the waterline armor is reduced in thickness, tapering to 4 inches as a minimum. From the top of the main armor belt to the main deck protection is afforded by a belt of 5½-inch armor which turns in to meet the barbette, thus forming a completely inclosed citadel. Immediately inside the 5½-inch armor are worked cofferdams, 3 feet in width by 3 feet in height, which are packed with corn-pith cellulose. Above the 5½-inch belt is another continuous wall of 5½-inch armor which extends from the main deck to the spar deck. This wall also terminates in forward and after transverse bulkheads. Within the protected citadel thus formed is mounted on the main deck a broadside battery of eight 6-inch 40-caliber rapid-fire guns, and on the same deck forward toward the bow, two 6-inch guns are mounted in two sponsons protected by 6 inches of armor. It should be mentioned that 1½-inch splinter bulkheads are worked in between each pair of 6-inch guns in the central battery. On the spar deck above the broadside battery are four additional 6-inch guns, with an arc of fire from abeam to dead-ahead and dead-astern. These guns also have 6 inches of armor protection. The armor on the conning tower is 10 inches in thickness and the tube which connects the conning tower with the central station below the protective deck has walls 7 inches in thickness.

The main battery consists of four 13-inch guns, mounted in turrets, one forward and one aft, protected by 15 inches of armor, which is increased to 17 inches on the port plates. These port plates, by the way, are another innovation, being inclined sharply to the rear with a view to deflecting projectiles and presenting a greater horizontal thickness to penetration should the projectiles "bite." The barbettes are protected by 15 inches of armor. The turrets, like those on the "Kentucky," are oval, the oval form being adopted to reduce unnecessary space at the side of the guns and provide extra room behind them for handling and loading. Another good feature of these turrets is that the center of gravity of the rotating parts lies in the axis of rotation, and the turret, being thus exactly balanced, can be turned without difficulty, even when the ship is rolling or has a heavy list. The forward 13-inch guns have a fine command, their axis being 26½ feet above the normal load waterline. The after turret swings just above the main deck and has a command of 19 feet. Each turret has three sighting hoods. The one in the center is occupied by the officer whose duty it is to keep the guns pointed at the target, and who is simply concerned with the turning in a lateral direction. The hoods on either side are occupied by the gun pointers, who attend to the elevation and depression of the guns. The secondary battery is made up of sixteen 6-pounder, rapid-fire guns, six 1-pounder, four Colts, and two 3-inch rapid-fire field guns for the use of landing parties. The vessels are provided with four long Whitehead torpedoes, which are discharged from the berth deck, the torpedo tubes being located behind the protection of the 5½-inch side armor. Although the contract speed for these vessels was only 16 knots, they each did over a knot better, the trial speed of the "Alabama" being 17.1 knots, that of the "Wisconsin" 17.17 knots, while the "Illinois" made 17.45 knots. As may be seen from the accompanying photographic view of the "Wisconsin," these vessels present a fine, seaworthy appearance, and while somewhat behind the battleships of their date in speed, they are superior in armament and protection.

ENGINES OF THE BATTLESHIP "WISCONSIN."

Although the work of the Bureau of Steam Engineering of the navy does not figure so prominently in the illustrated journals of the country as that of the Bureau of Construction, which is responsible for the design of the hulls of our warships, it is no less important, and to its efficiency we owe much of our naval prestige. Witness the feat of the "Oregon" in steaming 14,000 miles to the theater of war, and almost on the day of her arrival giving successful chase to a 20-knot cruiser and bringing her to, with a shell from her forward gun. Well-designed and well-built motive power and efficient engine room service did far more to win the victories of the late war than they have ever received credit for.

The engines of the "Wisconsin," herewith illustrated, were designed by the Bureau and built by the Union Iron Works, San Francisco. There are two sets of engines, rights and lefts, placed in separate watertight compartments, separated by a longitudinal bulkhead. They are of the vertical, inverted-cylinder, direct-acting, triple-expansion type. The high-pressure cylinder is 33½ inches, the intermediate 51 inches, the low-pressure cylinder 78 inches in diameter, the common stroke of all pistons being 48 inches. The maximum indicated horse power of the two sets as developed on trial was 12,609.

