reducing the temperature of the gases and the consequent erosion. A 14-inch caliber has been adopted, and several guns are being built. The new 14-inch gun will fire a projectile of 1,660 pounds, with a muzzle velocity of 2,150 feet per second. It will have about the same penetrating power at 8,700 yards as the 12-inch gun; and it will carry a bursting charge of high explosive over fifty per cent greater than that of the 12-inch projectile. Because of its shorter length, its weight, 49.5 tons, will be about the same as that of the 12-inch gun.

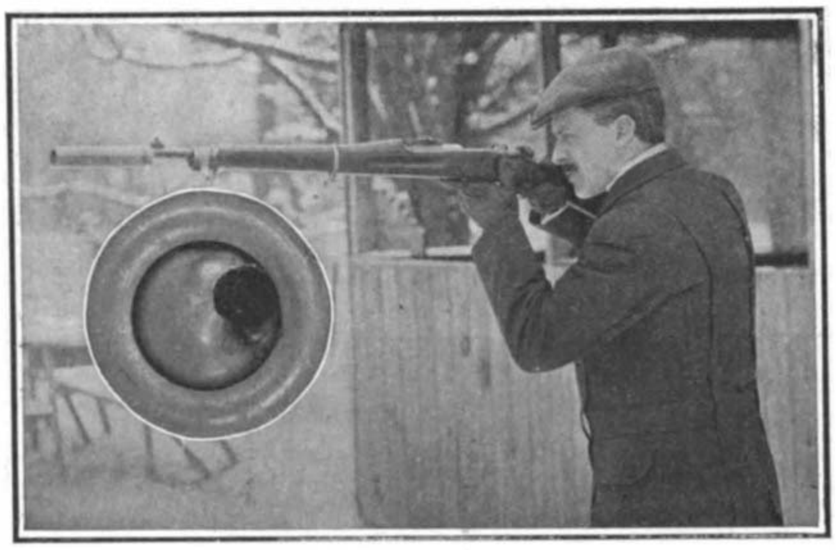
There are several objections to the 14-inch gun. In the first place, the rate of fire will be necessarily much slower than that of the 12-inch. Another objection is that the trajectory, or curve of flight, of the projectile is not nearly so flat as that of the 12-inch gun, and, therefore, the danger space, in which the enemy is liable to be hit, is less. On the other hand, instead of losing its accuracy after firing sixty rounds, the 14-inch gun would fire 245 rounds before deterioration set in. The original plan for arming our coast defenses included a large number of 16-inch guns. Only one of these, however, has been built. It is at present at Sandy Hook, where it underwent its trial successfully, but we believe it has not as yet been mounted in any permanent emplacement. This huge gun, the most powerful in the world, weighs 74 tons, and fires a 2,400-pound projectile with a muzzle energy of 77,000 foot tons, and a remaining energy at 8,000 yards of 40,540 foot tons. Its rate of fire is thirty rounds per hour, and it will lose its accuracy after 175 rounds. The gun cost nearly $200,000. It is too costly, and its rate of fire too slow, to make it a suitable weapon of defense against modern 50-caliber 13½- and 14-inch guns, such as are now being contemplated by foreign navies, whose striking energy will be not very much less at ordinary fighting ranges, and whose rate of fire will be at least four times greater. Hence, we are not likely to build any more 16-inch guns.

Although the heavy guns mainly will be depended upon to prevent the approach of the enemy, there will be two auxiliary elements, the submarine boat and the submarine mine, which, in our opinion, will be even greater deterrents in keeping the enemy well off-shore. The submarine is no longer an experiment, at least for sea-coast defense. An enemy's fleet attempting to enter, let us say, New York harbor, must be prepared, at any time after it has passed the three-mile limit, to receive the blow of the torpedo, delivered by an unseen and practically undetectable enemy. Should the fleet evade the submarines, at a distance of five miles it would come within range of the 10-, 12-, and 14-inch guns, and, because of the wonderful accuracy of modern range finders, these guns would be laid with deadly accuracy. Should the attacking fleet, however, pass without mortal injury through this five-mile zone of armor-piercing fire directed upon it from Sandy Hook, and through another five miles of fire of triple intensity, rained upon it from the combined batteries of Sandy Hook, Fort Wadsworth, and Fort Hamilton, it would have to pass through one or more fields of submarine mines laid in the manner described and illustrated in our issue of January 23rd, 1909.

