little—25 and 27 ft. on the Hoche, and 25 and 28 on the Trident. The first displaces 10,581 tons, and the second 8,456. Finally, the Trident is of wood, and the Hoche of iron and steel.

If, now, we descend to the engines, and compare those of the ship of 1876 with those of the armorclad of 1880, the progress is found to be still more perceptible. On the Trident, the engine, with three horizontal cylinders, is of the Wolff system. It is placed in the vessel's axis and actuates one screw. It is of 4,882 H. P., and gives the vessel a speed of 14·17 knots an hour. The evaporatory apparatus consists of eight rectangular boilers of the high type, with four furnaces to each. They are registered at 33 lb. to the square inch.

The Hoche's apparatus consists of two independent compound vertical engines with two cylinders each actuating a screw. The total power obtained should be that of 12,000 horses, which would give the ship a speed of from 16 to 17½ knots. Eight cylindrical boilers, of a special type, with three furnaces to each, with direct flame, registered at 85 lb., and forming four distinct groups, compose the evaporatory apparatus. The engines of both ships were constructed at our Indret works.

A speed of 16 knots, or 17½ at the maximum, will doubtless not appear great if compared with that of steamships of an equal displacement, some of which (like the City of Paris) make as many as 21 knots; but we must not forget the role of armorclads, which renders it obligatory to give them a width that shall permit of the installation of turrets and their dependencies, and to make them shorter,* so that they can perform their evolutions more rapidly in a battle. In naval construction every widening of the hull implies a diminution in speed, and every elongation an increase. Upon the whole, the packet boat is a race horse, and the armorclad is a draught horse.

But where the dissimilarities are especially shown is in the artillery. The Trident, which serves us as a point of comparison, carries six 10¾ in. guns, four of them in the central citadel and two on deck in semi-turret barbettes; two 9½ in. guns, one with direct fire ahead, upon the poop, and the other with direct fire aft; and six 5½ in. guns in battery.

The Hoche has four turrets in a bow and quarter line; two barbettes in the center armed with 10½ in. guns; one in front and one aft, in the axis, armed with 13 in. guns. There are more than eighteen 5½ in. guns in the battery, twelve revolving guns, eight rapid-firing guns, and six tubes for firing automobile torpedoes. It will be seen that the 13 in. guns do not exist upon the Trident.

Upon the ships of the Hoche type, which are three in number (the Magenta, Marceau, and Neptune), the 10½ in. guns are suppressed, and are replaced by 13 in. ones, the field of fire of which is much greater. They throw 770 and 530 lb. projectiles to a distance of 27,230 ft. with a charge of 300 and 330 lb. and with a velocity of 1,820 and 1,800 ft. The 10½ in. guns have a range of but 20,800 ft.

As the Hoche was put on the stocks with its three similars, the latter have not escaped that law of progress of which we have spoken. They have received quite important improvements in detail, especially in their armament. The name of the Hoche has often echoed in the discussions of parliament, of the technical press, and of maritime circles in recent times. The adversaries of the system of building by the state have been pleased to cite it as a striking example of the slowness of the arsenals. It is certain that the workmen of our five ports show less activity than is displayed by those of our private ship yards. But we must not exaggerate anything, even the indolence of the workmen of our arsenals.

If it takes England but three or four years to construct an armorclad, it is because parliament never refuses the credit that the admiralty asks of it. The English armorclads generally cost more than ours. Thus, the Trafalgar, a ship like the Hoche, cost $3,400,000, while the cost of the latter did not exceed $3,000,000. Not only does the English parliament not haggle about the funds to be given to the admiralty, but knows how to grant them at the hour desired. We, therefore, never observe the spectacle on the other side of the channel that was offered us in a certain year, precisely *apropos* of the Hoche, Neptune, and Magenta, when the chamber allowed $453,400 for manual labor and refused the $906,800 necessary for the purchase of materials.—*La Nature.*

[Referring to our engravings, the upper one shows the Hoche as she appeared during the process of construction. The other view shows the great ship as she now appears afloat.]

