THE NEW ARMY 16-INCH GUN.

The 16-inch rifle is the first of a series of similar gigantic weapons which were proposed for the sea-coast defense of the United States. The Endicott Board, which took the whole subject of sea-coast defense into consideration a few years ago, came to the conclusion that eighteen of these enormous weapons should be made for the protection of New York. The board also recommended that ten 16-inch guns should be mounted at San Francisco, eight at Boston, and four at Hampton Roads. It is not likely that this policy will prevail; for the time being, however, and until others of like caliber be constructed, this gun remains the most powerful piece of ordnance extant.

Guns of large caliber have been constructed in other countries, but a comparison shows how great is the ballastic superiority of the American gun over all others. Guns of the largest caliber ever built were the Italian gun with a caliber of 17·75 inches, the French gun of 16·5-inch caliber, and the Armstrong gun which is carried on the battleships "Benbow" and "Sans Pareil" of 16·25-inch caliber. Not one of these, however, can compare in point of energy and range with the 16-inch gun, the manufacture of which is nearing completion at the Watervliet Arsenal gun factory, New York.

The range and energy of the gun will, of course, vary with the quality and amount of powder used. Constant experiment is resulting in the production of greatly improved smokeless powders, and the question of the actual performance of the gun can only be determined when the conditions of its trial tests are known. If a charge of powder made from the present army formula were used, the gun would require a powder charge of 576 pounds of smokeless powder, or if the old black powder were used, 1,176 pounds would be required. With a powder pressure in the chamber of between 37,000 and 38,000 pounds to the square inch, it is estimated that the gun would throw a projectile weighing 2,370 pounds with a muzzle velocity of 2,300 feet per second and a muzzle energy of 88,000 foot-tons; but it is likely that by using a slower-burning powder, giving less initial pressure (these being the qualities constantly sought for in the manufacture of smokeless powders), the gun would develop even greater velocity and energy than this, with a relatively small increase in the chamber pressure. Even on the basis given above, however, this gun shows an enormous superiority to any of the large guns above mentioned. The Italian gun, for instance, throws a projectile weighing 2,000 pounds with a muzzle velocity of 1,700 feet per second and an energy of only 40,000 foot-tons, an energy something less than one-half that of the new army gun; the French gun projectile, weighing 1,700 pounds, with a muzzle velocity of 1,700 feet per second had a maximum energy of 36,000 foot-tons; while the English gun projectile, weighing 1,800 pounds, with a muzzle velocity of 2,100 feet per second showed a total energy of 51,000 foot-tons. The maximum energy of the Italian gun was thus 45 per cent, the French gun 41 per cent, and the English gun 65 per cent that of the Watervliet Arsenal gun.

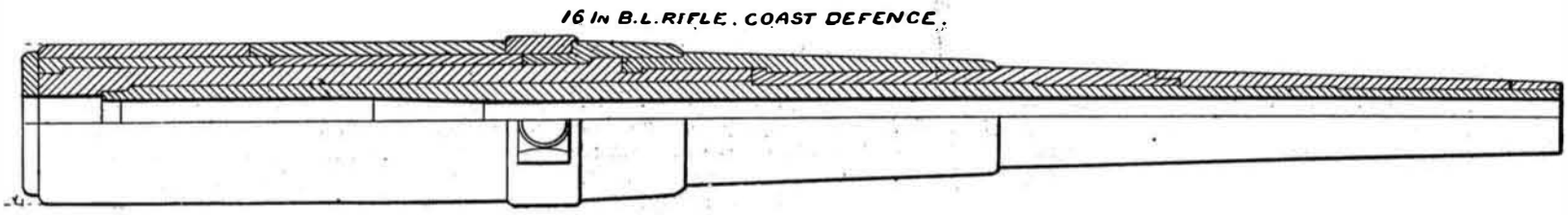


DIAGRAM SHOWING METHOD OF BUILDING UP 16-INCH GUN.