Now, a modern battleship costs from $8,000,000 to $10,000,000, and it might take but one blow by gun, torpedo, or mine to so cripple the ship as to place it at the mercy of the coast defenses. Moreover, the bombardment of cities will prove merely a strong irritant, and can never exercise a conclusive effect in determining the issues of a war. It is very unlikely that the costly battleships of the future will engage seacoast fortifications—certainly they will never risk the enormous losses involved in forcing an entrance through well-defended harbors such as those of New York, Boston, or San Francisco.

THE SILENT GUN.—COUNTERPART OF SMOKELESS POWDER.

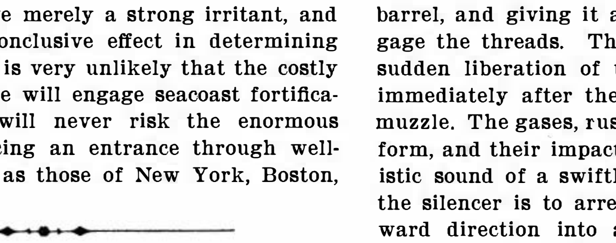
The public demonstration by the inventor, Mr. Hiram Percy Maxim, of his silent gun introduces a weapon which is destined to affect the conduct of military operations of the future in much the same way, and to almost the same degree, as did the introduction of smokeless powder. For many years past the military authorities have been devising ways and means for rendering the presence and movement of troops invisible. The first successful step in this direction was the introduction of smokeless powder, and this was followed up by a careful study of the uniform and equipments, in the effort to secure those colors which would blend most completely with the surrounding landscape, and render the presence or movement of troops difficult of detection. Smokeless powder and earth-brown khaki suits have done wonders in this direction. So perfect is the concealment, that, were it not for the rattle of the discharge of musketry, it would be well-nigh impossible definitely to locate the positions of a line of skirmishers, or even of a large body of troops taking advantage of natural cover. In determining the position of the enemy and strength of the attacking force, the leader of a body of troops is dependent almost entirely upon the sound of the enemy's rifles. In reading descriptions of battles, either by war correspondents or as contained in official reports, one frequently comes across such a phrase as this: "There was a sound of heavy firing on our right." If the sound of discharge could be eliminated, the principle of concealment would be worked out to theoretically perfect conditions; for it would be possible for an attacking force to deliver its fire, without the enemy having the slightest idea as to the range or direction from which it was delivered, or the strength of the force engaged.



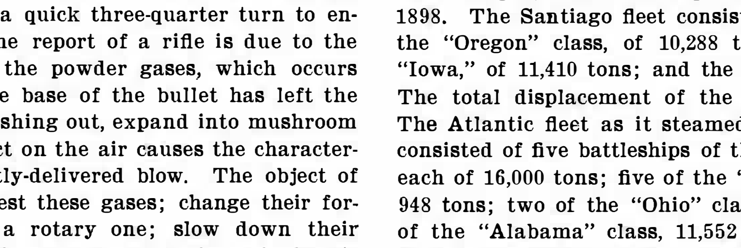
Front view of a disk. A military rifle with silencer attached.

The recent public demonstration made before a party of invited guests, including a representative of the Scientific American, occurred in an office building in this city, where a temporary shooting range, about 15 feet in length, had been erected, at the far end of which was a box of sand to receive the bullets. For the purposes of the test, a dozen modern rifles of high power, in which were included the best-known military rifles of Europe and America, had been provided, and from each of these a couple of shots were fired—one without the silencer, and the other with it attached.

The silencer is a small sheet-steel tube, 1½ inches in diameter, and from 4 to 6 inches in length according to the gun to which it is attached. For a .22-caliber rifle, it is about 4 inches long, and for a .30-30 rifle it is 6 inches long. The weight varies from 6 to 9 ounces.



