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MAJOR GENERAL CLARENCE C. WILLIAMS, U. S. A.
Chief of Ordnance

Foreword

By

MAJOR GENERAL C. C. WILLIAMS, U. S. A.
CHIEF OF ORDNANCE

THE PROBLEM of Ordnance in the World War was the problem of mobilization and co-ordination of science and industry with the military establishment. The scope of our effort was as broad as American industry, and it reached to the foundations of scientific research and knowledge. Although the Ordnance Department did not monopolize either field, it is safe to say that no other component of the war machine carried its responsibilities and effort as to design and invention, or production, into so many channels, or projected them upon so vast a scale.

Our undertaking was, indeed, at once so varied and so prodigious that few persons could possess the knowledge to pass judgment upon it intelligently. I remember upon one occasion listening to the complaint of a fellow officer anent the lack of sympathy entertained by the public for the work of our corps. It was during the days that the Browning gun was "on paper." Another officer present picked up from my desk a paper-weight made of a seventy-five millimeter shrapnel shell cross-sectioned. Turning the smoothly machined exterior of the steel jacketed shell toward him, he said, "General, this is what the public sees of our product. But this is what that product really is." Quickly he turned toward him the cross-section revealing the interior mechanism of the shell;

seventy-three component parts made with all the precision and delicacy of a watch.

But not only must we expect the public to fail in understanding of the scope and difficulty of our work. Do we not know, ourselves, from actual experience that extremely few officers of the corps could embrace the entire field; could give of their own knowledge a worth while opinion of how well or how poorly we measured up to the whole job. Each man knew his own specialty; knew the progress of his branch, section, division, or plant, or the few items of materiel included within his work. But only an extremely few could view the entire field, from tanks and tractors through field artillery and railway artillery, trench mortars, pyrotechnics, small arms and grenades to clinometers, alidades, protractors, steel helmets and harness. When your problem is the production of 200,000 separate components in more than 5,000 different plants, with those parts or items ranging from feed bags and star shells to complete trains of railway artillery, the judge who can competently say what your progress has been must indeed have a profound knowledge of the field.

It was my fortunate experience to view the work of our corps both in France and at home. For the first ten months of the war I was with the American Expeditionary Force. For the rest of the time it was my duty to keep in constant review the fruits of your labor at home. Of such knowledge I say that you did exceedingly well and that I am proud to have worked with you in this war.

I say this utterly without thought of any personal responsibility for that success. The tribute is not to me. It is not alone to the Army Ordnance Department of the regular establishment nor to the Ordnance officers of the Temporary Army. It is to American industry and engineering, to American science, that the credit for this achievement must be given. It was American industry and science that were on trial. The ninety-seven officers of the Ordnance Department of the regular Army and the government arsenals they administered could never have dominated this

work; have won the success or caused the failure of the 5,000 officers from civilian life and the 5,000 private industrial plants that were incorporated in the organization for the period of the war. The enlistment of industry, equally with the draft of man-power, was a success. And for that I thank you, the administrative directors and the engineering advisors of American industry who came into the service of the Ordnance Department during the war.

It is probable that the Army Ordnance Department exercised direction over a greater physical power than was ever concentrated upon a single purpose in the history of the world. The happy attainment of our objectives in the war within nineteen months gave insufficient time for the complete development of that power. Proper strategy required the projection of the Ordnance program upon a scale designed to secure an ultimate, overwhelming and continuous rate of production rather than a lesser rate of production at an earlier date. Obviously a housewife could buy an oven and bake six loaves of bread in less time than a bakery could be built and provision made for the needs of an entire city. But the rate of production from the housewife's oven would never feed the city. The Ordnance objective was a rate of production adequate for an Army of 5,000,000 men. That program was dictated to the Ordnance Department by the General Staff in accordance with its man-power program. To win that objective we had to allot time for the building of plants capable of such rate of production. We had to obtain designs and even, where necessary, discard existing designs, to get manufacturing methods on a basis permitting of such rate of production. We could not sacrifice production in 1920 to force a quicker but lesser rate of production in 1918. We were building to make ultimate victory absolutely certain and there never was a moment when the Ordnance program did not guarantee the ultimate defeat of Germany.

Under such a policy it was inevitable that the attainment of victory within nineteen months would leave the Ordnance program unfinished in certain respects. However, within that period we

effected the complete mobilization and perfected the co-ordination of science and industry with the war machine, we produced munitions of certain classes in unprecedented quantities, we developed and supplied materiel of such superior design as to receive the praise of our allies and the acknowledgment of our foes and we stood ready, during the month the armistice was signed, to turn on the taps at full force that had been made ready to provide a flow of munitions such as no nation had ever attempted. The fact that the American munitions program alone was greater than that which Germany could attempt after thirty years of preparation for war is apparently little realized in this country. But I have no doubt that it was realized in Germany and that such realization substantially contributed to victory by its reaction upon the minds of the military masters of the German empire.

I repeat, this achievement and this contribution to victory is more largely to be laid to man-power and brain-power mobilized in the service of the Ordnance Department than to any other single source. Your reward for service to country might well be in your realization that your ability was a part of the composite mind which, at the moment of victory was bringing forth the strength of thousands of industrial plants and the might of millions of American workmen and workwomen, to transmit that incalculable force three thousand miles oversees to Chateau Thierry and St. Mihiel. Nor could the power of our country have been made effective except as this composite mind harnessed science and industry in the service of the war machine.

