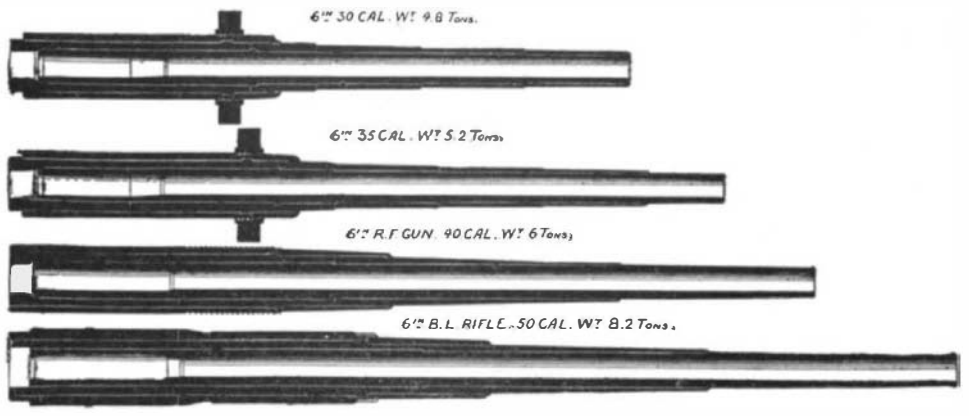
Guns and Armor.

LATEST TYPES OF NAVAL GUNS.

If it be considered that the striking energy of a ship, or her ability to deliver a maximum weight of projectiles against the enemy in a given time, is the supreme mark of her efficiency, then it must be admitted that the great development which has taken place since 1898 in our warships is due more than anything else to the remarkably powerful guns with which they are equipped.

There is no denying that the war caught us napping in the matter of smokeless powder; and had our struggle been against a first-class naval power, whose ships were armed with long-caliber smokeless-powder guns—well, to put it mildly, our repair bill would have been a heavy one. With a few exceptions our ships were armed with old-pattern, brown-powder guns, of low velocities and energies compared with the long-caliber smokeless-powder weapons with which our new warships are being equipped. The remarkable velocities obtained by projectiles in our new type of naval guns is due to the large powder chamber, big charge, slow combustion and sustained acceleration in the long bore of the gun, these combined elements enabling the new 6-inch gun, for instance, to deliver its 100-pound projectile with a muzzle velocity of 2,900 feet per second, as against a velocity of 2,000 feet per second in the old 30-caliber 6-inch gun, thereby more than doubling its energy.

There is no branch of the naval service in which a greater advance has been made in the past three years than in the Bureau of Ordnance, where the experimental work has been extremely successful. The starting point in the reconstruction of our naval ordnance was the powder; it was necessary to secure a smokeless powder that would give high ballistic results and at the same time would be perfectly stable. The Bureau has directed its attention with great success to the development of an all-guncotton powder, from which nitro-glycerine is completely excluded, and the last report of Rear-Admiral O'Neil states that this year's experience with the navy smokeless powder places it in a high position as a propellant, the results even exceeding those of the previous year. The accompanying table of the latest types of naval guns tells its own story, and we draw particular attention to the power of the new 12-inch rifle, which after a flight of 3,000 yards has sufficient remaining velocity to perforate 19.5 inches of Krupp armor. The table includes the new 7-inch gun, which is likely to take the place of the 6-inch gun in the broadside batteries of our future battleships. The 6-inch gun is unequal to the penetration of the 6-inch casemate armor of modern battleships at a range of 3,000 yards, whereas the new 7-inch piece can penetrate 8.3 inches of Krupp steel at that range and would, therefore, at least where the shot struck normal or approximately normal to the armor, have the intermediate guns of the enemy under control. We direct attention also to the diagram showing the development of the 6-inch gun from the 30-caliber brown-powder gun of 1883 to the 50-caliber piece mounted on the battleship "Maine" and class of 1901. To illustrate the enormous increase in power of our battleships due to the new guns, we offer a comparison of the total energy of fire of the "Oregon," as she was equipped during the war, with the total energy of fire of the new "Georgia" type now under construction. The "Georgia" is, of course, a larger vessel; but although the increase in displacement is only about 40 per cent, the total energy of five minutes' fire at the greatest practicable rate of firing aimed shots would be 2,765,830 foot-tons as against 819,456 foot-tons for the "Oregon," an increase of about 340 per cent. This enormous increase of total energy is not due so much to increase in rate of fire, as to the increase of muzzle energy, which energy in some cases, as will be seen from the accompanying table, is about double that of the same pieces as used in 1898.



