thick, the rest of the armor being 8 inches thick, with top plates of 2½ inches. The barbettes, which will rise from the protective deck to about 4 feet above the main deck, will be generally 10 inches thick, except to the rear of the transverse bulkheads, where it will be 7½ inches thick. These turrets will turn through arcs of 270 degrees, and be under complete electrical control, as will also be their hoists and their loading and training mechanisms. The 8-inch guns, also mounted in pairs, will be placed in four turrets of the same type, on the main deck, at the corners of the superstructure. The 8-inch turrets will have front plates of 6½ inches, and a general thickness elsewhere of 6 inches. Their barbettes will be 6 inches thick where exposed and 4 inches thick at the rear. The tubes leading below to the protective deck will range from 3¾ to 3 inches thick for the lower half. The top plates will be 2 inches thick. These turrets, also under electrical control, will swing through arcs of 120 degrees. The 7-inch guns will be mounted in two broadsides on the gun deck and protected by continuous armor 7 inches thick and stout shields 3 inches thick. The guns will be on pedestal mounts, and the re-entering ports will admit of stowing the guns within the line of the side armor, the advantages of which are plain in rough weather and while lying at a dock. The arcs of fire of these pieces will be 135 degrees, and the forward and the after gun on each broadside will be able to fire directly ahead and directly astern, respectively, thus giving a bow or stern fire of two 12s, four 8s and two 7s from the main battery. The 14-pounders will be variously distributed. There will be one on each bow forward on the gun deck, two on each quarter aft on the same deck, three in a bunch amidships on the main deck, and the rest on the hammock berthing fore and aft on the superstructure deck. Where mounted on the main deck and the gun decks, they will be protected by local armor, 2 inches thick, of nickel steel. The 7-inch guns are separated one from the other by splinter bulkheads of nickel steel 2 inches thick.

The 3-pounders are mounted on the tops of the turrets and on the superstructure deck and bridges, while the smaller pieces are placed in the fighting tops. All of these guns have wide arcs of fire and are placed where they can best do their prime work of repelling torpedo-boats, both surface and submarine, and of attacking an enemy's light armor and unprotected parts and open gun-stations.

The ammunition and shell rooms are so arranged that about one-half the total supply will be carried at each end of the ship. The allowance is a very liberal one, amounting to nearly 600 tons. The ammunition for the 7-inch and smaller rapid-fire guns will be conveyed by hoists directly from the ammunition rooms or passages to the deck on which required, or as near that as possible. These hoists will be driven at a constant speed by an electric motor and will be arranged to deliver seven pieces per hoist a minute. The 7-inch guns will have a hoist apiece. For the 3-inch there will be fourteen hoists, and for the 3 and 1-pounders there will be combined hoists. To supply the 7-inch hoists there will be four ammunition conveyors, operated electrically, fitted in the passages and running directly from the handling rooms to the base of the hoists. These conveyors are really traveling sidewalks, and all the men have to do is to pass them from the door to the moving platform, and the platform delivers them wherever needed. This is an essentially novel feature, and will completely revolutionize the rate of delivery heretofore attained anywhere. The turret guns have regular ammunition hoists operated by electricity and leading directly from the handling rooms or the ammunition passages to the turrets.

A comparison between the batteries of these ships and the British battleship "Commonwealth," rates of fire and muzzle energies being duly considered, show the "Connecticut" and "Louisiana" to be distinctly superior.

