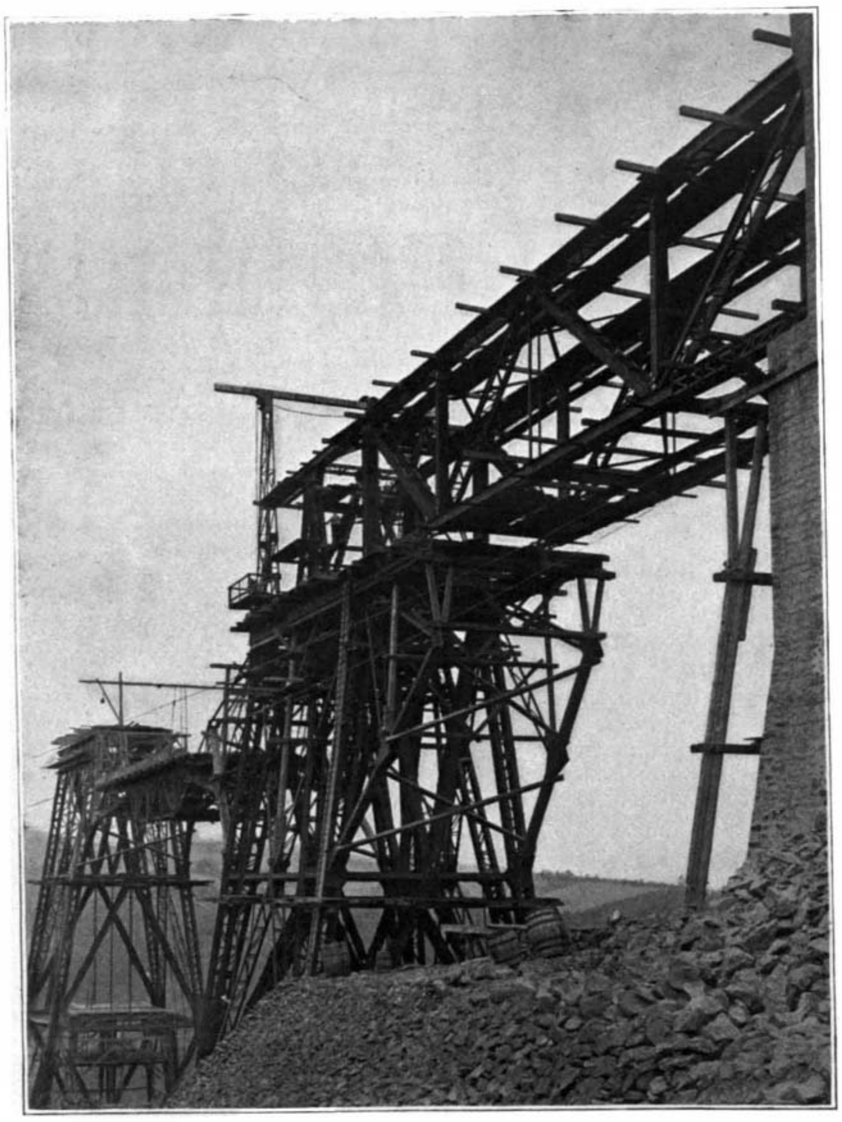
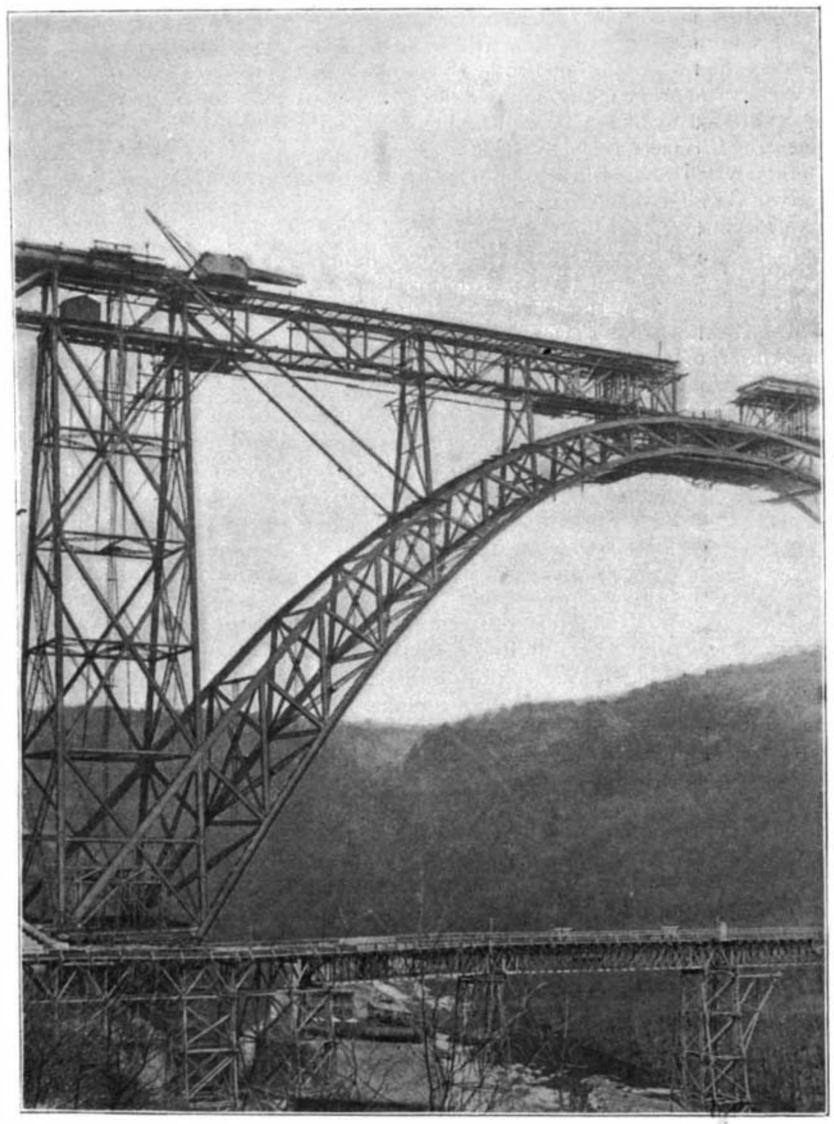
THE MUNGSTEN HIGH-LEVEL ARCH BRIDGE.