Half sectional view, showing the method of assembling the spiraled disks.



The silencer ready for screwing on to the threaded end of barrel.

THE SILENT GUN.—COUNTERPART OF SMOKELESS POWDER.

The silencer is attached by pushing it home on the barrel, and giving it a quick three-quarter turn to engage the threads. The report of a rifle is due to the sudden liberation of the powder gases, which occurs immediately after the base of the bullet has left the muzzle. The gases, rushing out, expand into mushroom form, and their impact on the air causes the characteristic sound of a swiftly-delivered blow. The object of the silencer is to arrest these gases; change their forward direction into a rotary one; slow down their velocity; and allow them to pass out through the air so gradually as to produce a but slightly audible sound. The principle upon which this is done was illustrated in a very homely way by the inventor, when he likened it to the effect produced when the stopper is taken out of a basin full of water, and a swift rotary motion is imparted to the contents, when the centrifugal force holds the water against the sides of the basin. As the rotary motion decreases, the water begins to descend and flow through the plug hole, the basin being slowly emptied. In the silencer, the gases are caught upon a series of spiral vanes, where their motion is turned from a rectilinear to a circular one. After the velocity is decreased, they flow out gently and without sound.

The construction of the silencer is shown very clearly in the half-sectional view, and in the photograph of one of what might be called the small turbine elements. Each of the latter consists of a sheet-steel disk, having a hole near the center slightly larger than the bullet, and with its outer edge turned over, so as to form an annular path in which the gases rotate. The inventor describes the action of the device as being practically the reverse of that of a turbine engine. In a turbine-driven engine the gases advance in an approximately rectilinear line, parallel with the axis of the turbine; and their effect is to make the bucket wheel revolve. In the silencer the bucket wheel or rotary blades are held fast, and as a result the steam, or gases, as in this case, are given the rotary motion. The central holes in the disks are all aligned perfectly with the axis of the rifle; and, as they are slightly larger in diameter than the bullet, the latter passes through them without being in any degree affected as to its velocity or accuracy. The gases, as explained above, are caught in the successive disks; their motion is changed from a rectilinear to a circular or spiral one, and their velocity is gradually reduced to a point at which they fail to make any audible concussion on leaving the silencer. In the demonstration referred to, the audible sound was mainly that produced by the impact of the bullet in the bed of sand and the click of the firing mechanism. In tests which had previously been made by the army authorities, observers standing several hundred yards away from the gun were able to hear only the ripping sound of the bullet as it cut its path through the air, and the blow as it struck the target.

SANTIAGO AND ATLANTIC FLEETS COMPARED.

It is probable that few people, outside of the navy, appreciate the astonishing growth which has taken place in the fighting power of our ships during the ten years intervening since the Spanish war.

We can vividly recall the profound impression of the destructive power of our little fleet of battleships under Admirals Sampson and Schley, which we all felt on reading the dispatches of July 4th, 1898, announcing that in a few brief hours their guns had completely annihilated the ships of Cervera's squadron, setting them on fire; driving them ashore, or, as in the case of the torpedo boats, quickly sending them to the bottom. In the present hour, when the Atlantic fleet of sixteen battleships have returned intact to a home port after a voyage of 42,000 miles around the world, it is opportune to compare this armada with that which made the eventful voyage to the south coast of Cuba to find and destroy the fleet of the enemy.

To state that in the fleet of 1908-9 there are sixteen battleships as compared with the five which we were able to muster off the south coast of Cuba, is to merely lay the foundation for our comparison. In the intervening period there has been a steady increase in the size of the battleship, until the largest unit, represented by the flagship "Connecticut," is over fifty per cent heavier than the "Oregon," our most powerful fighting ship in 1898. The Santiago fleet consisted of five battleships: the "Oregon" class, of 10,288 tons displacement; the "Iowa," of 11,410 tons; and the "Texas," of 6,300 tons. The total displacement of the fleet was 48,525 tons. The Atlantic fleet as it steamed into Hampton Roads consisted of five battleships of the "Connecticut" class, each of 16,000 tons; five of the "Virginia" class, of 14,948 tons; two of the "Ohio" class, of 12,500 tons; two of the "Alabama" class, 11,552 tons; and the "Kearsarge" and "Kentucky," of 11,500 tons; the total displacement of the fleet being 225,884 tons. In displacement, then, the Atlantic fleet is four and three-quarter times that of the fleet that fought at Santiago.