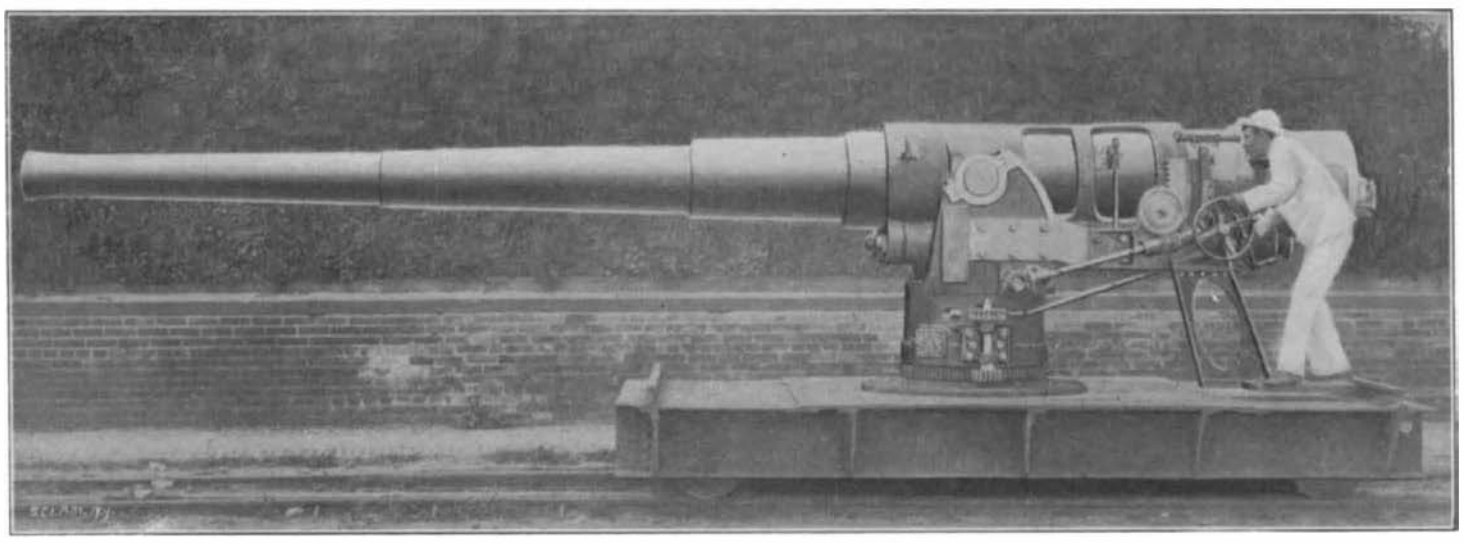
DEVELOPMENT OF 6-INCH GUN, 1883 TO 1901.

It will be noted that in spite of the great increase in length, there has been a simplification of the construction of the new type of guns. The 30-caliber gun, for instance, consisted of twelve separate pieces, whereas the new 50-caliber piece, although weighing nearly twice as much, contains only half a dozen separate pieces. The substitution of a long jacket and a few long hoops for the many short hoops of the 30-caliber gun not only cheapens construction, but adds greatly to the transverse strength of the piece.