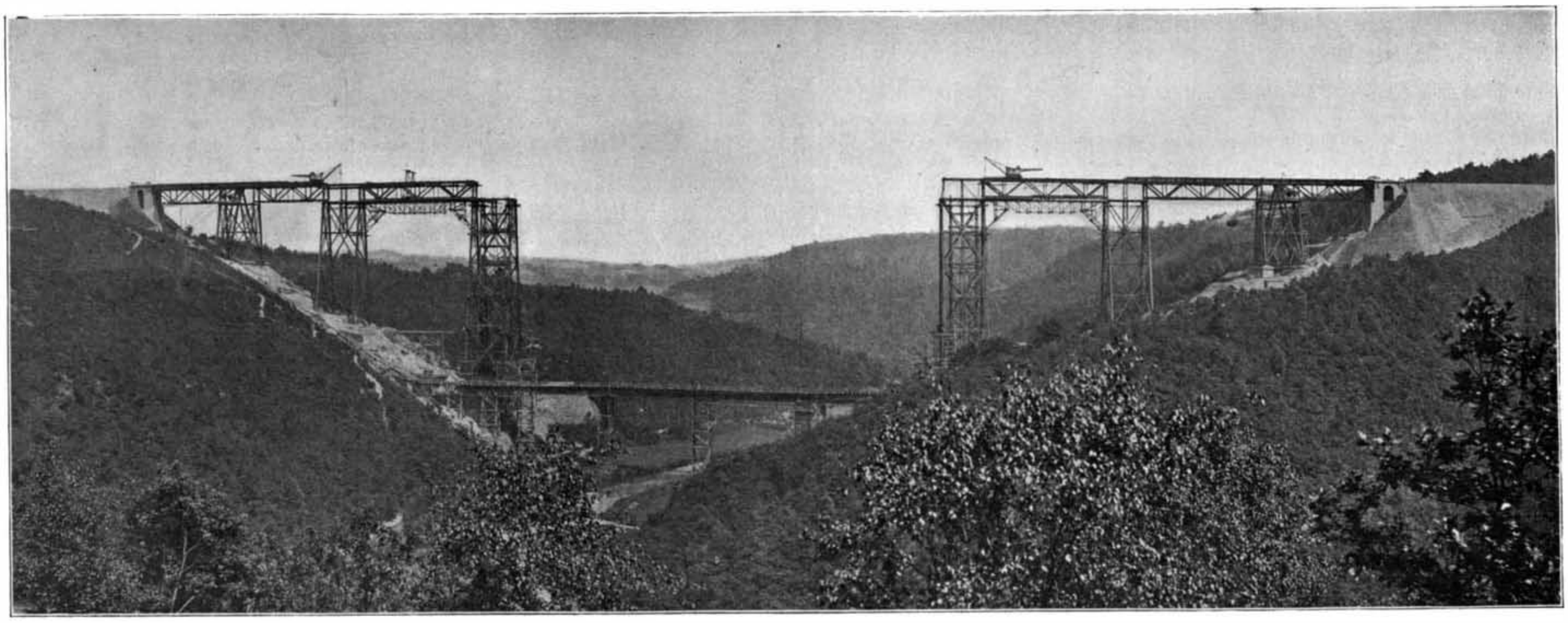
In the issue of the SCIENTIFIC AMERICAN of March 25, 1899, is an article on recent German arch bridges in which is given a comparative table of the largest bridges of this type throughout the world. Although the Müngsten bridge stands by no means near the head of the list in respect of the total length of the main span, it possesses certain features, such as its great height above the river, the unusual rise of the arch, the ingenious method of erection, and the extremely picturesque topography of the site, which render it second only to the great 840-foot arch bridge features of special interest; but the crossing of the valley of the Wupper involved the construction of a great viaduct, whose total length, including approaches, is 1,590 feet, and whose greatest height above the river is 354 feet. The plan adopted was selected from three different designs which were submitted to the government railway department. One of these proposed to span the valley with a bridge 1,630 feet long, which was to be carried on twelve skeleton towers, the four towers at the center of the bridge resting upon a trussed arch of 560 feet, which was to span the central portion of the valley. Another plan The lengths of the various trussed spans of the superstructure are as follows: On the Remscheid end there is first one span of 100 feet and then two of 148 feet, while at the opposite end of the bridge, commencing from the abutment, there are two spans of 100 feet and one of 148 feet. The main portion of the superstructure above the central arch is carried at its center by the crown of the arch, and on either side of the crown it is carried upon two vertical bents which extend from the arch to the superstructure at a distance of 148 feet and 100 feet from the crown. The width of the floor of the bridge is 16½ feet, while a batter of one in seven