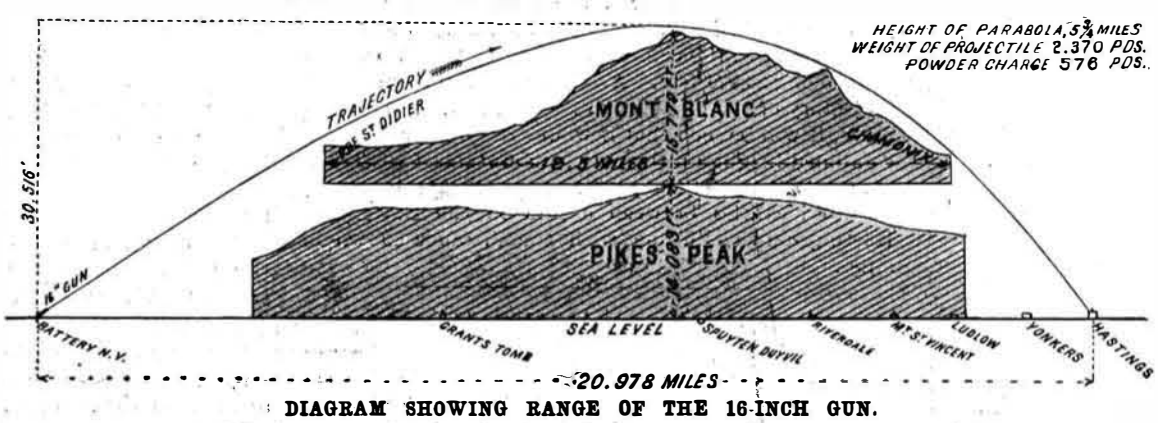
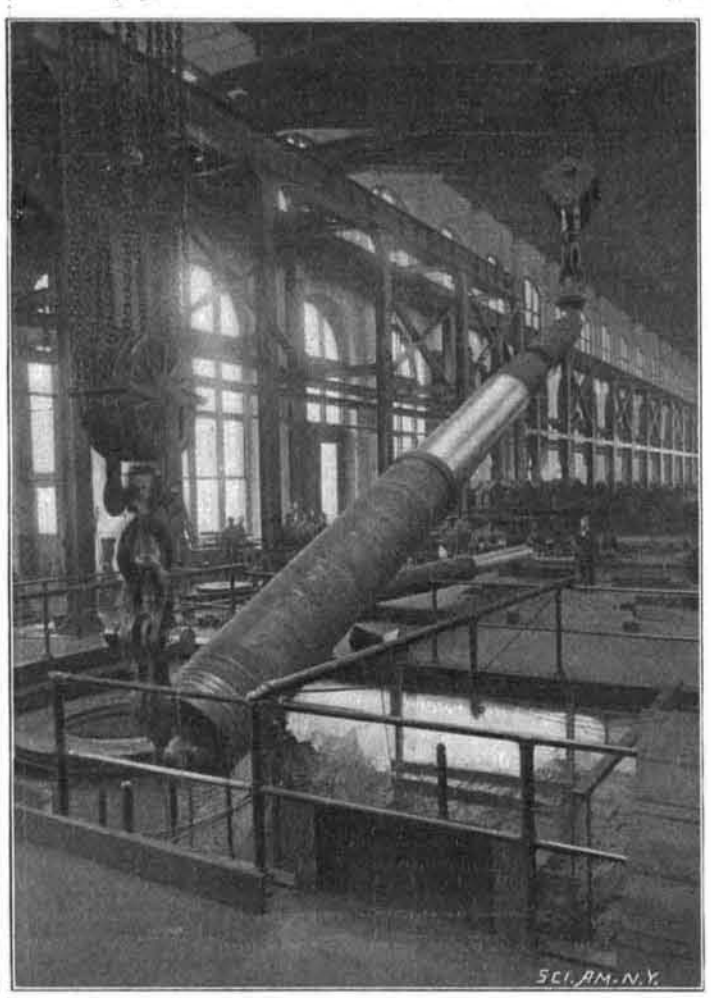


DIAGRAM SHOWING RANGE OF THE 16-INCH GUN.

