

36c. to 38c. each, and are preserved with copperas for 14c. and with creosote for 19c. each. The Orleans Railroad uses the same kind of sleepers, preserved with creosote, for about one-sixth of the whole consumption. The Northern Railroad finds that the use of a tarred felt paper between the rail and the sleeper increased the life of the latter about two years."

### ORDNANCE AND NAVAL.

**THE BRENNAN TORPEDO.**—Some further experiments have been made at Sheerness, with the Brennan torpedo, the results being described as exceedingly satisfactory. The experiments were carried on in conjunction with the electric search light at the Garrison Point Fort, and the weapon was steered about the harbor in different directions at the will of the operator in the torpedo room at the fort, and was finally directed at a target moored about a mile up the Medway, the mark being rendered discernible by means of the electric light. The torpedo is kept under control and steered by means of a wire attached to the machinery in the fort. When the experiments at the fort have concluded, it is proposed to test the adaptability of the torpedo for use as part of armament of ships of war.

**SUBMARINE MINING EXPERIMENTS.**—Extensive submarine mining experiments were carried out near Portsmouth on September 14, with the view of testing the efficiency of the present system of firing mines, the system, owing to the weakness of the detonating charges, having broken down at the recent naval review. Two experiments were made. The first was with observation mines, which consisted of a line of six mines, each containing 500 lb. of gun cotton, so arranged as to blow up an enemy's ship should it have crossed the line. The mines were at the bed of the channel, covered with 10 fathoms of water, and connected by an electric tube in which was inserted at each mine a charge of fulminate of mercury. On a key being pressed, four out of six mines were exploded, and each sent up a huge volume of water 400 feet high. Gunboats were stationed 600 yards off, and after the first violent shock the sensation was as though the boats were bumping heavily on rocks. These mines were laid on a mud bottom, large quantities of which, together with tons of fish, were blown up with the water. The next experiment was with a line of 12 countermines, supposed to be laid over an enemy's mined channel, and these also each weighed 500 lb. and were 180 feet apart. On the key being pressed, 11 out of the 12 mines exploded; but, owing to these being laid on a sandy bottom, the shock was no greater to the gunboats than in the first experiment. Tests were carried out on a point of land eight miles from Portsmouth, where the effect of the shock was not felt.

**THE "RESISTANCE" TORPEDO EXPERIMENTS.**—Under the direction of the officers of the Vernon Torpedo School a protracted series of torpedo experiments was commenced on September 21 at Portsmouth, and will be continued until

the Resistance, armor-clad man-of-war, which serves as the target, is blown up. The trial consisted in discharging 60 lb. of gun cotton at a distance of 10 yards from the ship, which is moored in such hollow water that, should she be sunk, she could be approached at low tide. At the trial the vessel was violently shaken by the concussion, but was not otherwise damaged, although it was clear that a much heavier charge would have done a good deal of mischief. The experiments were continued on September 22, and they constituted the first instance of a live Whitehead torpedo having been exploded against the hull of a ship. Hitherto their destructive effects have been a matter of assumption, and the present experiments are calculated to settle many practical questions connected with torpedo attack and defense which demanded a solution. The Resistance being an obsolete ironclad, several things were required to be executed on board to enable her to represent a modern battle ship attacked under approximate conditions. The bunkers below the armor shelf on the port side were accordingly made to represent the actual coal defense which is now applied for the protection of the boilers and machinery of a ship of war against submarine attack. The bunkers were fitted at Devonport with an iron longitudinal bulkhead, which divided them into two equal compartments. The one contiguous to the skin plating was filled with coal, due precautions being taken against firing by the provision of ventilating tubes. By these means there was a thick protection of coal sandwiched between the inner bunker and the wing passage. The whole port side of the ship was also defended against torpedo attack by Bullivant's service wire nets boomed out to the distance of 30 feet. This was the distance which previous trials had abundantly proved to be safe against the destructive force of a Whitehead torpedo; but the weight of such booms and the necessary working gear render them unhandy, cumbersome and burdensome, and the main object of the experiment was to ascertain whether the length of the booms could not be reduced without danger to the vessel attacked. As the purpose was to accurately ascertain the effect of a palpable hit, some sacrifice of practical conditions had necessarily to be made to ensure the hit being delivered precisely where it could inflict the most mischief. In actual warfare, it is presumed that the burst of a Whitehead torpedo would prove fatal to a ship wherever it came in contact with it; and although the projectile occasionally proves erratic from no ascertainable cause, save the proverbial refractoriness of inert matter, an ironclad presents so conspicuous a target that the torpedo would be almost certain to hit it somewhere. At the experiments on September 22, it was imperative and essential that the torpedo should hit her, not anywhere, but directly in a certain spot or compartment about 29 feet in length, and extending from the keel flat to the armor shelf amidships. To ensure accuracy, therefore, the old vessel was chained stem and stern in Portchester Lake, in the remote reaches of Portsmouth Harbor. She was a fixture, and in order that she should not have a chance of escape, the time of high