The design of Ordnance is a highly specialized science and its production a highly specialized industry. As a science it possesses a history of research and experimentation that reaches back hundreds of years beyond the earliest dates recorded in other fields of scientific knowledge applied in modern industry. The mastery of Ordnance design requires a command of that mass of scientific fact. It requires the devotion of a life-time of study and research to the science and it is utterly impossible to improvise a master in

Upper: Railroad gun in action north of Mailly, France, May, 1918. Lower: Railroad gun in transit. An 8-inch gun and narrow gauge armament train. Ordnance received assistance with its railway artillery program, finding available 464 big guns, completed or under manufacture, which came from the coast defense and from the Navy. Ordnance had to design and produce the gun cars and mounts, and complete armament trains. Despite delays incident to slow deliveries of material, labor shortage, etc., eighteen complete units had been turned out when the armistice was signed and—of even more importance—the plants had developed a capacity of fifteen units per month. Three complete units had been shipped overseas. No part of the Ordnance program shows more clearly the potential military strength America possesses in industrial genius and capacity, or more strikingly the need of a degree of industrial preparedness to mobilize that strength at the fighting front in due time.

ing for any industrial plant. The difficulty and complexities involved in the manufacture of more than 1,200 of them, under the pressure of limited time and the manifold handicaps of the industrial and transportation conditions then prevailing will be manifest.

The 240-howitzer project actually got under way on September 1, 1917, when an order was placed with the Watertown Arsenal for 250 carriages complete with recoil mechanism, transport vehicles, tools and accessories. Although this only opened the program, an allotment of $17,500,000 was necessary to cover the estimated cost of the order. Despite the elaborate equipment of this arsenal at the time for the production of heavy gun carriages, it was necessary to build an entirely new erecting shop with a capacity equal to that of all the old buildings combined. The force of mechanics was increased from 1,200 to over 3,000 in several months.

To obtain the extensive equipment of heavy machine tools required it was necessary to comb the entire country; experts were sent out to locate and procure them wherever available. Great difficulty and delay also developed in obtaining delivery of taps, dies and all necessary fixtures. Raw material deliveries always fell behind schedule, for even after they were produced and shipped there were endless transportation delays.

But despite all obstacles, work on the original carriage order was pushed unremittingly and the pilot carriage of the project was delivered in October, 1918. Some two months after this first carriage order was placed with the arsenal, the Standard Steel Car Company agreed to accept an order for 1044 carriages, complete with transport vehicles, limbers, etc., but without the recoil mechanism. Although as one of the most important freight and passenger car builders in the country this company possessed an extensive and well equipped plant, it was nevertheless necessary practically to double the capacity of its huge erecting shop by the construction of additional buildings and greatly to increase other plant facilities to make ready for the tremendous task undertaken.

To expedite production sub-contracts for many of the smaller component parts were immediately placed by the Standard company with more than 100 firms through the east and middle west. As many of these firms were already working on sub-contracts for the Watertown Arsenal carriage order, their utilization on the order with the Standard company meant better prices and closer standardization of parts. Subsequent placing of orders by these sub-contractors with manufacturers of raw and finished materials meant that the ramifications of this 240 carriage project soon had extended throughout the entire industrial fabric of the eastern and central states. This tremendous outlay obviously multiplied enormously the effect of delay and uncertainties in transportation, of fuel shortage and the other handicaps under which the project labored. Raw materials could in most instances be obtained only through allocation by the War Industries Board and the granting of priority orders on the manufacturers of these materials, who were over-loaded with other government orders of varying importance. Notwithstanding all handicaps, however, work was forced ahead and the deliveries contemplated for 1919 were in sight when the armistice was signed.

Construction of the 240 howitzer recuperators to match the carriages to be turned out by the Standard Steel Car Company was undertaken by the Otis Elevator Company. To carry out a contract for 1,039 recuperators accepted on May 1, 1918, this company had to completely rebuild and equip a plant which it already owned in Chicago. Forgings for the recuperators were furnished by the Carnegie Steel Company which completed the rough-machining before shipment to the Otis Elevator Company. The first recuperator was finished by the latter company early in November, 1918, a little more than six months after the order was placed.

Another independent order for recuperators to keep pace with the carriage capacity to be developed by the Standard Steel Car Company was placed with the Watertown Arsenal in the summer of 1918. This order called for 250 recuperators in addition to those

which the arsenal had already been called upon to deliver in its original carriage contract. Much new equipment had to be secured to take care of this order, but production was gotten under way rapidly. The arsenal furnished most of its own recuperator forgings but an additional supply came from the Carnegie Steel Company. Recuperators actually completed at the arsenal numbered 16 by December 31, 1918, and 280 forgings were in process of machining.

With both the arsenal and the Otis Elevator Company thus rapidly coming into quantity production on recuperators there was no danger of the 1919 program for 240 howitzer deliveries being held up by a lack of this mechanism.

The massive gun bodies for the 240 howitzer were placed in production at the Watervliet Arsenal, that is, they were ordered machined and completed there. Orders for rough forgings to be shipped to the arsenal were distributed between five or six plants. From November 20, 1917, to November 7, 1918, a total of 1,160 gun bodies were ordered completed at Watervliet. Construction of an entirely new machining plant was necessary to carry out the work and allotments to the arsenal during the war for increasing its facilities totaled nearly $14,000,000. The arsenal undertook to develop a maximum capacity of 100 cannon a month and to deliver the last of the 1,160 not later than September 30, 1919.

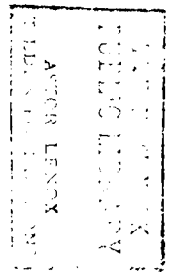
Gun bodies actually completed up to December 12, 1918, totalled 158, the pilot cannon having been delivered in August, 1918.

