ordnance Department and the Field Artillery Board occurred in 1938. After the Field Artillery Board had found a redesigned howitzer carriage unsuitable, the frustrations of both the developers and users prompted a conference to discuss and resolve the difficulties of the carriage development. This was a milestone in the development process. The results of the conference indicated that the Field Artillery had to clearly stipulate the desired characteristics of weapons to be developed, and the Ordnance Department had to be cognizant of those desired characteristics. The results of this mutual understanding between both agencies was the successful development of an excellent weapon, the light 105 millimeter howitzer, M2. This howitzer replaced the light field gun in 1940, and ended the era of the light guns.

The light howitzer replaced the field gun because the gun had been rendered obsolete by changing tactical doctrine after World War I which stressed mobility and the efficient use of terrain. To provide the fire-power necessary for this doctrine, indirect artillery fire became increasingly important, and the flat trajectory of the field gun did not have the flexibility required for indirect fire across a broad front. Although the Army recognized the changing needs in field artillery, it continued to use and improve upon the field gun because a large number of the field guns and considerable quantities of ammunition were in depot stocks. At the same time, the procurement of the light howitzer was uncertain until 1939. Only the worsening European situation in 1939 and the fact that European armies were moving away from the light field gun caused both Congress and the Army to re-examine the employment of the light howitzer as a replacement for the light gun. In 1940, the replacement was enacted, and the gun was phased out of the inventory.

The evolution of the modern light field gun was significant in a number of ways. First, the technology developed in producing this gun was soon adapted to all American field artillery. The split trail carriage is still being used on the Army's latest towed 155 millimeter howitzer, the XM 198. All artillery now has hydropneumatic recoil systems originally developed for the light field gun.

Second, the difficulties in the materiel acqusition process during the interwar period emphasized the need for better organization and communications between the developers and users of combat equipment. This began a long process of changes in the Army's materiel acquisition procedures, many of which are still in use today.

Next, the phenomenal growth of ordnance technology in the period from 1846 to 1897 was the result of an inter-related, international effort by both private and governmental agencies to develop modern artillery. By circumstance, France was able to combine all the cumulative developments into one highly successful weapon, the French Model 1897 field gun--a gun which, except for minor modifications, became the main light field artillery weapon for the United States Army from 1918 to 1940. The development of the French gun was the culmination of this rapid growth in ordnance technology. After this, the only significant development in field artillery was the use of the split trail carriage. The flexibility in elevation and traverse provided by this carriage facilitated the tactical use of indirect fires. Otherwise, there have been no fundamental changes in design or functioning of the basic gun tube, recoil system or carriage since World War I.