Tre framing consists of special forged and bolted-up columns for the back, and forged steel, turned columns for the front side. The forged column consists of two forged, scrap-iron, plate sides, with flanges for securing the column to the bed-plate, forged solid with the sides, as are also the flanges for securing the columns to the cylinder bottoms. Between these two sides is secured the casting that forms the main guides, which extends clear through from the front to the back of the columns and forms a rigid connection between the two sides. Below the guides the sides separate and form an inverted Y-frame, and here a plate is worked in between the two legs forming a strong intercostal. The construction provides a frame of great rigidity, which does not weigh any more than the cast steel frames, and provides a greater certainty of absolutely reliable material. It has given complete satisfaction in the engines of the "Olympia" and the "Oregon," and has been readily accepted by the Bureau of Steam Engineering in place of the type called for in the original specifications of these engines. The crank shaft is made in three sections, which are reversible and interchangeable. The crank pins are 14¾ inches in diameter and 17 inches long, and the crank webs are each 16¼ inches wide by 10 inches thick. A 7½-inch hole is bored axially through each shaft and crank pin. The thrust shafts are 14 inches in diameter with 9-inch axial holes. Each shaft has 11 thrust collars, 2 inches wide, placed 3½ inches apart, the outside diameter of the collars being 21½ inches. The propeller shafts are 14¾ inches in diameter, with a 9¾-inch axial hole bored throughout their length, the hole being tapered in the after section, where it passes through the propeller hub. All of the crank line and propeller shafting is of hollow, forged steel, of very high quality. The reversing gear is of the straight-push type, controlled by a hydraulic controlling cylinder and differential valve gear, and a hand pump is attached to the hydraulic end of the reversing engines for operating by hand. The air pumps, which are of the single-acting, vertical type, with inverted steam cylinders, are independent of the main engines. There are two air pumps for the set, which balance each other.

A special feature of the condensers for these engines is the fact that the shells are made of steel plate, the water ends being of bronze. This is a feature that may be considered as somewhat experimental, and the result of using steel for the shell will be watched by marine engineers with considerable interest. The main circulating pumps which supply the condensers with cooling water are of the centrifugal type. There are two of them, one being placed in each engine room. When they are used as emergency pumps on the bilge of the ship they will have a capacity of 12,000 gallons per minute each. Each engine room is also fitted with an auxiliary condenser with its air and circulating pumps, fire and bilge pumps, main and auxiliary feed pumps, and hydraulic steering pumps in duplicate.

The screw propellers are of manganese bronze and are three-bladed, the pitch being variable from 16 feet 6 inches to 18 feet 6 inches, the designed pitch being 17 feet 6 inches. The diameter of the propellers is 15 feet 6 inches. The starboard propeller is right, and the port propeller left-handed. Each blade is firmly bolted to the boss by tap bolts of rolled manganese or Tobin bronze, secured by lock plates. An interesting feature is that the hubs and plates for these propellers have been tinned, this being done for the purpose of maintaining a better surface on the propellers, and also with a view to mitigating, to a certain extent, any galvanic action which may arise between the propellers and the adjacent steel structural material. The ship carries eight single-ended steel boilers placed in four compartments, two boilers in each compartment. Each boiler has a mean outside diameter of 15 feet 6½ inches, and an outside length of 10 feet. They have a total grate surface of 685 square feet and a total heating surface of 21,200 square feet; the boiler pressure is 180 pounds to the square inch.

"MAINE" CLASS—FIRST-CLASS BATTLESHIP "MAINE."

The "Maine" class of battleships, which includes the "Maine," "Missouri" and "Ohio," was authorized May 4, 1898. The first plans drawn up for these vessels were almost identical to those of the preceding ("Alabama") class. The announcement of their contract speed, which was set down at 16 knots, aroused a storm of criticism, on the ground that this was at least 2 knots less than the average speed of foreign battleships at that time under construction, and the agitation resulted in a decision to enlarge the ships, and give them a speed of 18 knots an hour. The amended designs were a great improvement over those which they superseded. While the hulls are similar to the "Alabama" type, they are refined by the addition of 20 feet amidships, this lengthening being made to accommodate the increased motive power necessary to give the additional 2 knots speed. It also admitted of the addition of two more 6-inch guns to the broadside battery. The improvement of the "Maine" over the "Alabama" was not confined, however, to speed. The developments in armor manufacture, during the few years preceding the construction of the vessel, due to the introduction of the Krupp process of face-hardening, had enabled our Naval Constructors to secure the same amount of protection with considerably less thickness of armor, the weight thus saved being distributed judiciously among the other offensive and defensive elements of the design. Moreover, the Bureau of Ordnance had succeeded in making a highly satisfactory form of all-nitrocellulose smokeless powder, and it had brought out an entirely new set of guns suitable to the new powder, of great length and high velocity, which, piece for piece, were vastly more powerful and effective than the earlier weapons. Water-tube boilers had also been developed to a point at which the Bureau of Engineering felt justified in adopting them exclusively in the "Maine" class. One advantage of the reduction of weights, due to the use of improved materials of construction, is seen in the increase of the maximum coal-bunker capacity from 1,355 tons in the "Alabama" to 2,000 tons in the "Maine."