Thus, by December, 1918, it is seen that production in all parts of the 240-millimeter howitzer had been placed squarely upon its feet and promised rapid increase in deliveries. Had the war continued, by the spring of 1919, many of our overseas divisions would have been equipped with this splendid weapon produced wholly in American plants. It was planned to develop a capacity of 80 units a month in the early part of 1919.

on a curved track, or epis, when wide traverse movement is required for aiming the gun. Only part of the recoil shock is absorbed in the recoil system of the carriage, much of it being transmitted to the gun car itself, which necessitates the car being bolted to the track and braced from the ground. In the third mount, known as the Schneider type, also used for the heaviest guns, the gun trunnion and mount are fastened rigidly together. Thus with no traverse movement provided it is necessary to depend entirely upon movement of the car on a curved track to secure traverse aim. The carriage, of course, provides elevation for the gun. The entire recoil in this type is absorbed by a retrograde movement of the car along the track, the heaviest guns driving the car twenty or thirty feet back after fire.

The first railway mount project of the Ordnance Department was undertaken as a measure of defense against possible attempts by German submarines to raid our coast. The twelve 7-inch guns turned over by the navy were mounted for this purpose. A special pedestal mount was designed, giving the gun a 360-degree traverse. This gun was mounted on one of three standard types of railway artillery cars designed by the Ordnance Department for the 7- and 8-inch guns and the 12-inch mortars, the three types having the same general features.

Taking the projects in the scale of gun sizes, for the 8-inch coast defense guns the first type of mount was adopted. Orders for 47 gun cars and mounts were placed with three concerns, two of which had materially to expand their shop facilities before beginning work. The prevalent condition of congested railroads and depleted raw material markets proved a serious handicap to getting production under way. But by June, 1918, the first eight-inch railway mount had passed a thoroughly satisfactory test at the Aberdeen Proving Ground. When the armistice was signed 18 complete units had been turned out and the contracting plants had developed a capacity of 15 mounts per month. Three complete units had been shipped overseas. These units included ammunition



Six of these huge 12-inch guns were under manufacture in the United States for the Chilean government when the United States entered the war. They were provided with sliding railway mounts, one of which is shown in this picture. The mount is an American design though an adaptation from the French. The first of these mounts was completed within eighty-five days after the order was placed and all of them were awaiting shipment to France when the armistice was signed. The mount has thirty-six car wheels and a length of 105 feet, so that the track can stand the tremendous strain when the gun is fired. The range of these guns is 25 miles, firing a 700-pound projectile. As an indication of the sound basis of claims made as to what Ordnance production would have been with the continuation of hostilities, work on mounts for these guns was continued after the armistice and 45 were completed on April 7, 1919, whereas General Pershing had requested only 40 for the entire campaign of that year.

cars, transportation cars, tools, spare parts and all necessary appurtenances. It was necessary to equip the gun cars of these units with narrow-gauge as well as standard-gauge trucks so they could operate on the narrow-gauge track used in the fighting zone in France.

An eight-inch gun of longer range than the coast defense guns was subsequently designed with railway mount and an order placed for 25 for use abroad in 1920. When the armistice was signed this undertaking was abandoned.

Railway mounts for the ten-inch coast guns were divided between the Schneider and the Batignolles types. As a joint operation with the French government, we undertook to place 36 of these weapons on Schneider mounts, the forging and rough machining to be done in this country and the finishing in the French shops. Contracts for our part of the project were distributed among three plants. Gen. Pershing had called for the delivery of 36 sets of parts in France by March 2, 1919. When the armistice was signed 8 complete sets had been produced, and there is little doubt that had the war continued the 36 sets would have been delivered by the date specified.

The Batignolles mount project for the ten-inch coast gun was placed with the Marion Steam Shovel Co., which undertook to produce 18 of these mounts. Difficulty in translating the French drawings and in securing the necessary raw materials and machine equipment entailed serious delays in this project and the armistice was signed before any of the mounts were produced. The entire project was cancelled shortly after the armistice.

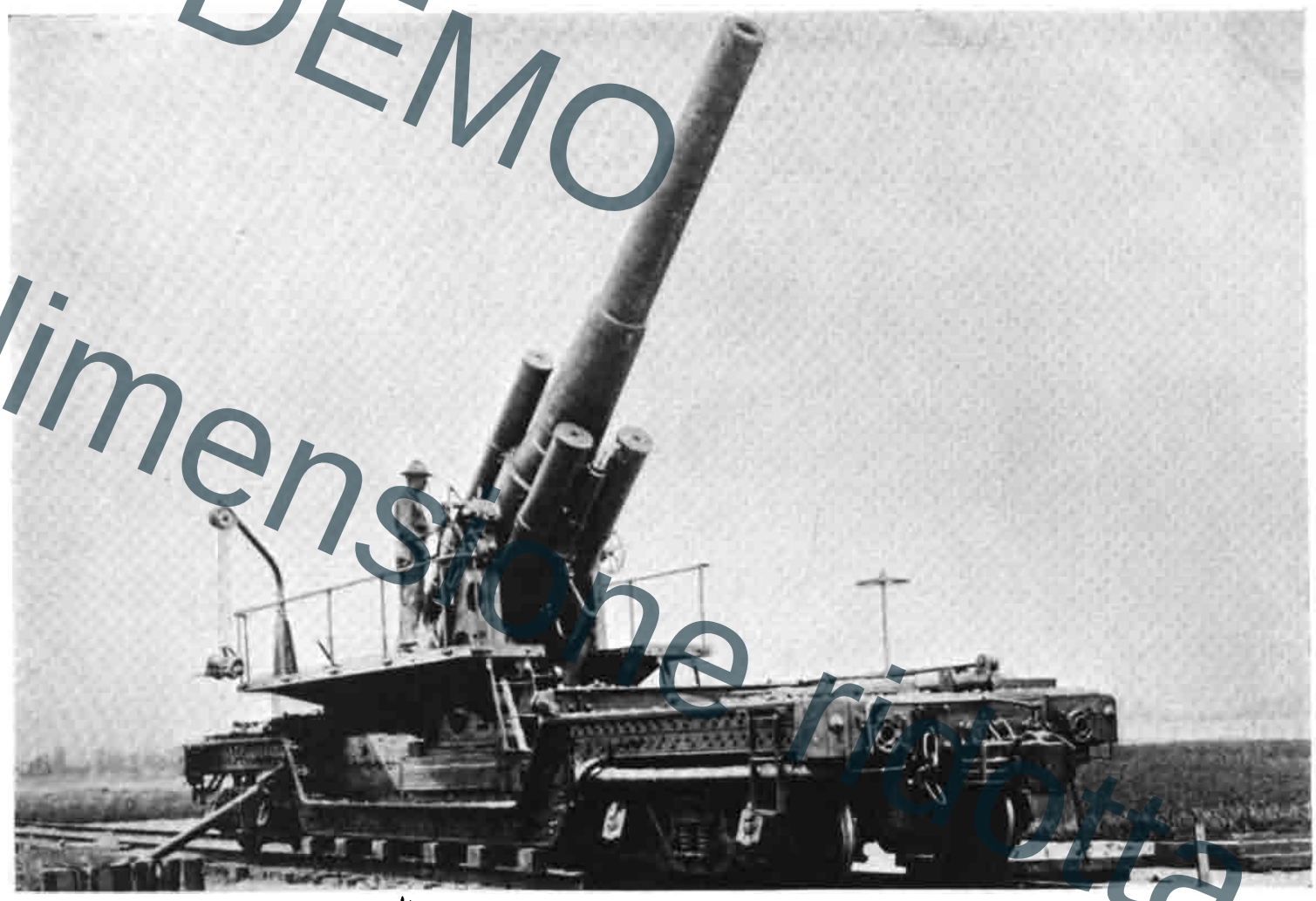
The Marion Steam Shovel Company also undertook the manufacture of Batignolles mounts for twelve of the 12-inch coast defense guns. This contract was given preference over the ten-inch mounts, and, although none of the twelve-inch mounts had been produced by November 11, work had progressed so far that the Ordnance Department ordered all 12 completed. The first was delivered about April 1, 1919.