FIVE days, nineteen hours, five minutes is the reported time made by the new steamer Teutonic, lately arrived at this port from Queenstown. She beat by two hours the City of New York, which started about the same time. This is said to be the fastest time by 13 minutes ever made, being that much faster than the time of the City of Paris.

* The City of Paris is 580 feet in length.

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SEAPORT DEFENSES.

The exposed and comparatively defenseless condition of our most important seaboard cities, in respect to foreign naval attack, has for years been the subject for talk in Congress, but up to the present time little of a practical nature has been done in the line of protection. It is true a few vessels of war have been ordered and some preliminary steps taken toward the manufacture of heavy guns for fortifications. But in regard to the systematic and permanent defense and safety of such important harbors and cities as Portland, Boston, New York, we believe no definite plan has been fixed upon, no material steps as yet taken.

It is, of course, to be hoped that no foreign nation will ever have the temerity to make an attack upon us, but it is impossibl to foresee the future; and, until the policy of universal peace becomes established among the nations, we must not neglect the science and means of defense.

At the present time most of our harbors might be successfully entered and cities burned by a skillfully directed fleet from England, France, Russia, Germany, Spain, or Italy. All thes powers have ships afloat which, in a few days' time, might reach our shores and reduce New York and Brooklyn to ashes, in spite of the best efforts that could be made to beat off an attack. From the Brooklyn Navy Yard to the 24 foot low water line, say a mile off Coney Island, it is nine miles, or within the range of modern heavy guns. The width of the waterway between Sandy Hook and Rockaway Beach is about eight miles, with no intervening fortification to check the approach of an enemy.

All that could be done in the event of sudden attack would be to assemble in the harbor as rapidly as possible the few weak vessels we have on hand, and provide as many torpedoes as we could. These would chiefly be confined to the inner parts of the harbor, leaving the enemy free to select his own positions in the open roadstead, and within range of our great cities.

Obviously what we greatly need for the defense of New York, likewise for Boston and other cities, is the erection in the outer roadsteads of the harbors, out at sea as it were, of suitable fortifications or artificial islands, so located as to command and protect the approaches to the harbors. This is a suggestion of Mr. John F. Anderson, of this city, an engineer of tried experience in the construction of works such as proposed. He is the contractor for the new lighthouse shortly to be erected upon Diamond Shoal, Cape Hatteras.

Mr. Anderson's plan for New York harbor defense is to erect three islands out in the sea, between Sandy Hook and Rockaway Beach, the islands to be about two miles distant from each other and from the shores. For the construction and formation of the fortifications, Mr. Anderson proposes to adopt the same simple and effective means he has heretofore used in erecting lighthouses in exposed situations, namely, construct on shore a large caisson or cylinder of iron, float it to the desired spot, fill with concrete and sink it, excavate the bottom through the interior, and continue to sink the caisson until the required firm foundation is reached; the walls to be built as far above water as desired.

Mr. Anderson proposes an exterior diameter of five hundred feet each for the three islands for this harbor, the caisson to be made double, that is, one caisson within another, a space of fifty feet between the two, to be filled with concrete, thus forming a fifty foot wall of solid artificial stone; the space within the inner caisson to be filled with sand dredged from outside the structure. If desired, the interior could be left open, with an entrance on the land side for torpedo boats. The depth of water at the points where these islands are proposed to be located does not exceed twenty-five feet at low water. Hence the cost would not be great. Mr. Anderson's estimate is one million dollars each.

The superficial area of each island would be about five acres, thus affording ample space for guns, mortars, torpedoes, and the most formidable military appliances. The range of the weapons to be here located would be ten miles, and the result of the proposed structures would be to restrain the approach of foreign fleets for about that distance.

The cost of a first class armored battle ship is about four millions of dollars, and when launched the vessel is always subject to sudden destruction by explosion, wrecking, or other accident. Then again the ship is in frequent need of repairs, is constantly deteriorating, and soon passes into the condition of old iron. Moreover, several such ships would be required for the sure defense of such a harbor as New York.

But these proposed outer sea fortresses would be permanent, effective, and yet economical means of defense. We commend the subject to the consideration of all who are interested in such matters, and should be glad to receive expositions of views thereon.