THE 16-INCH GUN IN THE LATHE BEING TURNED TO RECEIVE THE HOOPS OVER THE JACKET.

JACKET BEING REMOVED FROM THE SHRINKAGE FURNACE.



THE 16-INCH GUN BEING LOWERED INTO THE SHRINKAGE PIT.

From the accompanying diagram showing the method of assembling the gun, it will be seen that it does not differ materially, except in the proportion or distribution of its parts, from the average built-up army gun. It consists of a long inner tube; a heavy jacket extending from the breech to about 6 feet beyond the trunnions; the chase hoops, extending from the jacket to the muzzle, and the jacket hoops, inclosing the jacket and extending from the breech for about half the length of the gun. The length of the gun is 49 feet $2\frac{9}{10}$ inches; diameter of breech, 5 feet; of muzzle, 2 feet 4 inches; and the bore is 16 inches. The total weight of the forgings of the gun as received from the steel works was 368,000 pounds. The finished gun will weigh about 300,000 pounds, leaving the amount of steel removed from different parts during manufacture about 68,000 pounds. The projectile of the gun will be 5 feet 4 inches in length, and the penetration in steel at the muzzle corresponding to the energy given above is (De Marre's formula normal impact) 42·3 inches.

By the courtesy of the War Office, under authority given Colonel J. P. Farley of the Ordnance Corps, commanding the Watervliet Arsenal, New York, we are enabled to

present three very interesting photographs showing the gun in the boring lathe, the handling of the jacket preliminary to its being shrunk on to the tube, and the lowering of gun into the shrinkage pit to receive the locking or "D" hoop. At our request, this officer has also furnished us data from published official records relating to the oil and steam furnace and to the operation of the shrinkage of the gun jacket.

"The oil and high pressure steam shrinkage furnace for the 16-inch gun consists of a vertical, cylindrical 13-inch fire-brick wall resting upon solid rock in the southeast corner of the shrinkage pit, the maximum depth of which is 60 feet. Being upon the 30-foot level and 27 feet 9 inches high, the top of the furnace is 2 feet 3 inches below the floor level. Fuel oil is supplied through a 3 inch pipe from a 5,000 gallon tank upon the hill, and enters the furnace through twenty burner openings in five tiers of four burners each. The burner consists of an oil pipe enveloping a small steam pipe, with a small bole at the end of each pipe. The steam, issuing with high velocity through the small opening in the end of the pipe, carries the oil with it as a spray, thus supplying an exceedingly hot flame. The direction in which the burner points may be slightly varied by the bolts and nuts, a form of ball-and-socket joint of limited motion. To prevent the hoops being excessively heated where the flames would impinge, causing unequal expansion and even affecting injuriously the physical properties of the metal, a muffle or cylinder of one-half inch boiler steel surrounds the hoop to be heated, and prevents actual contact of the burning gases with it.