5-, 6-, 8-, 10-, 12-, and 14-inch Seacoast guns, 12-inch for mortars, 16-inch for howitzers and gas and smoke shell for the 5-, 6- and 8-inch seacoast guns. This group of guns and Howitzers is composed of heavy Seacoast Artillery mounted on mobile vehicles such as railway mounts. It is used for attack upon heavy structures such as depots, storehouses, dumps, railways, batteries and on massed troops, the ammunition having been changed from the armor-piercing type originally employed with this artillery against armored battleships to H. E. shell of both the impact and the timed type.

As the use of this as mobile artillery had never before been contemplated, the facilties in 1917 were practically negligible, with the exception of a few small shops in operation on British contracts. Enormous facilities were developed.

The 14-inch is probably the most interesting of this group as indicative of the nature of high calibre ammunition. It is a 1,200-pound projectile carrying a powder-charge of 490 pounds of H. E. and having an extreme range of 26 miles. At the highest point in the arc it describes, this shell is 11 miles above the earth. Upon explosion, it digs a crater 30 feet in diameter and 25 feet in depth. It is fatal within a radius of 150 yards, death being caused by concussion alone, which is so great as to drive the eyeballs back in the sockets, crushing them against the bony structure of the brain and to produce hemorrhages at the ears, nose and mouth. Beyond the 150 yard area, the concussion may render the victim blind and insane without causing death. But like every frightful weapon of warfare, it gives its own warning. Its approach is heralded by an unearthly screaming which may be heard for 15 seconds before it strikes, so that there is a chance of diving into a shell-hole or dug-out, or, in the absence of such shelter, of falling flat on the ground where the concussion will not reach. The cost of a single one of these shells is $600.

The 16-inch is used in bombarding heavy fortifications. Its



An 8-inch Seacoast gun on a barbette type railway mount which permits of fire in any direction. Ninety-six such guns were removed from the seacoast fortifications and mounted on these specially designed railway mounts by Ordnance. Three plants were devoted to the manufacture of these mounts, two of them finding it necessary to enlarge their facilities and machine tool equipment to undertake the work. The first of these mounts was completed in May, 1918, and by the end of that year twenty-four complete units, with ammunition cars for standard guage track, shell cars for narrow gauge track, transportation cars, tools, spare parts, etc.. had been turned out. Three of the units were shipped overseas before the armistice was signed. The contracting plants had developed a capacity of 15 mounts per month. This rate of production is a more certain standard of measurement for American strength than production as of any given date. The problem was to continuously sustain the armies.

found to be highly efficient when adjusted with the bomb mechanism. About 30,000 of these in storage were modified and used accordingly.

Approximately 194,000 dummy bombs, used for training purposes, were also made.

For the early pyrotechnics program the capacity of the three largest fireworks manufacturers in the country, together with the Lewis Nixon works at New Brunswick, N. J., was sufficient, but with the new requirements schedules in June, 1918, tremendous expansion became necessary. This was after the cable order to change to the French type of pyrotechnics had been received and work had been suspended until new drawings could be made ready.

The new pyrotechnics program was very extensive, involving about 65 new types and styles. Production up to the time of the armistice was as follows: signal rockets, 450,000; position lights, Mk. I, 743,000; position lights, Mk. II, 807,032; rifle lights, 55,000; signal lights, Mk. I, 110,000; V. B. cartridges, 500,000; signal lights, Mk. II, 2,551,000; smoke torches 110,000; wing tip flares, 80,165; airplane flares, 4,900.

Signal pistols were made exclusively by the Remington Arms UMC. Of the 10-gauge, 20,164 has been made before the change to the French 25 m/m was made on August 5, 1918. Fifteen thousand of these had been completed by December and the 35 m/m was well under way.

The 3-inch trench mortar was used chiefly against personnel by the infantry. It fired a shell of twelve pounds at the rate of from 35 to 40 per minute to a distance of 750 yards.