1.—MUNGSTEN BRIDGE—ERECTING THE STEEL-WORK OF THE APPROACH VIADUCT.



2.—MÜNGSTEN BRIDGE—ARCH COMPLETED AND FLOOR TRUSSES BEING BUILT OUT TO A CONNECTION.



3.—MUNGSTEN HIGH LEVEL BRIDGE, SHOWING CONSTRUCTION OF THE VIADUCT APPROACH TO THE CENTRAL ARCH. TEMPORARY ROADWAY BELOW.

which has recently been opened across the gorge of the Niagara River. The Müngsten arch has a rise of about 225 feet, a span of 557·6 feet, and its floor is about 354 feet above the surface of the river Wupper, which flows beneath.

The bridge was built for the purpose of carrying the new railroad which has been constructed between the manufacturing towns of Solingen and Remscheid over the precipitous valley of the Wupper. Prior to the construction of the road, the distance between these two centers was about 28 miles, whereas the carriage of freight by the new road will only necessitate a haul of about one-fourth of that distance. The new railroad does not in itself present any constructive proposed a bridge 1,584 feet in length, which was to be carried upon nine braced towers of the type common in American railroad trestle work, with short inverted bowstring trusses between the piers. The third design was for a cantilever bridge with a central span of 560 feet and two shore spans of about 370 feet each, the total length from abutment to abutment of the cantilever being 1,530 feet. The first of these three designs was decided upon, to be built in the somewhat modified form presented in our illustrations.

The floor of the viaduct, where it extends above the sloping sides of the valley, is carried upon a number of braced piers, while the central portion is carried across the Wupper by a central span of the braced arch type. is given to all the towers throughout the bridge. The piers are built in 40-foot panels, and the bracing, both for wind and static strains, is made particularly heavy. The two arched trusses are inclined inwardly and are arranged to lie in the same inclined plane as the towers of the bridge. At the crown the twin-arched trusses are the same distance apart as the width of roadway, that is to say, 16½ feet. They are parabolical in form, and the depth of the trusses between their upper and lower chords is about 13 feet at the crown and 39 feet at the springings. As will be seen from our illustrations, the alternate web members of the arch lie in a true vertical plane, with the result that they coincide with the vertical piers and supports and form with them unbroken lines from the bottom chord of the trussed arch to the top chord of the superstructure trusses. The whole effect is harmonious and extremely pleasing.