FOR waterproof cement use a mixture of Burgundy pitch or asphalt and gutta percha melted together.

Gradual Exhaustion of Natural Gas.

That which comes easily is not regarded with the same favor nor held in similar esteem to that which is more difficult to secure, even though both have equal value for the results sought. And so it is with natural gas for fuel purposes. Thousands of millions of cubic feet were worse than wasted; prodigality was the rule in its use; in fact, forming an opinion from the practices of those who supplied it and those who used it, the idea was to see which could outdo the other in recklessness. It seemed as if both suppliers and users had joined in the belief that there could be no end to the good thing that was thrown out in vast volumes from Nature's storehouse. The change came, however, and with it the time for paying up for past transgressions. Weakening pressures and diminished volume aroused the suppliers, who, with as much intemperance in their schemes for metering and increased payments as formerly characterized their lavishness and wastefulness, awoke to the fact that to keep in the swim they must regulate the flow of the tide. Their regulations grew so "pronounced" that the price was finally placed at a point where the larger manufacturing concerns "looked backward" at their old servant, coal, which, it would seem, is again in a fair way to assume its sway in Pittsburg. While we do not wish to be understood as saying that "King Coal" is to at once regain his supremacy in the "Smoky City," it is nevertheless true that his return is certain, although the immediate rate of progress may be slow. These remarks were brought out by advices received the other day from Pittsburg, to the following effect: "The Pennsylvania Tube Company is preparing to abandon the use of natural gas in its works, and return to the use of coal for fuel purposes. At the present time thirteen regenerator gas producer furnaces are being put in the works by the Smythe & Laughlin Company, some of which will be ready to use in about thirty days. The company has had this in contemplation ever since the price of natural gas began to go upward, or to the point where it was a question whether its use was more economical than that of coal. Slack coal will be used for making gas in the regenerators. This is the first industrial institution in Pittsburg to abandon natural gas entirely and to start to using manufactured gas for fuel purposes. Some other firms have the question under consideration." In the meantime there can be no doubt that the makers of artificial gas are under great obligations to the suppliers of natural gas, in that the prodigality of the latter taught the housekeepers of the natural gas districts much in respect to the intrinsic merits of gas as a domestic aid. And it may be accepted as an assured fact that when nature's produce gives out, the artificial gas manufacturer will have rich fields to glean in.—*Gas Light Journal.*

Electric Lighting of Trains.

From a paper on "Electric Lighting in Train Service," read by M. B. Leonard, superintendent of telegraph of the Chesapeake & Ohio Railway, before the recent convention of railway telegraph superintendents, we extract the following concerning the electric lighting of passenger trains:

The Boston & Albany Railroad Company, after two and a half years' trial, recently abandoned electricity on the two trains that were so lighted, and substituted the Pintsch gas system.

The Pennsylvania Company, however, still continues to light cars from storage batteries, using a low voltage lamp.

The Intercolonial Railway Company of Canada has adopted the accumulator system alone on the trains between Halifax and Quebec, and now has more than 40 cars fitted up with electric lamps, which are of 10 candle power, and vary from 11 to 22 to a car. The accumulators are charged at four different points on the line, running about 500 miles with the one charge, and the results thus far obtained are very satisfactory, but to provide for emergencies oil lamps have been retained in each car.

The combination of dynamo and storage battery first adopted by the Pullman Company is gradually being extended in this country, and is giving great satisfaction in the East and West, but, it appears, at a large expense for maintenance. The Chesapeake & Ohio vestibule train, "Fast Flying Virginian," running between New York and Cincinnati with six cars, is supplied with 118 lamps divided up thus: two Pullman coaches with 30 lamps each, dining car with 26, day coach 16, combination car 13, and the baggage car three. Up to May 1, 1890, the average cost per lamp for maintenance and renewals was $1.10 per month; yet where the exhaust steam is utilized for heating the train, the cost can be very materially decreased.