It should be mentioned in connection with the table showing the ballistic powers of the guns that the velocities shown are the service or designed velocities. As a matter of fact, at the proving ground the new powder proved to be so excellent that higher velocities than these have been obtained with powder pressures lower than the 17 tons per square inch for which the guns were designed. Thus the 12-inch piece has given a muzzle velocity of 2,854 foot-seconds and corresponding energy of 47,944 foot-tons with a powder pressure of 16.5 tons to the inch. The 7-inch 45-caliber gun has given a muzzle velocity of 3,000 foot seconds with a chamber pressure of 17 tons. The 6-inch gun has shown 2,935 foot-seconds with a little over 16 tons pressure. The 5-inch gun has done even better, having delivered a 60-pound projectile with a muzzle velocity of 3,100 foot-

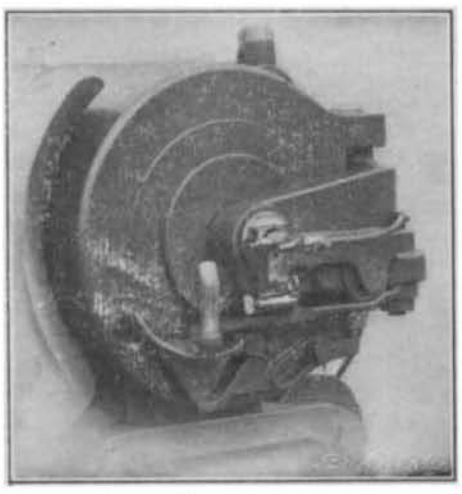
TABLE OF ELEMENTS OF LATEST TYPES OF NAVAL GUNS (MODELS OF 1899), GIVING PERFORATION OF FACE-HARDENED ARMOR, SERVICE VELOCITIES, AT RANGES UP TO 3,000 YARDS, WITH SMOKELESS POWDER, CAPPED AND UNCAPPED ARMOR-PIERCING PROJECTILES, AT NORMAL IMPACT.

Caliber of gun.	Weight in tons.	Length in caliber.	Approximate charge of smokeless powder for maximum velocity.	Weight of projectile.	Muzzle velocity.	Muzzle energy.	Perforation at muzzle. Krupp armor. Projectiles. Capped.	Perforation at muzzle. Krupp armor. Projectiles. Uncapped.	Remaining velocity at 1,000 yds.	Perforation at 1,000 yds. Krupp armor. Projectiles. Capped.	Perforation at 1,000 yds. Krupp armor. Projectiles. Uncapped.	Remaining velocity at 2,000 yds.	Perforation at 2,000 yds. Krupp armor. Projectiles. Capped.	Perforation at 2,000 yds. Krupp armor. Projectiles. Uncapped.	Remaining velocity at 3,000 yds.	Perforation at 3,000 yds. Krupp armor. Projectiles. Capped.	Perforation at 3,000 yds. Krupp armor. Projectiles. Uncapped.
			Lbs.	Lbs.	Ft.-secs.	Ft.-tons.											
3-in., Mark I ..	0.87	50	5	13	2300	709	4.4	3.6	2130	3.1	.....	1620	.....	.....	....	.....	.....
4-in., Mark VII	2.56	50	15	32	2900	1870	6.4	5.6	2380	5.2	4.4	1955	4.	3.4	1605	3.2	.....
5-in., Mark V .	3.3	50	27	60	2900	3503	8.4	6.6	2460	6.7	5.6	2085	5.5	4.7	1770	4.6	4.6
6-in., Mark VI.	8.37	50	46	100	2900	5838	10.9	7.3	2525	8.8	6.8	2185	7.2	6.	1895	5.9	5.2
7-in., Mark I...	13.33	45	74	165	2900	9646	13.2	10.5	2580	11.4	8.9	2295	9.7	7.6	2040	8.3	6.5
8-in., Mark V..	18.	45	115	250	2800	13602	15.	12.1	2530	13.2	10.4	2290	11.7	9.1	2070	10.3	7.9
10-in., Mark II.	33.4	40	240	500	2800	27204	20.	17.1	2585	18.3	15.	2380	16.5	13.5	2210	15.	11.5
12-in., Mark III.	52.	40	385	850	2800	46246	25.	21.7	2620	23.	19.4	2450	21.2	17.9	2295	19.5	16.2