"Operation of Shrinkage of Jacket.—To drill the workmen in handling the jacket, weighing about 74,000 pounds, and especially to drill the cranemen in the operation of lowering the jacket into place on the tube, which operation had to be directed from a position 70 feet below the crane cage, a wooden tube one-tenth inch less in diameter than the bore of the jacket when cold was constructed and placed in position in the shrinkage pit, and for a week two drills per day were held of the entire shrinkage operation. Finally, on March 28, 1900, at 2:30 P. M., the jacket being in the furnace, the burners were started to heat it for shrinkage. The expansions were tried at eight different spots a number of times. During the following day it was allowed to soak in the furnace with intermittent heating during the following night, and on the morning of March 30 its seating on the tube was attempted, but without success; and a week after the first attempt, on April 6, 1900, at 4:30 A. M., the furnace burners were again lighted to heat the jacket. During this heating the jacket was measured to determine its expansion three times, and on April 7 was successfully shrunk in place. This operation took the entire day. An examination commencing at 7:30 A. M. was completed and the jacket returned to the furnace by 8:30 for additional heating at the breech end. It was again removed at 10:30, being out of the furnace at 10:41, measured and in position over the tube at 11:05, centered and started to lower over the tube at 11:16, and in place at 11:23. Preparations had been so made that water was applied to the muzzle end in less than one-half minute after the jacket was in place, and the application of water continued until 8:15 P. M., four water rings being used until about 4 P. M., the number of rings being then reduced to three, and during the last two hours of the cooling to two water rings. So much water was used during the cooling that by about 4 P. M. the lower part of the shrinkage pit was filled with water to a depth of from 25 to 27 feet, notwithstanding the fact that the pit was practically free from water when the operation was commenced and the steam pump was running constantly. This pump continued to run even when submerged by as much as six feet of water, and soon after the number of water rings was reduced to three, the capacity of the pump caused the water to fall rapidly."

The gun without the jacket weighs 102,000 pounds, and the jacket 76,000 pounds.

The difference between the outside radius of the gun itself and the inside radius of the jacket after it was heated was only six one-hundredths (0·06) of an inch. It will be readily understood that to lift the huge mass of steel out of the furnace, swing it over the gun and lower it accurately into position required the greatest care and good judgment. Any inequality in heating, the smallest fragment of an error in measurement, the slightest variation of alinement between the jacket and the tube in the pit, would have ruined the work of many months of careful preparation; for had this jacket stuck fast upon its tube before it was in the correct position, it would have been a problem to puzzle over.

Undoubtedly the most spectacular feature in connection with this gun is its enormous range, which is estimated at about 21 miles, or to be exact, 20·978 miles. This theoretical range has been calculated by Major James M. Ingalls, Fifth United States Artillery, for many years instructor at the Artillery School for officers at Fort Monroe, Va. The firing table for this gun prepared by Major Ingalls shows that the above range is obtainable with a muzzle velocity of 2,300 feet per second, the necessary angle of elevation of the piece being 40°. The trajectory of the projectile shows that in ranging to 20·978 miles the shell would reach the maximum elevation of 30,516 feet. This is enormously greater than the maximum range hitherto obtained by any other gun, which at present stands to the credit of a Krupp 9·45 inch gun, which was fired on the Meppen range, in the presence of the Emperor of Germany, on April 28, 1892. The measured range was found to be 22,120 yards, or roughly speaking, 12½ miles. The greatest height reached by the Krupp shell in its flight was 21,456 feet, and the time occupied between the firing of the gun and the striking of the projectile was 70·2 seconds. It was pointed out that had this gun been placed at Pre St. Didier in the Alps, elevated to 44°, and fired, its shell would have ranged 8,956·8 feet higher than Mt. Blanc, and its fall would have been in the neighborhood of Chamounix on the other side of the range. This performance, great as it was, becomes positively insignificant compared with the capabilities of the new army gun. To show what it could accomplish, we have prepared the accompanying range diagram. In a map of New York and vicinity the gun is supposed to be set up at the Battery. With a radius of 20·978 miles a circle is struck inclosing the territory that would be reached by the projectile of the huge weapon. Pointed to the north, the gun would throw its shells far beyond New Rochelle on the Sound, and Tuckahoe would be easily within range, as would be Hastings-on-the-Hudson. The circle inclosing its zone of fire would pass through Hempstead and Long Beach on Long Island, and its shells would pass far above Sandy Hook and fall half a mile beyond the Atlantic Highlands; Keyport and Perth Amboy would be open to attack, as would Westfield and Millburn in Jersey, while the residents at Orange could hear the huge projectiles roaring high overhead, to fall nearly seven miles distant in the valley beyond; Paterson would be within reach with four miles to spare, and Ridgewood would be an easy mark.