The propelling engines will be vertical, twin-screw, 4-cylinder, triple-expansion engines, having cylinders of 32.5, 53, 61, 61 inches in diameter, with a common stroke of 4 feet, and a speed of 120 turns a minute at 18 knots. These engines will be in two separate watertight compartments. Steam at a working pressure of 250 pounds will be supplied by twelve water-tube boilers of the Babcock & Wilcox pattern, and they will have a total grate surface of not less than 1,100 square feet and a total heating surface of 46,750 square feet. Forced draught will be on the closed ash-pit plan with a pressure of 1 inch of water. The three funnels will be 100 feet above the keel line. Feed-water will be carried in the double bottom. The refrigerating plant will be equal to the cooling effect of a daily output of three tons of ice. This plant will be of the dense-air type and will have leads to the magazines for use in case of a dangerous rise of temperature therein. The evaporating plant, of not less than four units, will have a daily output of 16,500 gallons of fresh water, and the distilling apparatus will have a diurnal capacity of 10,000 of drinking water. All of the ventilating blowers will be driven by electricity—those for forced draught by steam. There will be a laundry, a mechanical bread-mixer and a special bakery plant apart from the regular ship's galleys.

The electrical generating plant will consist of eight 100-kilowatt steam-driven generating sets, all to be of 125 volts pressure at the terminals. There will be six electrically driven generators for supplying power to turret turning motors. The ship will carry six searchlights of 30-inch pattern, and there will be no fewer than 1,100 electric light fixtures otherwise, besides truck-lights, signal lamps and a number of diving lamps. There will be six portable ventilating sets of ¼ horse power and forty-five 1-12 horse power desk and bracket fans, and eight 1-6 horse power bracket fans. These, with the thirty-three large blowers, will be able to keep up a pretty comfortable circulation of fresh air. All boat cranes, anchor cranes, deck winches, ash hoists and tools in the machine shop will be driven by electricity.

Wood will be reduced to a minimum, and all of it, with the exceptions of decks exposed to weather and some few articles of furniture, will be fireproofed. Asbestos sheathing and mill board will cover the outer hull plating in living spaces; and metal ceiling will be fitted to the outer hull in all living quarters not sheatned with non-conducting material. Quarters will be provided for an admiral, his chief of staff, the commanding officer, nineteen wardroom officers, nineteen junior officers and ten warrant officers.

A WATER-WHEEL DRIVEN BY A FLOWING WELL.

The ships will carry twenty boats, including two 36-foot steam cutters and a fine 50-foot picket launch, which will be especially useful for shore communication and in going from ship to ship in rough weather, and also in convoying landing parties.

The coaling arrangements will be quite unique. They will consist of six electrically-driven deck winches and a dozen booms—six on each side, together with all necessary fixed chutes, etc. The booms will be so placed that three can be worked to a barge, and it will be possible to coal from four barges at a time—two on each side. Some of the working gear will be automatic. It is not possible to tell now just what the rate of coaling will be, but it is manifestly sure to be much more rapid than any present system.

The nation is to be congratulated upon the promise of these ships; and Chief Constructor F. T. Bowles has marked the first ships designed under his administration of the Bureau of Construction and Repair with a stamp of distinct advance over anything yet turned out by the department, and every contributive bureau has lent its best efforts within its province.

## POWER FROM AN ARTESIAN WELL.

Our engraving shows perhaps the only power water wheel in America driven by an artesian well. It is at St. Augustine, Florida, and supplies power to a wood-working shop. The wheel is 16 feet in diameter, the well 6½ inches and 240 feet deep. Since the well does not supply power enough, however, a second well has been driven nearby to reinforce the present one. The new well is 8 inches in diameter. The contractor first drove an 8-inch iron tube about 150 feet through the sand, when he struck bedrock. On drilling into this some 50 feet, water overflowed in considerable quantity, but it was not until he penetrated quite through the rock strata (about 100 feet thick) that the well gave a normal volume of water.

The Navy Department has decided for experimental purposes to equip the torpedo boat "Rogers" for the use of oil fuel.

## Engineering Notes.

It is said that by June, 1903, the Tehuantepec Railroad, across the isthmus of that name in Mexico, will compete with the Panama route and the American overland lines for a share of the shipments between the Atlantic seaboard and the Pacific coast.