water was chosen, so as to avoid the deflective influence of currents, and also to prevent the destructive agent itself from being arrested in its course by lack of water and coming to an ignominious end in the mud. The instrument of execution selected for the occasion was the old 16-inch Whitehead torpedo. An obsolete torpedo was chosen because, although it may not pursue quite so straight a course through the water as a modern one, it carries considerably more in its head, its full charge of gun cotton being 91 lb. as compared with the 65 lb. of the modern 14-inch Whitehead. The torpedo was also fitted with a new pistol trigger, which is exceedingly sensitive, and explodes the charge upon traversing the meshes of the netting. The Vesuvius torpedo vessel was at a comparatively remote distance to the westward. The effective range of the improved Whitehead is understood to be 600 yards, but as it was expedient for many reasons to attack the net defenses of the Resistance at close quarters, the Vesuvius got underway, and, when passing her at a distance of 100 yards, discharged the projectile. The path of the torpedo through the water was clearly indicated by the air bubbles which it threw up, and though straight, its progress was undeniably deliberate. The torpedo struck the defenses a little forward of the target, but, though the visual force of the explosion was very great, those who expected to see the destruction of the old Resistance were disappointed. As soon as the fountain of water thrown up had subsided, it was manifest that the netting had served the intended purpose, and that, so far as could be seen, the ironclad had not only survived the attack, but remained uninjured. The nearest boom had been unshipped from its support, but the whole of the others remained intact. The meshes in the immediate vicinity of the burst had been carried away, but the area of positive destruction was so exceedingly limited that a second discharge would have proved just as harmless, unless it happened to have passed through the rent in the defenses inflicted by the first. Of course, the exact amount of dislocation on board can only be known after a careful survey, but so far as could be seen the ship was undamaged. The length of the booms will be gradually diminished until the vessel succumbs to the attack. The only foreign representative present at the trial was the German naval attaché. The torpedo experiments were resumed September 24 and resulted in serious damage to the old ship. So far as the experiments had previously proceeded, the results obtained had been little more than verifications and amplifications of the submarine mining data derived from the operations against the Oberon; but last Friday an important step in advance was made, and it was evident to all that the final stage in the endurance of the ship was near at hand. The former experiment had shown that the progress of a locomotive torpedo could be effectually arrested by the ordinary service protective nets now in use, and that the burst of a full charge of gun cotton at the theoretical distance of 30 feet from the ship's side was perfectly harmless. The attack was advanced to closer quarters, and as the value of the nets

had been demonstrated, it was deemed no longer necessary to employ costly Whiteheads in the assault. A fixed charge of gun cotton representing the normal explosive energy of a Whitehead was accordingly slung from the booms at a distance of 20 feet from the skin plating (10 feet nearer than before, and submerged at a depth at which a torpedo would be set, and afterwards electrically exploded from a cutter. The explosion produced the usual detonation and spout of water, but its force expended itself in the air without inflicting any perceptible damage to the old hulk, which still continued to hold its own. A second charge of the same character and weight was afterwards sunk 5 feet nearer the ship, that is, 15 feet from the side, and exploded in a similar way. In this case the differences were manifest and significant. Though the volume of water thrown up was about the same, the detonation was less diffused, and, whereas the previous spout was perfectly clean, the outer ridges of the dome in this instance were discolored with mud, and presented a very vague outline. It was evident that considerable work had been performed and that the energy of the burst, being confined to some extent by the proximity of the ship, had rebounded from the harbor bottom. The Resistance, which was held down by four anchors, did not rock, but the shock on board must have been very severe. It appeared, too, at the time, that the explosion had damaged the vessel, as she seemed soon afterward to give a slight list to port, but, as she is divided into numerous water-tight compartments, even had the charge blown a hole in her, her heeling over would not be great. She was, however, greatly strained and shaken, and, though the booms remained in place, and none of the bottom skin was displaced, it began to leak until eventually the wing passage in wake of the target compartment became filled with water, and several runlets found their way into the bilges. During Friday night the water rose 5 in. an hour, and, although thirty men were engaged at the pumps, and were subsequently increased to close upon 300, they could not keep the water under. The diver, on being sent down to examine her sides and keel, reported that the main injury done was the straining of one of her plates; but it has now been ascertained that one of her Kingston valves was also extremely damaged, and the repairs will necessitate a postponement of the further trials. At five o'clock on Saturday morning, the large crew had the utmost difficulty in keeping the vessel afloat until half past seven, by which time she was towed up the harbor and hastily put into dock. Considerable interest was shown in the operation, and many naval officers awaited the clearing of the dock in order to inspect her hull; but a casual observation revealed little damage, the intruding water being attributed more to the injury to the Kingston valve than to the straining of plates. When her defects have been made good, the Resistance will be taken back to Portchester Creek, where the experiments will probably culminate in her being blown up.

**N**ORDENFELT VERSUS HOTOHKISS GUNS.—  
Some important trials have been made