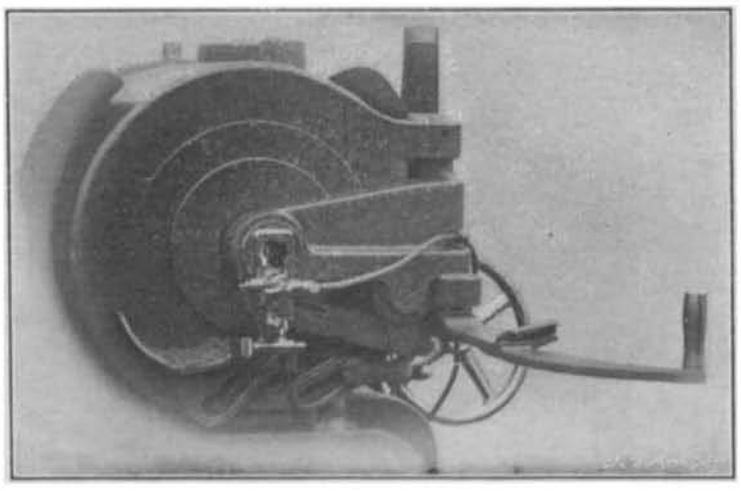


NEW NAVAL, 50-CALIBER, 6-INCH, RAPID-FIRE GUN.

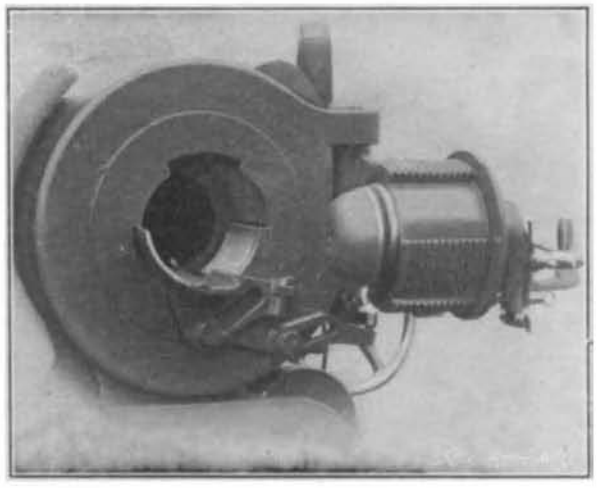
Weight, 8.2 tons. **Length,** 25 f et. **Muzzle Velocity,** 2,900 foot-seconds. **Muzzle Energy,** 5,838 foot-tons.



Breech Closed and Locked.



Breech-Plug Rotated Ready for Withdrawal.



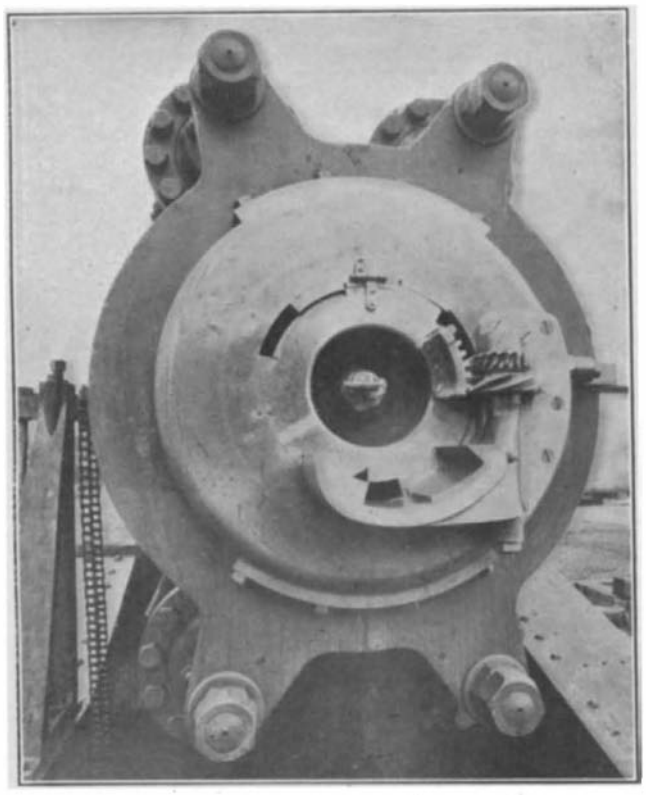
Breech Opened, Ready for Loading.