The 4-inch mortar is used for the most part by special gas troops to gas the enemy front line and communicating trenches, as well as for a smoke barrage for starting fires and lowering the morale of the enemy troops by spreading molten iron on them. Its shell is a 24-pounder with a 1,000-yard range.

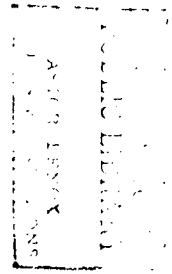
The 6-inch mortar is a demolition agent and is extremely effective against machine-gun nests, barb-wire entanglements, forti-

Upper: Grenade throwers. There is a distinct form developed in grenade throwers quite different from that of the Big League pitcher, but this picture shows that the training officer has allowed the grenade thrower in the foreground to depend upon his trusty Southpaw, doubtless as he did in the Bush League back home. Lower: Types of hand grenades. 1, Defensive; 2, Offensive; 3, Gas; and 4, Phosphorus. The ancestor of the hand grenade is the Chinese stink pot of the 15th century. A total of 34,800,000 grenades were produced in the nineteen months of the war. The grenade represents the chief contribution to the winning of the war of the women munition workers. Of the 5,000 persons engaged in grenade manufacture, ninety per cent were women, and at no time was there a strike or any labor disturbance, a record that is without parallel in the annals of Ordnance in the World War.

Chief of Ordnance and was charged with all inspection matters regarding seacoast carriages and with several other heavy duties, of which machine-gun development was but one. In the field the machine-gun problem was left to Captain (later Lt. Col.) J. S. Hatcher who, under the commanding officer of the Department of the Southwest, established in 1916 the first school for the instruction of line troops in the use and care of automatic weapons. So much for the prologue. To appreciate better the terrain over which the Ordnance Department progressed in the development and supply of machine guns until the day of the signing of the armistice, let us just here glimpse the final achievement.

At the outset of the war Germany was credited with a stock of 50,000 machine guns and was the only belligerent nation to perceive the character of the role to be played by these weapons. Nor did Germany then place all the emphasis advisable upon her machine-gun program.

As a result of a careful study of the experiences of our allies in the war, it was decided at an early date that each of our divisions should be equipped with seven hundred sixty-eight automatic rifles and two hundred twenty-four machine guns. When this requirement is compared with the pre-war allowances of about fifty machine guns and no automatic rifles at all to an Infantry Division, and when it is remembered that at the beginning of the war this country had on hand only approximately thirteen hundred machine guns of all types, and these were not generally accepted as suitable for service in the war, some idea may be gained of the difficulty confronting the Ordnance Department relative to weapons of this type. As an indication of how well the Ordnance Department met its obligations in this regard, it should be noted that during the nineteen months we were in the war, sufficient automatic rifles were produced to equip over one hundred divisions at seven hundred sixty-eight guns each, or an army of approximately three million five hundred thousand men, and sufficient machine guns were produced to provide an army of seven million men. In addition to



Upper: The Light Browning Automatic Rifle. Lower: The Heavy Browning Machine Gun mounted on tripod. The automatic rifle is a weapon of fourteen pounds weight which is carried forward in an infantry advance and operated by one man, firing from shoulder or hip in short bursts of fire. Such tactical use of an automatic weapon was a development of this war, perfected through the superior design of the Light Browning. The heavy machine gun is a water-jacketed weapon capable of continuous stream fire. A Browning heavy has fired as many as 40,000 rounds without malfunction or jamming. During the nineteen months the United States engaged in war, enough automatic rifles were produced to equip an army of 3,500,000 men, and enough machine guns were produced to equip an army of over seven million men. These guns develop more power than does a racing automobile.

these weapons which were provided for use on the ground, the Ordnance Department produced during the nineteen months of the war, seventy-one thousand one hundred twenty-five aircraft machine guns. In all a total of eighty-one thousand automatic rifles and one hundred twenty-five thousand seven hundred fifty-two machine guns of all types were produced.

Quantity production, however, poorly measures the full extent of the achievement. Testimonials as to the quality of that production are available from officers of the American Expeditionary Forces, from machine-gun experts of the Allied Armies and, indeed, from the enemy himself who swallowed the fire of our product.

Back of this prodigious production, is the expert organization which Ordnance improvised and developed—the work of the Ordnance Department. I know of no standard of measurement, no calculation that will permit the layman to sum up the human labor this accomplishment required. The work of the Ordnance personnel is always, for the layman, the incalculable component of victory. But to return to the details of the task:

The rifle and small arms manufacturing facilities of the country had been largely developed prior to our entry into the war, due to the fact that the Allied governments had placed large orders for rifles and ammunition with our manufacturers. This condition of affairs did not exist in the case of machine guns and automatic rifles inasmuch as the Allies depended almost wholly upon their own resources for these weapons. Only two American plants were actually producing machine guns in quantity; the Savage Arms Corporation of Utica, N. Y., was nearing the completion of an order of 12,500 Lewis machine guns for the British and Canadian governments, and the Marlin-Rockwell Corporation had manufactured large numbers of the Colt machine gun (old type) for the Russian government. On April 12, 1917, a week after the declaration of war, an order for 1,300 Lewis guns was placed with the Savage Arms Corporation and on June

2nd an order was placed for 2,500 Colt guns for training purposes. The stock on hand when war was declared consisted of 670 Benet-Mercie machine rifles, 285 Maxim machine guns, Model 1904, and 350 Lewis machine guns chambered to use the British calibre .303 ammunition. It is evident from these facts that manufacturing facilities were extremely limited and that to achieve the rate of production of machine guns and rifles required for the man-power program of the General Staff new plants had to be provided and tooled up, an operation that requires a long time.