Mere size, however, is of little value, unless it is taken in connection with other elements of efficiency; and the first among these that we will consider are those of horse-power and speed. The "Oregon" class were designed for 9,000 horse-power and 17 knots speed; the "Iowa," for 11,000 horse-power and 16.5 knots; the "Texas," for 8,000 horse-power and 17 knots

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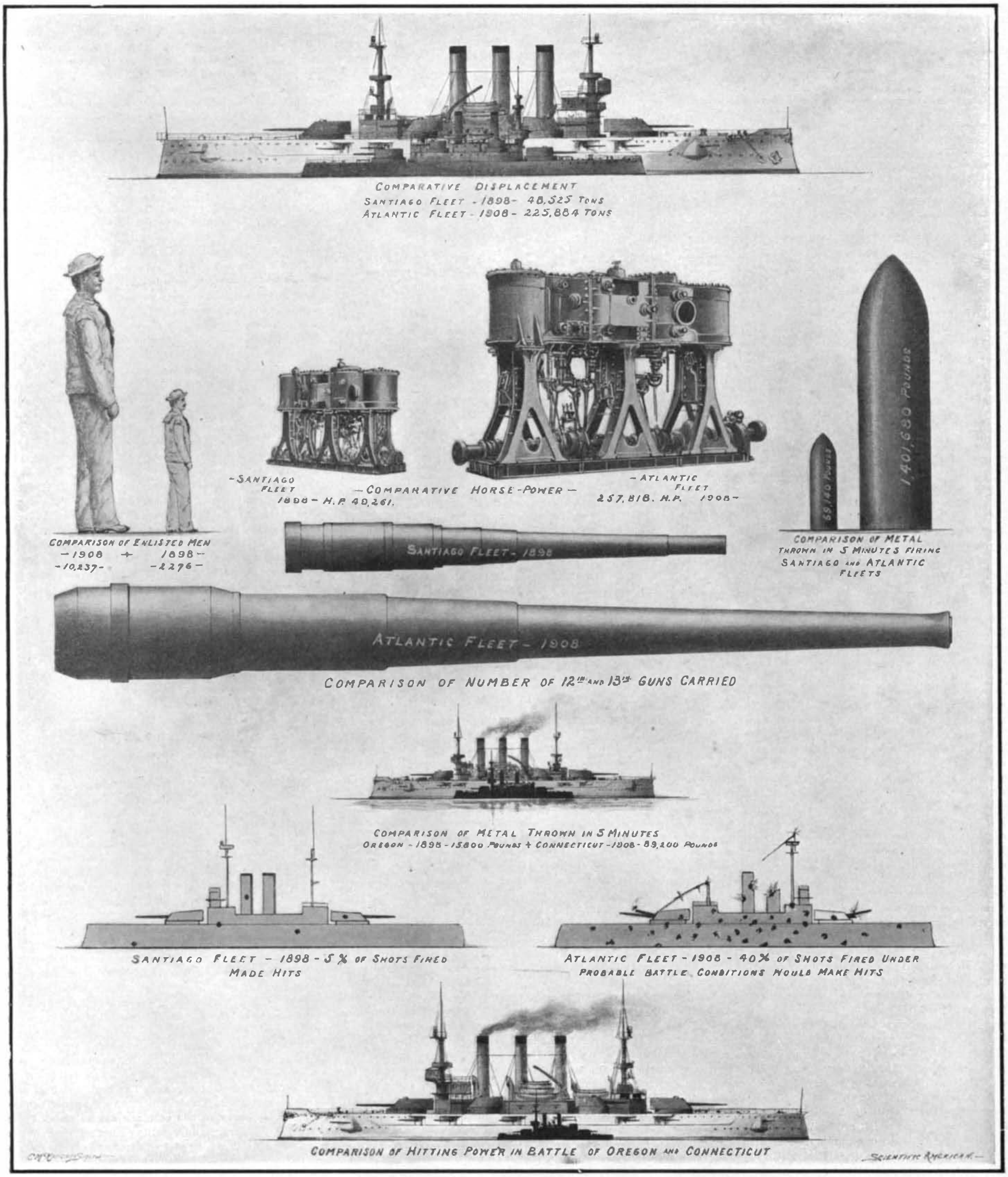