BREECH MECHANISM OF NEW 6-INCH RAPID-FIRE GUN. SAME MECHANISM ON 5-INCH AND 7-INCH GUNS.

seconds and 17 tons pressure; while with a 50-pound projectile and a chamber pressure of 16.4 tons, the remarkable velocity of 3,380 foot-seconds was obtained. This is the piece that will form the main armament of the cruisers of the "Denver" class.

GUN-MOUNTS AND BREECH MECHANISMS.

The increased rate of fire of the new guns is chiefly due to the improved gun-mounts and breech mechanisms. In the first place, all guns recoil in a sleeve which carries the trunnions. Upon this sleeve are mounted the telescopic sights, and the man who traverses and elevates the gun, in the case of the large rapid-fire pieces, stands on a platform which is supported from this sleeve. He is thus able to keep the gun steadily upon the target, and is not affected by the recoil. His position, with his hands upon the traversing and elevating handwheels and his eye at the telescopic sights, is shown clearly in the photograph of the 6-inch gun. All guns from 3-inch up are fitted with the "Welin" patent breech-plug, the rights for which were purchased for several hundred thousand dollars from the Vickers-Maxim firm. The thread is cut in steps of varying radius—a device which reduces the amount of cutting away of the thread and also the depth of the plug and the distance it must travel before it is fully inserted.



Breech of New 12-Inch Rifle Closed.

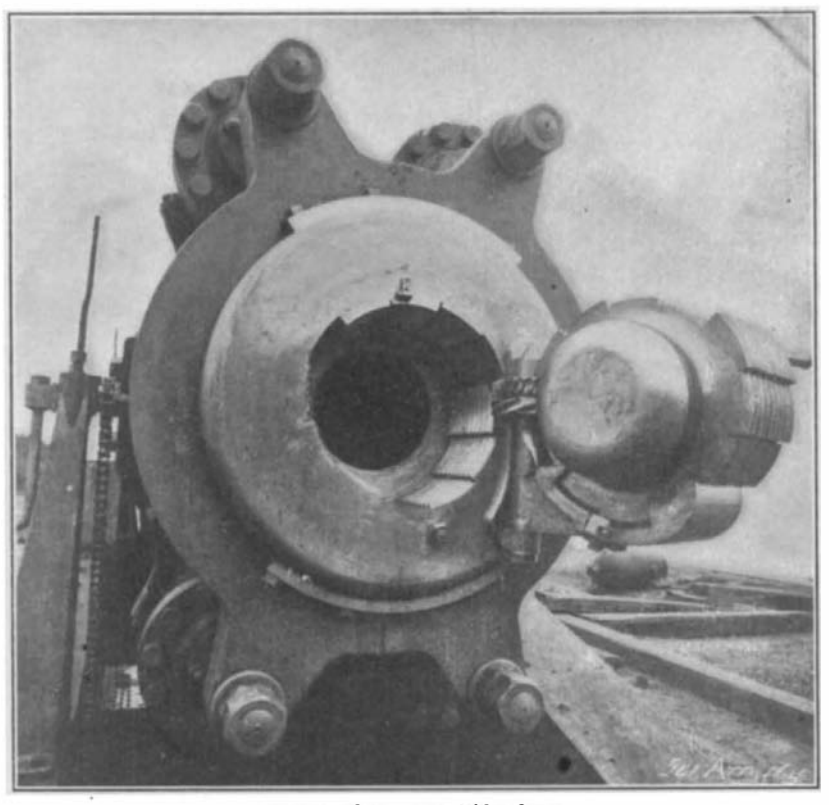
The 7-inch and all calibers below open the breech with a horizontal lever. One sweep of the lever unlocks the thread, withdraws the plug, and swings it clear of the breech, as shown in the illustration.