With this object in view, the Chicago, Milwaukee & St. Paul Railway Company has recently added to its equipment two independent light and heat tenders, which carry their own boilers for steam heating and for running a Westinghouse automatic engine attached to a No. 4 Edison compound-wound dynamo, supplying the current direct for lighting all the cars in the train, thus doing away with the dynamo on the baggage car and storage battery combination.

The results have been very favorable, and during more than six months of constant service there has not been a single failure. This company has four trains covering about 45 cars lighted by electricity, and expects to adopt this system of illumination on all of its through trains. It is stated that the expense of building and equipping these tenders is not much greater than the cost of the storage battery-dynamo combination, with the expensive wiring required in that system.

It is confidently believed that the cost of lighting trains by electricity in the United States can be greatly reduced by adopting the method so largely used abroad of gettting power from the axle. Mr. Houghton, the telegraph superintendent of the London, Brighton & South Coast Railway Company, one of the patentees of the system, advises me that there are sixteen trains running on that road which are so lighted—thirteen of them local trains and three express. The speed of the express trains reaches 70 miles an hour, while that of the locals runs from 20 to 60 miles per hour. The express trains are wired for an average of 70 lamps, and the others 40. The candle power of these lamps varies from 8 to 16, according to the speed of the train. The dynamo furnishing current for these lamps is placed in the baggage car and has a pulley at each end connected by belts direct with the axle of the car, no intermediate shafting being used. The slack is taken up by loose pulleys that can be pressed upon the belts.

In the same car with the dynamo, 22 accumulators weighing about 4,000 pounds are placed in parallel with the dynamo, for use whenever the train stops.

Connected by a belt from the dynamo is a centrifugal governor which joins up the circuit at any desired speed, causing the dynamo to charge the accumulators. When the lamps are not lighted, the governor introduces resistance into the dynamo field, reducing the output to about 40 amperes, in order not to damage the accumulator plates. When, however, it is necessary to light the lamps, the dynamo makes the full current, of which about 35 amperes pass into the lamps, the balance being stored in the accumulators.

In each lamp circuit a regulator is placed in order to keep the light in the lamps at the same power regardless of the speed of the train, and shunt any surplus current into the accumulators; so that 42 volt lamps may be used with a dynamo of any E. M. F. above that voltage without any variation in the light of the lamps.

The connections between the cars are made by coupling two cables together, and when the dynamo runs below a certain speed, a cut-out breaks the circuit of the armature, preventing the cells from discharging themselves through and burning it out. Should the current not furnish enough current for the lamps, the accumulators supply the balance, and in doing so strengthen the field magnets, and thereby cause an increase of current in the dynamos.

One arrangement of the circuits of these trains has the field magnets of the dynamo wound with two wires in opposite directions, one of which is shunt to the armature as if the dynamo was an ordinary shunt machine; the other is wound in the reverse direction as if the dynamo were a compound machine, and the accumulators are in series with the wire. The lamps are also in shunt with the armature.

The trains on which this system is used consist mostly of ten cars which run solid, that is, are not broken up, and average 40 12-candle power lamps to a train. By using accumulators in each car, however, no difficulty would be found in splitting up the train at various points.

The figures given by Mr. Houghton are as follows:

Total weight of the plant on each train, three tons; cost of plant on each train, £400 sterling; cost of maintenance per annum, £65 sterling.

The only attention given trains is at each terminus, where one man inspects the apparatus, oils the pulley bearings, etc., before the train pulls out. One of these trains has been running since December 19, 1883, without a single failure being reported. During the first eleven months of its use, it made 2,352 trips, and ran 27,322 miles.

The Midland Railroad Company, of England, is running three trains lighted by electricity, and has recently fitted up two others. Two of these are short trains always run solid, and the others main line trains made up at various points. The dynamo is placed in the baggage car, and is also driven from the axle with about the same electrical arrangements as are used on the London and Brighton Road. The short trains have eighty-five lamps run from one set of storage batteries, in the baggage car. On one train the batteries are in series, but on the others in parallel. This seems to be the most satisfactory. Eight candle power lamps are used on this road, two to each compartment, which can be turned down, and this feature is found to be very convenient to through passengers.