DIAGRAMMATIC COMPARISON OF THE SIZE AND POWER OF THE FLEET WHICH FOUGHT AT SANTIAGO IN 1898 WITH THAT OF THE ATLANTIC FLEET OF 1908, WHICH HAS RECENTLY CIRCLED THE GLOBE.—[See page 150.]

speed. At the time of the Santiago engagement, these ships were good for from 15 to 15½ knots with clean bottoms, and the total horse-power of the fleet was about 50,000. When we come to consider the Atlantic fleet, there is a marked increase in speed and power. The five ships of the "Connecticut" class, designed for 16,500 horse-power and 18 knots, developed, on trial, from 19,000 to 20,000 horse-power, and speeds of from 18.3 to 18.8 knots. The five ships of the "Virginia" class developed from 20,000 to 24,500 horse-power, and all steamed at over 19 knots on trial. The "Maine" and "Missouri" made over 18½ knots for 16,000 horse-power; the "Illinois" and "Wisconsin," 16.2 and 17.2 knots for 11,000 and 12,300 horse-power; and the "Kearsarge" and "Kentucky" made 16.8 and 16.9 knots with 11,788 and 12,179 horse-power. The total horse-power of the whole fleet, as developed on trial, was 258,000, as against 50,000 developed on trial by the Santiago fleet. This is an increase of 500 per cent in power. There is no corresponding increase in the cruising speed of the fleet as a whole, since it is governed by the speed of the slower ships of the "Alabama" and "Kearsarge" class, whose sea speed is probably not much better than that of the Santiago fleet. The ten ships of the "Connecticut" and "Virginia" class, however, have a sea speed two to three knots greater.

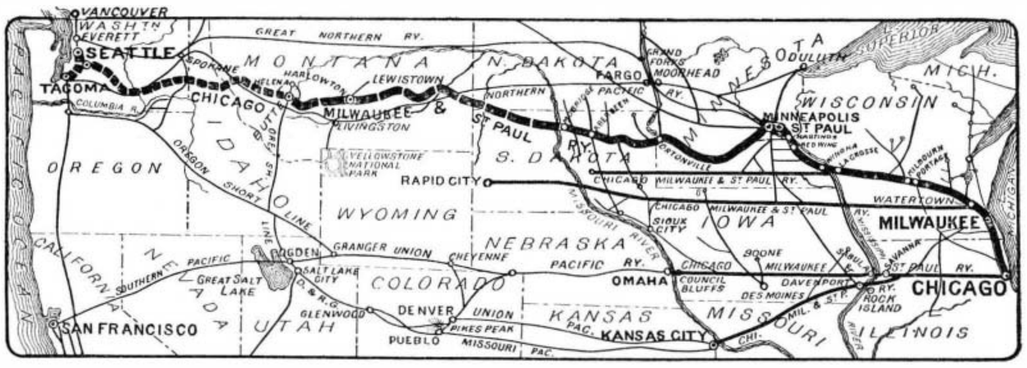
In a comparison of the crews of the two fleets, there is the same increase of from 450 to 500 per cent. The total number of officers and men in the Santiago fleet, if they contained the regular complement, was 2,276, and in the battleships of the Atlantic fleet, it is about 10,237. It is probable, however, that the crews were temporarily increased during the Spanish-American war, and we know that large numbers of extra men were carried on the cruise around the world.