Adopting the method pursued by the German artillerists to give a graphic picture representative of the range, we have prepared the accompanying profile showing Pike's Peak, Colorado, with Mt. Blanc superposed above it, the combined height of the two mountains being 29,926 feet. As the extreme height of the trajectory of the 16-inch gun is 30,516 feet, or above 5¾ miles, it will be seen that it would rise higher than the combined height of these two mountains by 590 feet. On the base line of the profile are marked various well-known localities between a line on the Battery to Hastings-on-the-Hudson, with the distance shown in miles.

New Chemical Reactions.

A series of reactions has been discovered by Mr. P. Cazeneuve by which a very small proportion of some of the metals, even $\frac{1}{100000}$ part, may be detected, the solutions giving a fine blue or violet tint. In the case of chromium, the experimenter claims that a solution of $\frac{1}{1000000}$ part of the metal gives a decided violet color which is quite characteristic. These reactions are obtained by using the diphenylcarbazide, which is transformed by certain metallic salts to diphenylcarbazone, losing two atoms of hydrogen. This action is especially noticed in the case of mercurous, cuprous and ferrous salts, which give a very intense color. The organic compound used as a reagent should be in a pure state; it is obtained thus by crystallizing it in concentrated acetic acid, or even better in acetone, and drying it at 60° C. It is then dissolved in benzine, in which it is slightly soluble. To produce the reaction, the metallic salt in very dilute solution is agitated with the benzine solution, when the characteristic color appears. The copper salt gives a fine violet color, which passes into the benzine; it is not decomposed by agitating it with ferrocyanide of potassium. The mercurous salts give a dark blue tint, and ferrous salts a pinkish color, which becomes brown when agitated with the ferrocyanide. Solutions of $\frac{1}{100000}$ give a strong coloration, and may be thus detected when other reagents fail. The color is destroyed by the addition of mineral or organic acids in excess. The other metals do not produce this reaction, except in the case of gold and silver, which give rose tints with precipitation of the metal. The most remarkable reaction is that of chromium; in the state of chromic acid, $\frac{1}{1000000}$ part of the metal, or even less, is detected, giving a reaction which is not to be confounded with the preceding. It is only necessary to acidify the aqueous solution of chromic acid or chromate with hydrochloric acid, and to add the organic compound in powder in excess, and agitate. A fine violet color is obtained, which is, no doubt, due to the formation of chromated organo-metallic compounds of a basic nature. The reaction is characterized by the fact that it is stable in the presence of excess of acids; it is thus given by no other metal. The color is not taken from the water by benzine, but it will pass into amylic alcohol.

Coal in England.

Now that the question of exporting American coal to Europe, and thus securing the markets that have hitherto been controlled by England, is being so widely discussed in consequence of the high prices demanded by English colliery owners, it is interesting to study the magnitude of England's market for coal upon the Continent. For the first seven months of this year England has exported no less than 26,044,227 tons, an increase of 1,059,655 tons upon the quantity exported for the same period in 1899. The principal purchasers of this aggregate were France, Germany and Italy. The following tables will show what is the present demand in these countries for English coal in comparison with the two previous years:

	1900	1899	1898	
France	4,936,428	3,980,959	3,033,023	tons.
Germany	3,240,808	2,788,747	2,427,826	"
Italy	3,060,715	3,389,509	2,639,014	"

It will thus be seen that, with the exception of Italy, the exports to the principal European markets have increased. In London a little while ago a great outcry was raised against this enormous export of coal, as it was felt that it was only being purchased for the use of the various Continental fleets. To a certain extent this is indubitably true, but at the same time there is a remarkably increasing demand for coal for the European markets. The English colliery owners are making a rich harvest as a result of their enhanced prices. The aggregate amount of coal exported from England for the first seven months last year was valued at $64,610,290, whereas this year the value of the exported coal for the same period is estimated at $104,251,270, an increase of about eighty per cent. Notwithstanding the high increase in prices, the demand is greater than the supply. The English Admiralty are just placing their contracts, which must necessarily run into two or three hundred thousand tons, and many of the large corporations, manufacturers and railway companies are tendering for their annual supply.