The policy of the Ordnance Department was to employ every available resource and to create new resources as quickly as possible. Existent facilities for the manufacture of Lewis guns were fully employed and new facilities were sought for the manufacture of the Browning (heavy type) machine gun and the Browning automatic rifle which were not only proven to be excellent in design but also comparatively easy to manufacture in quantity with standardization and interchangeability of parts.

Surveys were made of the facilities of various plants for the manufacture of the Browning guns, the Government having compensated Colt's, owners of the Browning patents, and Mr. J. M. Browning, the inventor, for this right. In July, 1917, orders were placed with the Colt's Patent Fire Arms Manufacturing Company for ten thousand Browning machine guns and twelve thousand Browning automatic rifles; in September, 1917, orders were placed for fifteen thousand Browning machine guns with Remington Arms Union Metallic Cartridge Company of Bridgeport, Conn., for 5,000 Browning Aircraft guns with the Marlin-Rockwell Corporation, New Haven, Conn., and for 20,000 Browning automatic rifles, light type, with the Marlin-Rockwell Corporation. The Winchester Repeating Arms Co., of New Haven, Conn., also began preliminary work on the manufacture of the Browning automatic rifle and a formal order for 25,000 of these rifles was placed with that company in October. Facilities of the Mayo Radiator plant at New Haven, the New England Westinghouse Company's plant at

before the Yankee pistol than any other weapon, that the American pistol shooters were feared no less than the mysterious "Ladies from Hell," and that military surgeons reported that pistol wounds were rare among the Allied troops.

The Colts Patent Fire Arms Company was tooled up for a large production of this weapon and it was believed by both the plant and Ordnance Department officials that they would be able to take care of the entire program. That this prediction later proved erroneous is not surprising, nor can blame be laid on either the company or the Ordnance Department. With no precedent, neither could foresee and count on the magnitude of the labor situation about to confront the country, the scarcity of steel, the tremendous increase in requirements in the Spring of 1918, the crippling lack of expert tool-makers, the railway congestion, and the score of other limiting factors which played so great a part in the pistol program.

When it became apparent in December 1917 that the Colt plant could not possibly meet requirements, contracts were placed with the Remington Arms and that company immediately started to create facilities. But tooling up a plant for quantity production is no sinecure. A minimum of four months is required before a pistol can be started; two more are necessary for any production; securing that most elusive of all artisans, the expert tool-maker, has proved far more elusive than gunning for the Hun; the necessity for making new drawings and effecting absolute interchangeability in the product of the two plants; the nicety of pistol manufacture itself, representing 619 separate operations with exceedingly close tolerances; the securing of the necessary eight grades of material and the building of the 1,264 machines for the Remington plant, presented a problem which made the opening production in August 1918 an unusually quick piece of work.

By that time the situation had become very serious and contracts to the extent of 2,550,000 pistols were placed with eight commercial firms such as the Burroughs Adding Machine Company,

the Lanston Monotype Company and other firms whose peace-time products required machinery which might be converted to manufacture pistols. None of these, however, got into production up to the time of the Armistice.

At that time, cumulative production totaled approximately 450,000. The practically negligible production of 1917 had been built up to 65,000 monthly, and had the War continued until the new contracts were under way, the Spring of 1919 would have seen a monthly output of 650,000 pistols.

That pistol production could not at once meet the tremendous immediate requirements was inevitable and it was decided to use the caliber .45 revolver as a substitute until such time as pistol production should justify its abandonment.

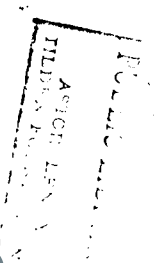
The revolver in question had several drawbacks; it was two inches longer than the pistol, harder to manipulate, capable of only about 1/3 the speed in shooting and it contained only 6 instead of 7 cartridges. On the other hand, it was capable of using the same ammunition as the pistol; there were two plants, Colts and Smith & Wesson, sufficiently tooled up to begin almost immediate production, and it was the best available substitute.

Its production started in October, 1917, and remained throughout the summer of 1918 at a fairly even average of 25,000 monthly, no attempt at increase being made, as this would have entailed a corresponding decrease in pistol production.

Only about 268,000 were produced to November 11, 1918, the October production having reached 33,400, a daily output of 1,200, double that of January, 1918.

SMALL ARMS AMMUNITION

The story of cartridge production during the War is one of the most spectacular in the history of industry. Early in 1917, existing facilities could not produce more than a small fraction of requirements. Frankford Arsenal, the chief source of manufacture, had a



The best military pistol in the world, the U. S. 45. During the trials when this pistol was made the standard of the United States Army, the two models of the famous German Luger proved the least destructive, which may account for the fact that the Germans, with their 26 types of pistols and including the famous "murder" and "camerad" pistols, were reported to turn tail before the Yankee pistol quicker than before any other weapon. At the time of the armistice the United States was producing more small arms ammunition of the service type than France and England combined. A single plant, the Remington Arms U M C Company, was turning out 6,000,000 rounds daily, double the quantity of the largest order they had ever received prior to the war. This plant's first year's output of 1,000,000,000 rounds equaled 35 years of peace-time manufacture.