The 8-inch rifle and all calibers above this open with a crank, as the plug is too heavy and the swing is too great for opening with a lever. The time consumed in opening and closing the breech, however, is but a minute fraction of that required for the service of the gun; it is loading and pointing that take the most ime.

In the case of the 12-inch guns, the continued movement of the crank first rotates or unlocks the plug, which is followed by its withdrawal and the swinging round of the plug. It takes about 7½ turns of the crank to open or close the breech of a 12-inch gun, which can easily be performed in less than 5 seconds. The 8-inch gun breech is practically the same, but being lighter, can be handled more quickly.

The recoil of the 12-inch gun is taken up by four hydraulic cylinders placed symmetrically around the gun, but attached to the sleeve or non-recoiling part. A yoke on the rear end of the gun serves as an attachment for the piston rods, which work in the recoil cylinders, and recoil is checked by the escape from the pressure to the reverse side of the piston of the liquid contained in the cylinders. The escape orifices for the fluid are grooves cut in the walls of the cylinders, which are wide enough to give a full opening at the beginning of recoil, gradually contracting in area until the proper limit of recoil is reached, when the grooves come to a point and thus cut off any further flow of liquid. The recoil of the 12-inch guns for the "Maine" and class and for the monitors is 33 inches. Inside each recoil cylinder is a series of heavy triple-spiral springs (about one ton in weight), which are put in the cylinders under an initial tension sufficient to prevent the gun from moving when the ship rolls, or when the gun is elevated to its maximum limit. When recoil takes place these springs are further compressed, and they exert sufficient force to return the gun to the firing position as soon as recoil ceases. As the force exerted by these springs is great enough to return the gun to battery at extreme elevation, it follows that they have an excess of power to return the gun at level, and hence it would run out with great violence, probably injuring the mount, were it not that a hydraulic buffer, or counter-recoil check, is fitted in the front end of each cylinder, which gradually brings the gun to rest as it runs out.

The 8, 7, 6, 5, 4 and 3-inch guns all recoil in an oscillating sleeve. The piston rods are attached to the rear end of the gun by a yoke, and the recoil cylinders contain the counter-recoil springs. The recoil of the 8-inch gun is 24 inches, of the 7-inch 21 inches, of the 6-inch 15 inches, and of the 5-inch 11½ inches. None of the new guns above 4 inches in caliber uses the brass cartridge case, but the powder is put up in bags. The guns of and above 7 inches in caliber have the charge in two sections, as one section would be too heavy and too large to handle conveniently. In turret guns of large caliber the elevating, training, hoisting ammunition, and loading are all done by machinery operated by electric power. Guns of and below 7 inches in caliber are handworked. They are mounted on pedestal mounts, turn on ball bearings, and are balanced in their sleeves. Hence they can be elevated or depressed with great ease. In the case of the 6 and 7-inch guns, the gun-pointer stands on a platform attached to and turning with the gun. All guns above 3 inches in caliber are fitted with telescopic sights, also with open day and night sights and with electric and percussion firing gear.



Breech of 12-Inch Rifle Open.

COMPARISON OF TOTAL ENERGY OF FIRE IN FIVE MINUTES OF BATTLESHIPS OREGON (IN 1898) AND GEORGIA

Oregon in 1898.				Georgia.			
Gun.	Muzzle Energy of Gun.	*Rate of Fire per Minute.	Muzzle Energy in Five Minutes.	Gun.	Muzzle Energy of Gun.	*Rate of Fire per Minute.	Muzzle Energy in Five Minutes.
4 13-inch.	33 627 foot-tons	0.4	269,016 foot-tons	4 12-inch.	46,246 foot-tons	0.66	610,447 foot-tons
8 8-inch.	8,011 "	1.0	320,440 "	8 8-inch.	13,602 "	1.2	652,896 "
4 6-inch.	2,990 "	2.0	119,600 "	12 6-inch.	5,858 "	3.5	1,225,980 "
20 6-pounders.	138 "	8.0	110,400 "	12 3-inch.	709 "	6.5	276,510 "
Total energy all guns in five minutes.....			819,456 "	Total energy all guns in five minutes...			2,765,833 "

*This is the *practicable* number of *carefully aimed* shots that could be fired per minute for a few minutes, as given by Rear-Admiral O'Neil, Chief of the Bureau of Ordnance.