The hull is constructed with the usual double-bottom, elaborately subdivided, and controlled by powerful pumps. The upper, or spar-deck, as in the "Alabama," extends aft to the after barbette, the freeboard forward being 19 feet and aft 11 feet. The vessels have the seaworthy qualities and handsome appearance of the "Alabama" class, but the effect is enhanced by the greater length and by the arrangement of the funnels on the longitudinal axis of the vessel instead of transversely, as in the preceding class. The waterline belt has a thickness amidships of 11 inches at the top and 7½ inches at the bottom. It extends from abaft of the after barbette forward to the stem, decreasing to 4 inches in thickness as a minimum at the bow. The protective deck is 2¾ inches on the flat above the engine and machinery spaces and slopes with a thickness of 3 inches to the bow, and aft, with a thickness of 4 inches, to the stern. Diagonal bulkheads of heavy armor will extend athwartship from the main armor belt at each barbette. Resting upon the main belt and its bulkheads is another wall of armor, 6 inches in thickness, which will be about 16 feet in height and will extend unbroken, from the main belt to the upper spar deck. This wall of armor will prevent the entrance of explosive shell beneath the central, 6-inch rapid-fire battery, and will form a complete wall in front and around this battery.

The turrets containing the four 12-inch guns will have a thickness of 11 inches and 12 inches on the port plates. Forward, in the bow, the two sponsons which carry, each, a 6-inch gun, will be protected by 6 inches of armor, and the same thickness will protect each pair of guns on the upper deck amidships. All of this armor will be face-hardened by the Krupp process and, ton for ton, its resisting power will be from 40 to 50 per cent greater than that of the untreated plates, with which our ships of twelve or fifteen years ago were protected.

The main armament will consist of four of the new smokeless powder, 40-caliber, 12-inch guns, and sixteen 6-inch smokeless powder 50-caliber guns. This 12-inch gun has developed on trial a muzzle energy just under 48,000 foot tons, or nearly double the energy of the 12-inch guns of the "Iowa," when using brown powder during the war. The 6-inch gun has shown a velocity of over 3,000 feet per second and a muzzle energy of over 6,000 foot tons, or about double that of the 6-inch guns firing brown powder with which our vessels were equipped during the Spanish War.

Other novel features in the "Maine" class are the fitting of under-water torpedo tubes, the advantage of which over above-water torpedo tubes in respect of safety from explosion by the enemy's shell-fire is obvious. The lessons of the war, as shown in the destruction by conflagration of Cervera's fleet, are exemplified in the fact that wood is used very sparingly throughout the vessel. With the exceptions of the main deck outside the superstructure, the upper deck and the bridges, decks will be covered with linoleum, rubber tiling, wire mats or cement, and such wood as is used will be fully fireproofed. Wherever it is possible light metal will be used for gangways, bridges and all fixtures, except such as can be readily thrown overboard when going into battle. Another noteworthy feature in these vessels is that electricity will constitute the motive power of many of the auxiliary engines. It will be used to run the ventilating blowers, hoist the ammunition, to turn and control the turrets, besides furnishing light throughout the vessel and providing current for four searchlights and a double set of Ardois night signals.

"VIRGINIA" CLASS—FIRST CLASS BATTLESHIP "GEORGIA."

The five great battleships of the "Virginia" class form by far the largest and most important addition ever made to the United States navy. Never before have we built so many armored ships of one class, and never a vessel of the great displacement of 14,948 tons. The "Maine" of 12,300 tons is a big ship; but the "Georgia" will be larger by 2,648 tons. The story of the increase is shown in the accompanying table.

The vessels of the "Virginia" class will be known as the "Georgia," "Nebraska," "New Jersey," "Rhode Island" and "Virginia." The first three were author-