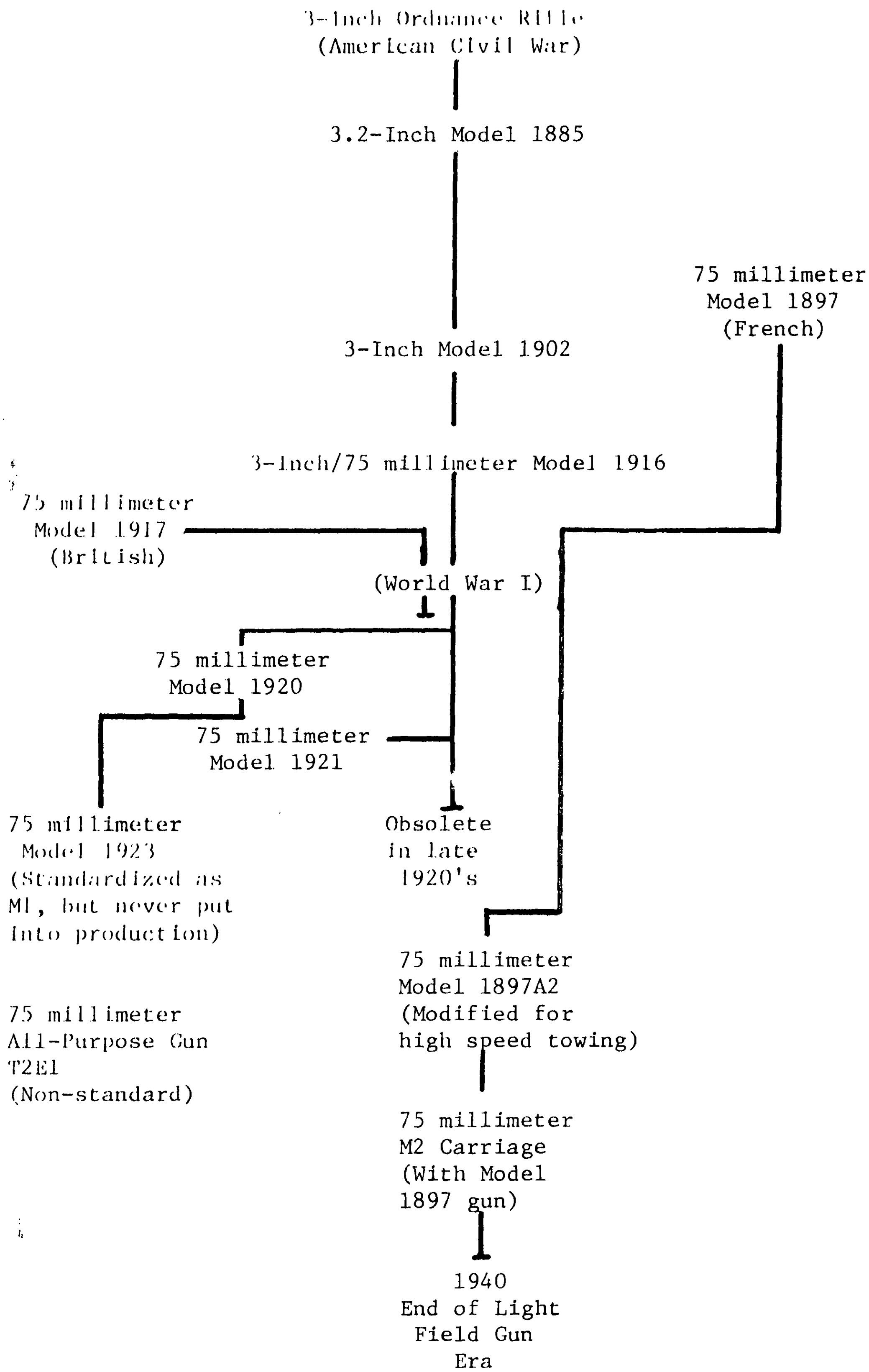
In the past fifty years, the basic artillery piece has remained essentially unchanged. Despite modern research and development efforts and the expenditure of large sums of money, the field artillery weapon which existed at the end of World War I is essentially the weapon which exists today. The trend has been toward larger calibers, such as the replacement of the 75 millimeter by the 105 millimeter, but little else has changed.

Based upon the experience of the past, it is doubtful that new advances in field artillery will occur until new technologies in physics, metallurgy, electronics or chemistry provide the basis for fundamental changes in design or function. These future developments, combined with new tactical doctrine visualized by another Wille or Langlois, will bring about artillery systems which will be as radically different from current artillery as the French Model 1897 was from the Napoleon 12-pound field gun.

APPENDIX A

APPENDIX A

AMERICAN LIGHT FIELD GUN LINEAGE



APPENDIX B

APPENDIX B

WEAPONS CHARACTERISTICS

Field Gun Model	Weight of Gun and Carriage (in pounds)	Elevation Limits	Traverse Limits	Muzzle Velocity with Explosive Shell (in feet per second)	Maximum Range Allowed by Carriage (in yards)	Type of Recoil System	Type of Carriage
3.2-Inch Model 1885	1,960	-5° +20°	-0-	1,685	6,631	None	Single Trail
3-Inch Model 1902	2,520	-5° +15°	8°	1,700	6,000	F,HS*	Single Trail
75 mm. Model 1916	3,045	-7° +53°	45°	1,900	12,360	V,HS** V,HP	Split Trail
75 mm. Model 1897 (French)	2,657	-10° +19°	6°	1,738	7,500	F,HP*	Single Trail
75 mm. Model 1917 (British)	2,945	-5° +16°	8°	1,900	8,100	F,HS*	Single Trail
75 mm. Model 1920 (Note 1)	3,660	-4½° +80°	30°	2,175	15,000	V,HP*	Split Trail
75 mm. Model 1921 (Note 1)	2,900	-7½° +45°	10°	2,175	15,000	F,HP*	Box Trail
75 mm. Model 1923 (Note 2)	3,160	-4½° +45°	45°	2,100	14,880	F,HP	Split Trail
75 mm. T2E1 (Note 1)	5,900	0° +80°	360°	2,175	15,000	F,HP*	Pedestal Mount
75 mm. M2	3,447	-10° +46°	90°	1,955	13,500	F,HP*	Split Trail

*Abbreviations: F=Fixed length recoil; V=Variable length recoil
HP=Hydropneumatic; HS=Hydrospring

**Later changed to hydropneumatic recoil.

Note 1: This was a developmental weapon. It was not accepted for standardization.

Note 2: Accepted and redesignated M1, but not put into production.

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