Automobile News.

Chicago now has an automobile club, and among its members are enrolled most of the prominent automobilists of the city. It is estimated that there are 400 automobiles in Chicago.

Buffalo has a very active automobile club, the members of which are constantly taking club runs. Owing to the splendidly paved condition of the city, Buffalo affords an additional field for the use of the automobile.

Albert C. Bostwick, of New York, won a 10-mile open automobile championship at the Tri-State Fair at Guttenberg, N. J., September 18. The fastest mile of the championship race was made in 1 minute 27⅘ seconds.

The New England Electric Vehicle Transportation Company is doing considerable business at Boston, having 154 automobile vehicles of various kinds, and about 60 more are to be added for delivery wagon purposes. The mileage since October 2 of last year was 112,000 miles, and between 400 and 500 tons of batteries are handled every day at the station.

A large number of automobiles will be sent through the country as movable headquarters for political orators. With their aid it is possible to hold meetings at places far away from railroads, but which are still accessible by roads. Many people in the rural districts have never seen an automobile, and they would have curiosity enough to turn out to view them.

The experiments with automobiles by the Austrian army in their maneuvers in the Carpathian Mountains have been of a most exacting nature. Twelve automobiles, each of 32 horse power, started from Vienna en route to Taslo in Galicia, 480 miles distant. The road was via the Carpathian Mountains, which, in some instances, involved a climb of 3,250 feet. The hills, as may be naturally supposed in such a mountainous district, were often very steep, an incline in one case attaining a gradient of as much as 1 in 6. The automobile, however, behaved very well throughout the whole of the journey, only occupying thirty-two hours to cover the distance between Vienna and Taslo, which is an average speed of 15 miles per hour.

An attempt is now being made to provide London with motor omnibuses. This improvement is to be accomplished by the Motor Traction Company. At the present moment, there are two petrol-motor buses plying between Oxford Circus and Kensington Gate, but they are not ideal vehicles in which to travel. They are cumbersome and ugly, and create tremendous noise while traveling. Still, the experiments through which these buses have passed have been productive of valuable experience, and several improvements upon them have been made. The type of bus at present under construction will possess all the good features and none of the drawbacks of the experimental vehicles. At present, the cost of these vehicles is $2,000 each, a sum which is rightly considered excessive in view of the imperfections still inherent in the vehicle.

The automobile risk is attracting the attention of underwriters of accident policies in the United States, and the fire hazards are creating considerable interest abroad. Some serious losses have resulted from the destruction of motor carriages. A writer in a foreign insurance journal describes two heavy losses: "A friend of mine, manager of a leading insurance office, issued a policy for £700 upon a motor car, rate two guineas per cent. The owner and his wife were going for a ride, and had just taken their seats, when, before it had even moved, the car became a sheet of flame. No efforts of the groom made any impression on the fire, and in a few minutes nothing was left except a barrow-load of old metal. Fortunately, no one was injured. Five hundred pounds was accepted in settlement of the damage. Again, only recently, a motor car was being driven from Harrogate to Leeds. Half way on the road a pair of nervous horses were met, and the car driver had reason to rapidly apply his brakes, when over went the car into a ditch. The petrol at once fired, and in an instant the whole was a mass of flame. The owner of the vehicle was standing near, an interested spectator, watching his £500 motor consumed. Quite apart from the hazard, nothing could be more unsatisfactory to insure, because upon the slightest accident by fire to a good motor car the whole has generally to be returned to the makers, frequently in Paris; and, what with the monopoly, the delicacy and skill of workmanship necessary, together with the high rates of such labor, etc., the bill generally works out to about the price of an entirely new vehicle."