The aggregate tonnage of launches on the Clyde during the month of May constituted a record which has only been twice before exceeded in the whole history of Clyde shipbuilding. Twenty-three steamers were launched, of a total of 54,960 tons; three large sailing ships, totaling 5,676 tons; two steam yachts, of a total of 465 tons, and six sailing yachts of an aggregate of 135 tons. The shipbuilding industry on the Clyde is remarkably prosperous at the present time, and notwithstanding the above abnormal output of new vessels the berths are filled up with fresh orders amounting to about 50,000 tons.

The British government has been requested to sanction the construction of an important railroad from Berbera, on the North Somali coast, to a spot adjoining Harrar, just inside the Abyssinian frontier, to provide rapid communication between the latter country and the sea. The distance is about 220 miles. The railroad is to be a lightly built one, and will cost $3,750,000 to construct, unless the promoters follow a route over the formidable Harrar escarpment. On this outlay the government is asked to guarantee a return of 3 per cent—a relatively small sum. The Emperor Menelik favors the construction of the line, which would tap the trade of a most wealthy district and afford an easy and direct route for the conveyance of British manufacturers into Abyssinia, in which country there is a heavy demand for such goods.

Owing to the extensive and frequent bucklings that have recently occurred upon several of the torpedo boats of the British navy, the English Admiralty propose carrying out a series of severe experiments to ascertain the amount of "hogging" and "sagging" strains the torpedo boat will withstand. The inability of this type of craft to stand the varying strains imposed upon them by wave action, especially in rough seas, is attributed to structural weakness. The Admiralty are preparing one of the drydocks at Portsmouth specially for the tests, which are to be carried out on the torpedo destroyer "Wolf." The vessel will first be "sagged" by being suspended by the head and the stern only from two platforms, one at each end, all support being removed from beneath the middle portion of the ship. She will be "hogged" by being balanced in the center of her length across a pile of timber, so that the full weight of the vessel is thrown fore and aft. By means of these experiments the Admiralty anticipate obtaining reliable and conclusive evidence as to whether, as is generally contended by marine experts, a destroyer's hull is so weak that her back will break when she is lifted by the sea fore and aft in such a manner that there is a wave hollow beneath her center, or when a wave lifts her amidships, leaving stem and stern unsupported.

Engineering says that the Cunard Steamship Company is with characteristic caution considering the question of 24-knot ocean liners in all its bearings. Hitherto the company has merely asked three firms, Vickers Sons & Maxim, of Barrow; the Fairfield Shipbuilding Company, of the Clyde, and Messrs. Brown, to submit three alternative designs for a vessel 700 feet long and with speeds of 24, 23 and 18 knots an hour, along with an estimate of the first cost and information regarding crew and coal expenditure. In this way the company raised the whole question of whether the game was worth the candle. The "Campania" and "Lucania," of 12,500 tons burden, to make 22 knots speed developed 28,000 indicated horse power. To make 23 knots would necessitate a larger and more costly ship, besides an additional 8,000 indicated horse power; while to make 24 knots it is estimated that a ship would require 48,000 indicated horse power. It would thus come about that to add two nautical miles to the hourly speed would mean an additional 290 tons of coal to be consumed daily. This would mean a consumption of 750 tons per day, or 1.3 tons per mile steamed. Engineering points out that an 18-knot steamship would consume less than half this amount of coal per day, while the expenditure in wages and engineering would be correspondingly lessened. It remarks, futhermore, that such a vessel could profitably carry a large cargo, as her machinery would require only half the weight and space of the swifter vessels. It does not pay to take a cargo at a high speed. On the other hand, there is the opportunity of securing higher passenger rates. Many Americans insist on traveling on fast ships. There is also the factor of larger Admiralty subventions made justifiable by the ships being an addition to the resources of the country in time of war. It is stated that in consequence of the efforts of the American syndicate controlling the Dominion Line of steamers to capture the Boston trade the Cunard Line has decided to build a new ship to strengthen its traffic with that port.

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