Equally impressive are the two diagrams in the accompanying drawing, showing the relative power in the number of heavy armor-piercing guns of 12- and 13-inch bore. In the Santiago fleet there were mounted twelve 13-inch guns and six 12-inch. The Atlantic fleet mounted altogether sixty-four 12-inch guns. It should be noted, however, that the above comparison is based merely upon numbers, and takes no account of the enormous increase, both in the rapidity of fire, and in the striking energy of each projectile as it left the gun. To get an accurate idea of the comparative weight of metal thrown by the two fleets in a given time, we must turn to the diagram showing, by the outlines of the two projectiles, the comparative amount of metal which could be thrown from the broadsides of the two fleets, during five minutes of an engagement. The enormous difference is explained by the fact that improved methods of mounting the guns, improved ammunition hoists, breech mechanism, rammers, etc., have increased the rapidity of fire about five times, so that for every single shot delivered from a 12-inch gun in 1898, the crew of a 12-inch gun on the Atlantic fleet can deliver five shots. There has been a similar increase in the rapidity of the smaller guns, and the result is shown in the total metal delivered, which in five minutes' firing by the Santiago fleet would amount to only 69,140 pounds, as against 1,401,680 pounds, which could be delivered in the same time from the broadsides of the Atlantic fleet, an increase of 2,000 per cent.

But this is not all; for not only has there been an increase in the rapidity of fire, but the energy of a given weight of metal thrown has also been greatly increased. In the intervening ten years there has been a great improvement both in the powder and the guns. The old brown powder has given way to smokeless powder, and the length of the guns has been increased from 30 and 35 calibers to 40 and 45. The smokeless powder, giving off greater volumes of gas, exerts its accelerating pressure upon the base of the projectile through a greater length of bore, and the energy imparted, which varies as the square of the velocity, has risen, in the case of the 12-inch gun, from 25,985 foot-tons to 44,000 foot-tons. Applying these results to the two fleets, we find that in five minutes' firing with all guns on one broadside, the metal delivered by the Santiago fleet would have a total energy of 2,146,738 foot-tons, whereas the total energy of five minutes' broadside from the Atlantic fleet would be over thirty times as great, or 66,328,910 foot-tons.

But it is not the amount of metal that leaves the muzzles of the guns that determines the issue of a sea fight, but rather the amount of it that lands on the enemy—"it is the hits that count." Therefore, we will now substitute two individual ships for the two fleets, and compare the actual ability to inflict damage on the enemy of the "Oregon" of 1898 and the flagship "Connecticut" of 1908. The "Oregon" in five minutes' firing from all the guns which she could train on one broadside was capable of hurling at the enemy 15,800 pounds of metal. In the same time the "Connecticut," from her 12-, 8-, 7-, and 3-inch guns could deliver 89,200 pounds of metal. After the battle of Santiago our ordnance officers made a count of the number of hits on the sunken Spanish ships. Comparing this with the number of shots fired, which, of course, was known for each of our vessels, it was found that only two per cent got home on the enemy. It is generally believed, however, that more hits than this were made. Many of the shot holes being below water could not be counted; many shots must have entered previous shot holes; and additional hits were probably made upon portions of the vessel which were subsequently blown bodily away. Let us then assume that the average of hits at Santiago was five per cent, as shown in the accompanying left-hand diagram representing a modern battleship. In our latest target practice, conducted as nearly as possible under battle conditions, the average efficiency of the ships of the Atlantic fleet is sixty per cent of hits. But in an actual engagement the shells of the enemy would be getting home upon our own ships, and therefore, to a certain extent, disturbing the aim of our gunners. On the other hand, there would be no smoke, as at Santiago, to hide the enemy. We have therefore cut down the average to forty, and represented in the right-hand drawing the same modern battleship as she would appear after the first five minutes of an engagement with the "Connecticut." Applying this comparison of accuracy to the diagram showing by the size of the ships the relative amount of metal thrown, we find that the "Connecticut" from being over five and a half times as large must be represented, as in the lowest diagram, by a ship forty-five times as large as the "Oregon"; or, to put it in other words, the "Connecticut," during a five minutes' engagement with the "Oregon," would land forty-five times as much metal on the "Oregon" as the "Oregon" would land on the "Connecticut." Furthermore, this preponderance is yet further increased by the fact that the relative energy of this metal, as thrown, is, shell for shell, from 30 to 40 per cent greater in the case of the "Connecticut."