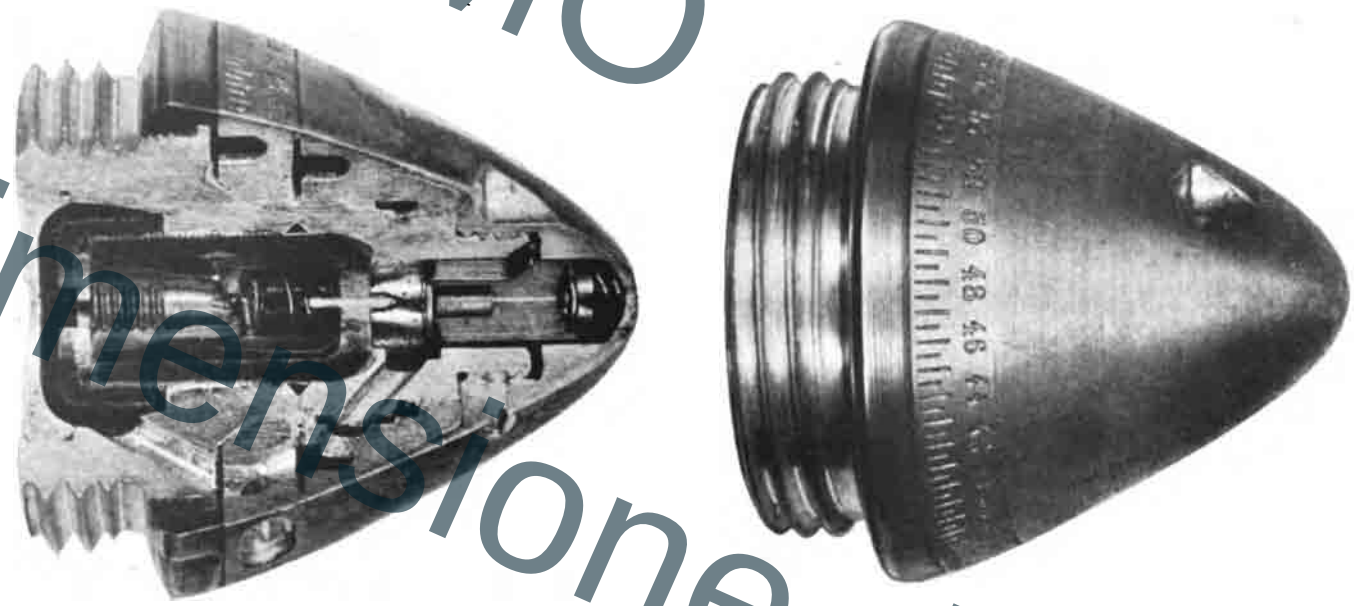


Fig. 1: What the public sees of our product. Fig. 2: What that product really is. An exterior and a cross-section view of the head of a seventy-five millimeter shell. The shell is composed of seventy-three component parts made with all the precision and delicacy of a watch. The layman, observing an ammunition dump with these shells stacked in thousands, has no appreciation of the difficulties of design and manufacture encountered in the production of the first type shell and until quantity production is achieved. This intricacy of design is what makes possible the timing of the explosion and the perfect control of the force of the shell. A particular shell is developed for each tactical requirement; shrapnel, high explosive or gas. Shrapnel would be employed against personnel, high explosive for demolition purposes, and gas to break down the morale of an enemy force preparatory to an advance.

capacity of 100,000,000 yearly. Requirements called for 2,756,608,000 to July 1, 1918.

The difficulties attendant upon the production of the cal. 30 service cartridge were numerous. Heretofore, our service ammunition had been used in one type of rifle and two machine guns. Owing to the impossibility of having the complication resulting from a variety of small arms ammunition, it now became necessary to develop a cartridge which would function satisfactorily in two rifles and seven machine guns, each having firing-pins of differing shapes, sizes and methods of functioning, and each giving a different pressure on the primer. To develop a cartridge adapted to the eccentricities of any one of these guns would have been a comparatively simple matter, although the logical method is to fit the gun to the cartridge. To develop one suited to all nine, one which was adapted equally well to service on land and in the air, which must therefore be absolutely free from jamming and hang-fire and which could be produced in billions by a dozen different manufacturers was a task challenging the keenest faculties of ammunition experts. To devise a perfect cartridge for peace-time manufacture is one thing; to develop one which can be made at the rate of 11,000,000 per day is another.

The cartridge itself is one of the most difficult in the word to make, many of its tolerances being less than a thousandth of an inch. There are 88 operations aside from gauging and inspection on each cartridge.

Early in the fall of 1917, a conference of all the small arms ammunition manufacturers in the country was called to devise a means of creating new facilities and to discuss standardization. The problem of facilities was settled by an agreement on the part of the manufacturers to expand as much as possible, thus providing for an extra billion rounds per year. Existing facilities, however, which were for the cal. 303 British cartridge of the rimmed type, had to be modified to produce the U. S. ammunition, which was very different. This required six months before quantity pro-

To send this gun back to the firing line was a part of the job of Ordnance with the A. E. F. To make repairs to guns and Ordnance equipment at organization and training centers or instruction camps, more than twenty-five repair shops were equipped and maintained in the S. O. S. The greatest of these, at Mehun, was itself designed to handle repairs to all artillery and Ordnance equipment for an Army of 2,000,000 men. It covered 50 acres of ground, was manned by 6,000 technically trained soldiers, and could remake anything from a tank or a piece of heavy artillery to a mess-kit. It was designed for a capacity of relining 1,245 guns, repairing 2,000 Ordnance gun vehicles and 3,000 Ordnance motor vehicles and overhauling 150,000 rifles, 5,000 pistols and 20,000 machine guns a month.

put into action against the retreating Germans 28 pieces of their own artillery, ranging from 77-mm. to 210-mm. guns. The Mobile Ordnance Repair Shop attached to the 35th Division established the record of having no piece of artillery out of action over five minutes during the Argonne drive.

These repair shops took care of all Ordnance materiel, and many other things besides, such as water carts, rolling kitchens, bicycles, typewriters, shower baths, watches, meat grinders, steam rollers, stone crushers, trench pumps, captured German baths and delousing plants. They also assisted in the salvage of Ordnance equipment.

It is said that some chronicler of Ordnance activities, seeking local color, was invited to visit one of these mobile repair shops at work. As he arrived a hugh motor truck, which had been brought in helpless, was snorting away, restored to full vigor. A Y. M. C. A. secretary was waiting with a Victrola to be fixed. In a few minutes it went away singing. Then a heavy tractor lumbered in, towing a great 155-mm. G. P. F. gun which had been put out of action. It was repaired and returned to the lines.