The thread is cut in steps of varying radius—a device which reduces the amount of cutting away of the thread and also the depth of the plug and the distance it must travel before it is fully inserted.

The 7-inch and all calibers below open the breech with a horizontal lever. One sweep of the lever unlocks the thread, withdraws the plug, and swings it clear of the breech, as shown in the illustration.

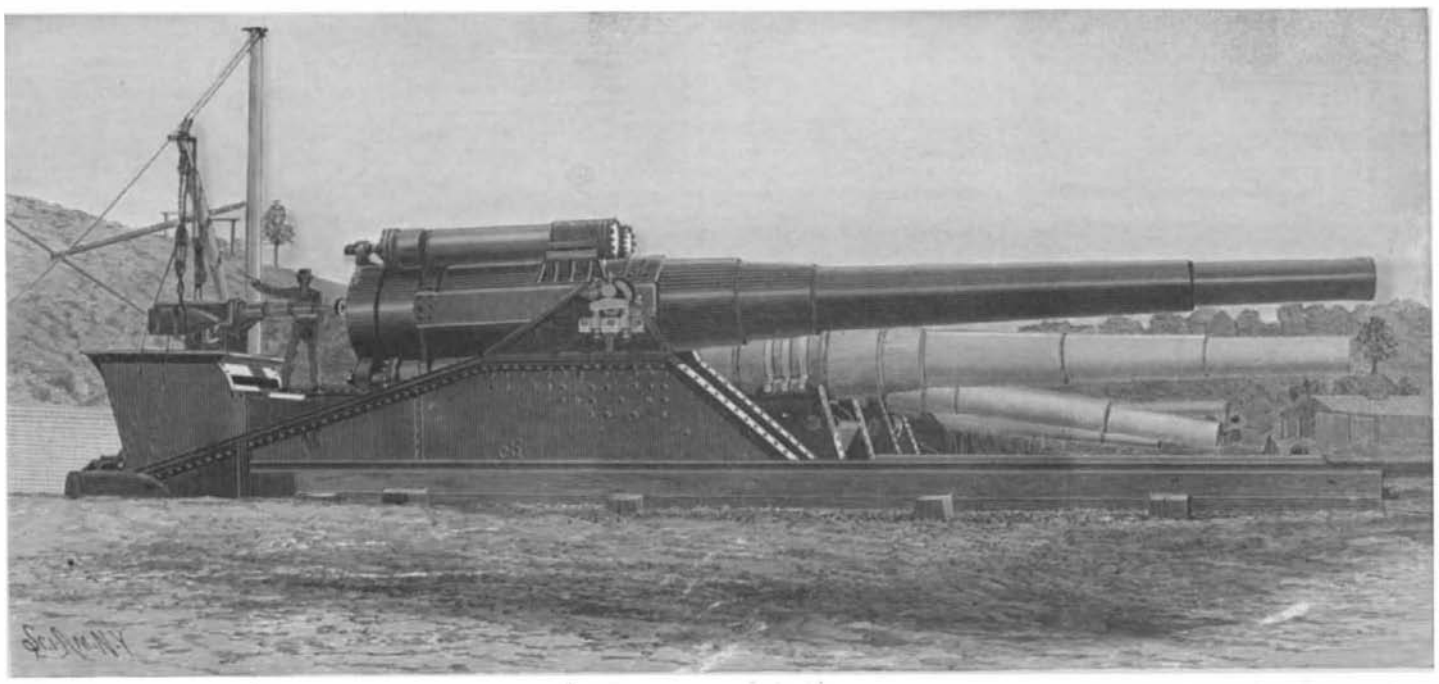
The 8-inch rifle and all calibers above this open with a crank, as the plug is too heavy and the swing is too great for opening with a lever. The time consumed in opening and closing the breech, however, is but a minute fraction of that required for the service of the gun; it is loading and pointing that take the most ime.