This system of illuminating passenger trains is becoming very popular in England, and it is believed that all such trains on the important roads of the kingdom will shortly be equipped in this way. The expense as shown by seven years' experience on the London and Brighton Road is certainly not greater than where common oil is used, and seems to corroborate the report made by Sartiaux and Weissenbruch to the International Railroad Congress at Paris a year or two ago, in which it was stated that for lights of the same candle power, gas supplied by the Pintsch system would cost about 11·3 centimes and coal oil about 16·9 centimes per lamp hour as against 5·6 centimes for the electric light.

Compared with the practice on American roads, the economy of this method of generating this current is remarkable. It has been stated, however, by various authorities that it is impossible to secure even fair results in train lighting in this country where the power is supplied by the car axle, owing to the numerous curves on American roads, around which the wheels will often slide without turning the axle a single revolution, thus seriously damaging belts and armature, and the constant changes in speed, while English roads are almost always tangents, and a high and constant rate of speed is maintained. The experiments made here some years ago seem to corroborate these statements.

In 1886 or 1887, Mr. Barrett, of Springfield, Mass., fitted up a train on the Connecticut River Railroad to be lighted with electric lamps run from a dynamo obtaining its power from the car axle. A countershaft was used, and a peculiar arrangement of a friction clamp transmitted the power to a pulley on the shaft. This clamp was governed by centrifugal weights balanced by stiff springs. When the dynamo ran at its normal speed, these springs just balanced the friction of the clamp, and there was no slip; any increase of speed then caused the friction to diminish and the pulley slipped upon the shaft until the equilibrium was restored; 24 accumulators were connected with the circuit as a regulator, keeping the lamps lighted when the train stopped, and a centrifugal governor broke the accumulator circuit when the train slackened its speed. The brushes were attached to a rocking arm or lever, which was tilted by magnets in either direction in accordance with the forward or backward movement of the train.

Owing to the arrangement of the car trucks, it was found very difficult to obtain the proper speed of the dynamo, and after successive trials with belts, ropes, and chains it was finally abandoned. Since that time there have been no further experiments of this character in the United States, but it is said that such improvements are now being made in the driving gear as will obviate the difficulties heretofore encountered, and that further trials in this direction may be looked for within the next six months.

Coffee Cochineal.

The coffee plantations in the department of Amatitlan, Guatemala, have lately been ravaged by a peculiar insect, which M. Adolf Vendrell has ascertained to be a new species of cochineal (*Coccus coffea*). The principal industry in this district formerly was the cultivation of cochineal. When examined microscopically, one of the insects is seen to contain a yellowish liquid with thousands of little eggs. As the development of the eggs continues they become larger, and the liquid diminishes, so that a dry insect contains no liquid, but innumerable eggs of a reddish yellow color, which look like very fine powder, and are transported by the wind as easily as the pollen of flowers. In December the insects are in the former condition, and about February and March the female insect reaches the stage of full development and ejects the eggs, covering them with its body. The insects are only noticed on the coffee plants when the females are fecundated; but by this time the plant has become sickly and yellow; it is imperfectly nutrified, and, should it reach the fruiting stage, the berries are small and of little value. M. Vendrell thinks that this is because the insects extract nitrogen from the plants, and he consequently advises manuring with nitrate of soda.

A Monster Piece of Granite.

Vinalhaven, Maine, claims to have produced the largest stone ever brought to light. The Bodwell Granite Company recently quarried a shaft of granite which is the largest piece of stone ever quarried anywhere, and, if erected, will be the highest, largest, and heaviest single piece of solid stone standing, or that ever stood, so far as any record can be found. In height it considerably exceeds any of the Egyptian obelisks. The tallest of these, which was brought from Heliopolis to Alexandria by Emperor Constantine, and afterward taken to Rome, where it is still standing, is 105 feet 7 inches high, while the Vinalhaven shaft is 115 feet long, 10 feet square at the base, and weighs 850 tons. It is understood, says *Stone*, that the company quarried this immense monolith of their own account, not having an order for anything of the kind, and they suggest that it would be a fitting contribution from Maine for the monument to be erected in honor of General Grant.