As it went away a general's car drove up and the general himself got out. "Captain," he said, "I have lost a little screw out of my eyeglass and I am helpless without them. Is there any way you can fix them?" There was. "That will do," said the historian, closing his note book, "I have local color enough for one day."

Some of the notable work of the Ordnance Department was done in arming planes for the American front. The aircraft armament shops were at Orly and Romarantin, the two airplane assembly plants of the A. E. F. The adaptation of American armament to European planes was a knotty problem consummately handled. The Vickers, Lewis, and Marlin machine guns with which our planes were armed proved highly satisfactory in combat.

The supply of aircraft armament, ammunition and drop bombs at all times met the demand, and, to quote the verdict of experts, was of "proven efficiency against the enemy."

Not only had our Ordnance Department at the time of the armistice matched the armored seat provided by Germany for the protection of her aviators, but steps had been taken to put on the front an invincible armada of all-armored planes. None of these ironclads of the air had actually taken the field, but the project had long passed the experimental stage. The Ordnance Department, indeed, before the war ended, had equipped the forces at the front with veritable flying fortresses, fitted with eight guns instead of two or four. Four of these guns projected through the floor of the plane, two fore and two aft.

Another contribution of our Ordnance to airplane warfare was a parachute dropping device, with a 14-foot spread, for dropping food, supplies and ammunition to troops in the trenches. This device was completely successful and was actually employed on a large scale.

The Ordnance Department had well in hand the production of a standard American parachute for the use of aviators in jumping from their planes, but none was ever used by us at the front. The Germans actually used the parachutes successfully during the last few weeks of the war.

There should also be mentioned the American bomb dropper, furnished our planes, by which our aviators could take any kind of an Allied bomb on their bombing expeditions. The American Wimpers and the Franco-American Michelim bomb site proved 100 per cent efficient in guiding bombs to their objective.

In addition to its achievements in the field another great problem that confronted the Ordnance Department of the A. E. F. was storage and heavy repair in the S. O. S.

The base section of the A. E. F. was the great reservoir of Ordnance materiel and facilities into which the initial Ordnance supplies were poured. The intermediate section was the regulating mechanism taking up fluctuations of supply and demand. The advance section was the sensitive system in direct touch with the Army and responsive to its needs from day to day. For the pur-

pose of maintenance and reserves, it was planned to keep 45 days' supply in the base section, 30 days' in the intermediate and 15 days' supply in the advance section. This idea was never fully realized, but it was well approached in the summer of 1918.

To effect the distribution of Ordnance materiel, it was necessary to stretch multiple chains of general and ammunition storage depots across France from the base ports to the front lines. Thus, for example, at the coast were the great general storage depots of St. Sulpice and Montoir; in the intermediate area, Gievres with its acres of buildings; in the advance zone, Is-sur-Tille, which long bore the brunt of the supply service—all of them handling hundreds of cars a day.

The ammunition storage projects alone of the A. E. F. covered enough of France to make a good sized county in New England.

The depot at St. Loubes was two miles long and nearly two miles wide. The ammunition storage project at Donges extended along two sides of a triangle for nearly four miles. Foecy deserves a place on the map of the A. E. F.; here thousands of tons of French, British and American ammunition were received and stored, reclassified and sent to the front.

As many as 1,500 ten-ton cars of guns and ammunition were sent out from this center in a day, the storage project employing 1,000 men. Jonchory, with its spider-web system of tracks and its warehouses cleverly hidden and naturally camouflaged by the trees, housed tens of thousands of tons of shells, grenades and bombs, and during active offensives handled 300 cars a day in and out.

To make repairs to guns and Ordnance equipment at organization and training centers or instruction camps, more than 25 repair shops were equipped and maintained in the S. O. S. The greatest of these, at Mehun, was itself so designed as to handle repairs to all artillery and Ordnance equipment for an army of 2,000,000 men. It covered 50 acres of ground, was manned by 6,000 technically trained soldiers, and could remake anything from a tank or a piece of heavy artillery to a mess-kit. It was designed for a capacity of

relining 1,245 guns, repairing 2,000 Ordnance gun vehicles and 3,000 Ordnance motor vehicles and overhauling 150,000 rifles, 5,000 pistols and 20,000 machine guns per month.

Whether in depot, shop or ammunition dump, the work of the Ordnance Department required individual fitness and special training. To supply the latter, the department organized and operated six great schools—St. Aignan, for office work and care of Ordnance equipment; Foecy, Jouchery and Bourges, for ammunition; Is-sur Tille, for artillery, small arms and Ordnance supply and shop work, and St. Jean de Monts, for the aerial armament training which contributed to the brilliant results already spoken of. The alumni of these schools numbered some 5,000 to which the graduates of many smaller centers of instruction added a considerable number.

The work of the Ordnance Department in the A. E. F. was neither a small nor an easy job. Some idea of its extent can be estimated from the fact that it handled more than 500,000 tons of materiel and spent more than $50,000,000 and made every ton and every dollar count.

To their credit it should be said, in conclusion, that this program was carried through by a little band of 1,803 officers and 12,205 enlisted men, whose work was as hard as any in the Army and as hazardous, even if in the S. O. S. According to the schedules of requirements the Ordnance force of the A. E. F. should have been 2,145 officers and 35,330 enlisted men, while the program for July 1, 1919 called for 3,454 officers and 70,550 enlisted men.

The history of our Ordnance is the history of success in a race between handicap and American brains and energy, and therefore one in which we can all take pride.

Roster of the Commissioned Personnel

Ordnance Department—United States Army

As Compiled by the Office of the Chief of Ordnance as of November 11, 1918.

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