In the case of the 12-inch guns, the continued movement of the crank first rotates or unlocks the plug, which is followed by its withdrawal and the swinging round of the plug. It takes about 7½ turns of the crank to open or close the breech of a 12-inch gun, which can easily be performed in less than 5 seconds. The 8-inch gun breech is practically the same, but being lighter, can be handled more quickly.

The recoil of the 12-inch gun is taken up by four hydraulic cylinders placed symmetrically around the gun, but attached to the sleeve or non-recoiling part. A yoke on the rear end of the gun serves as an attachment for the piston rods, which work in the recoil cylinders, and recoil is checked by the escape from the pressure to the reverse side of the piston of the liquid contained in the cylinders. The escape orifices for the fluid are grooves cut in the walls of the cylinders, which are wide enough to give a full opening at the beginning of recoil, gradually contracting in area until the proper limit of recoil is reached, when the grooves come to a point and thus cut off any further flow of liquid. The recoil of the 12-inch guns for the "Maine" and class and for the monitors is 33 inches. Inside each recoil cylinder is a series of heavy triple-spiral springs (about one ton in weight), which are put in the cylinders under an initial tension sufficient to prevent the gun from moving when the ship rolls, or when the gun is elevated to its maximum limit. When recoil takes place these springs are further compressed, and they exert sufficient force to return the gun to the firing position as soon as recoil ceases. As the force exerted by these springs is great enough to return the gun to battery at extreme elevation, it follows that they have an excess of power to return the gun at level, and hence it would run out with great violence, probably injuring the mount, were it not that a hydraulic buffer, or counter-recoil check, is fitted in the front end of each cylinder, which gradually brings the gun to rest as it runs out.

The 8, 7, 6, 5, 4 and 3-inch guns all recoil in an oscillating sleeve. The piston rods are attached to the rear end of the gun by a yoke, and the recoil cylinders contain the counter-recoil springs. The recoil of the 8-inch gun is 24 inches, of the 7-inch 21 inches, of the 6-inch 15 inches, and of the 5-inch 11½ inches. None of the new guns above 4 inches in caliber uses the brass cartridge case, but the powder is put up in bags. The guns of and above 7 inches in caliber have the charge in two sections, as one section would be too heavy and too large to handle conveniently. In turret guns of large caliber the elevating, training, hoisting ammunition, and loading are all done by machinery operated by electric power. Guns of and below 7 inches in caliber are handworked. They are mounted on pedestal mounts, turn on ball bearings, and are balanced in their sleeves. Hence they can be elevated or depressed with great ease. In the case of the 6 and 7-inch guns, the gun-pointer stands on a platform attached to and turning with the gun. All guns above 3 inches in caliber are fitted with telescopic sights, also with open day and night sights and with electric and percussion firing gear.

It may be well to add a word of explanation, just here, on the question of rapidity of fire. The rates of fire given in the accompanying comparison of the "Oregon" and the "Georgia" will, doubtless, appear to some of our readers to be very low; but they must remember that these are *practicable* and not *ideal* rates of fire. Lieut. Meigs, ordnance officer of the Bethlehem Steel Works, in his recent address before the Society of Naval Architects in New York, quoted approvingly a record recently made by an English ship of 8 shots from a 6-inch gun in one minute, all of which struck a target 15 feet high, at a range of 1,500 yards. Here, the conditions were doubtless ideal, the ammunition being probably piled ready close at hand. The 3.5 rounds per minute, given in the table, represents actual conditions, in which the ammunition is being brought, round by round, from the magazines, and all the death and destruction of a sea-fight is present. Even 3.5 rounds per minute could be maintained for a few minutes only, since the heating up of the gun, alone, would necessitate a rest.



Maximum Muzzle Velocity, on trial, 2854 foot-seconds. **Muzzle Energy,** 47,994 foot-tons. **Foot-Tons Energy per Ton Weight of Gun,** 893. **Chamber Pressure,** 16.5 tons per square inch.

NEW NAVAL 12-INCH. 40-CALIBER GUN.