This brings us face to face with the astonishing fact that the "Connecticut" of 1908 would be probably more than a match for the whole Santiago fleet of 1898. Having an advantage of three knots in speed and of the greater range and accuracy of her high-velocity guns, she could maintain a position beyond the effective hitting range of the older ships, and cripple or sink them in detail.



Map showing the extension of the Chicago, Milwaukee & St. Paul Railway from the Missouri to the Pacific coast.

THE EXTENSION OF THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY TO THE PACIFIC COAST.

With the completion to the Pacific coast in the near future of the extension of the Chicago, Milwaukee & St. Paul Railway (now known as the Chicago, Milwaukee & Puget Sound Railway) one more of the great railroad systems of the West will be entitled to rank as a transcontinental line. For the beginnings of this great railway system we must go back to the year 1865, when the Minnesota Central, now known as the Iowa and Minnesota Division of the Chicago, Milwaukee & St. Paul Railway, was completed to Faribault, Minn. This road reached the Iowa line in 1866, and was completed to St. Paul in 1867. Since that time the growth of the system has been rapid, the total mileage reaching 4,721 miles in 1884, 6,065 miles in 1892, 6,382 miles in 1903, 7,264 miles in 1907, and 7,451 miles in 1908. The total length of the extension now being completed from the Missouri River to the coast is 1,400 miles, and by the time it is opened the total mileage of the whole system will have reached 9,000 miles.

It is probable that by the time of its completion the new line will have created a record for rapidity of construction. Work was begun in April, 1906, and if the expectations of the engineers and contractors are fulfilled, the last main line rail will be laid by April 1, 1909, and the whole stretch of 1,400 miles will have been built in the remarkably short time of three years. During this period 60,000,000 cubic yards of material will have been excavated, 360,000 yards of tunnel driven, 20 miles of bridges erected, and 200,000 tons of 85-pound rails laid, at a total cost of $85,000,000.

Steam shovel work at Lock Bluffs, Montana.

THE EXTENSION OF THE CHICAGO, MILWAUKEE & ST. PAUL RAILWAY TO THE PACIFIC COAST.

The new line being the latest of the transcontinental roads to be built, has all the advantages which come from accumulated experience in the construction of similar roads that have already been built. From the standpoint of operation, the most important question is that of grades, and particularly what is known as the "ruling grade," this last being the maximum degree of grade occurring on any given stretch of the line. No matter how short its extent may be, the ruling grade determines the total weight of train which can be hauled over the division upon which the ruling grade obtains. If a short stretch of only a quarter of a mile of two per cent grade occurs on a division of say 100 miles, where there is no stretch of grade exceeding say 0.5 per cent, the maximum train-load must be reduced on that division to the maximum which an engine can haul unassisted over the short stretch of two per cent grade, or additional pusher engines must be maintained at the ruling grade to assist the trains over this quarter of a mile of track. The new line, however, is characterized by favorable gradients and easy curvature. Between the Missouri River and Marmarth, N. D., the ruling grade east-bound is 0.5 per cent, and between Marmarth, N. D., and Melstone, Mont., a distance of 235 miles, it is 0.4 per cent. From Melstone, Mont., to Harlowton, Mont., 104 miles, there is no adverse east-bound grade; the entire distance being a very gradual descent conforming to the valley of the Musselshell River. The maximum grade of the Montana Railroad, when revised, will be one per cent. Between Lombard, Mont., and Piedmont, Mont., the maximum east-bound grade is 0.3 per cent, and between Piedmont and Butte, crossing the continental divide, the ruling grade is 1.66 per