A study of our illustrations, of one-half of the great central arch, shows that there is a line of wind bracing running through the lower chord of the arch and that sway bracing is introduced between each pair of vertical members throughout the whole arch. There is no lateral bracing, however, between the upper chords of the arch, the whole duty of resisting the wind strains being thrown upon the lower lateral system.

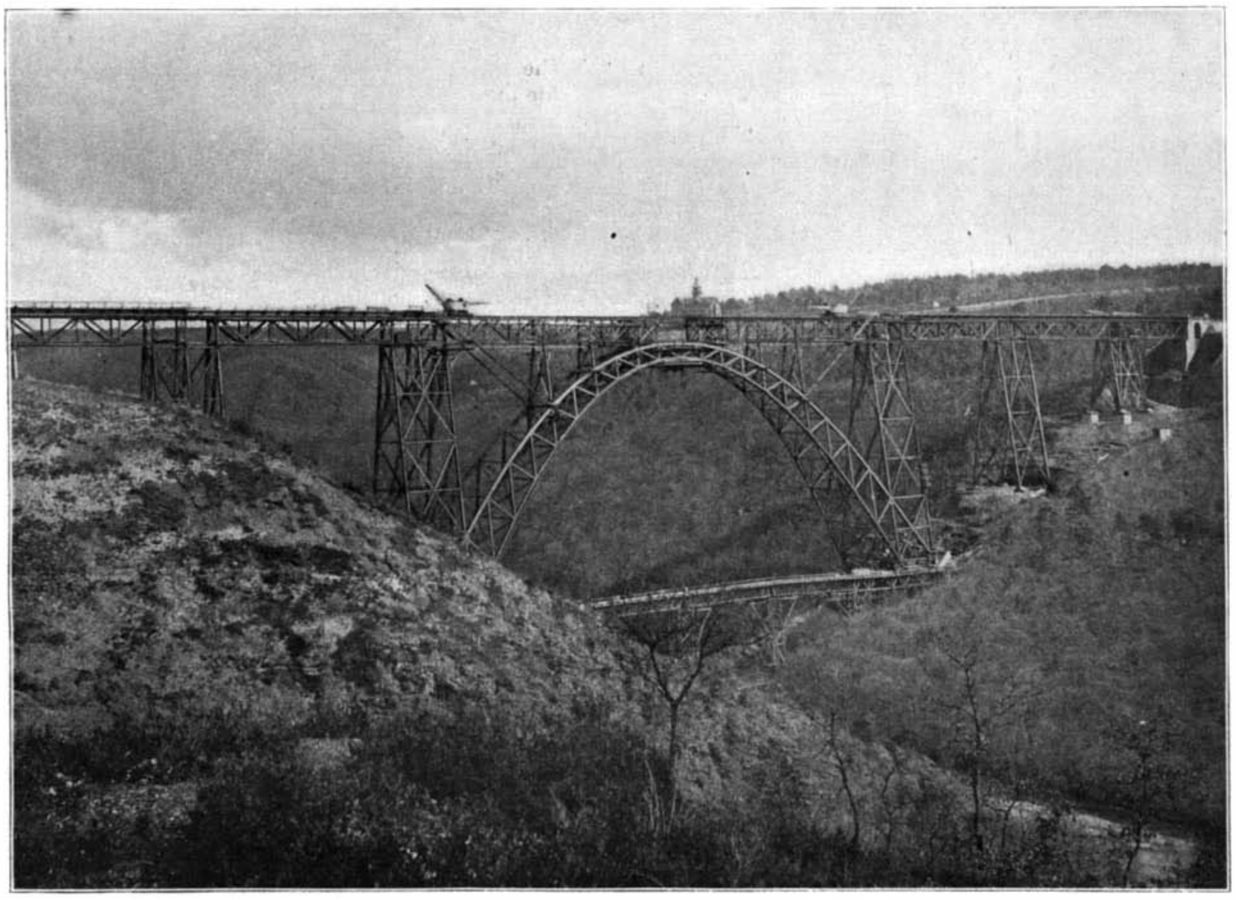
The superstructure trusses do not call for any special description. They are of the standard Warren type, with alternate struts and ties at each panel point. To provide for expansion and contraction, the superstructure trussing is divided at two points, which are located at the towers above the springing of the main arch.

The construction of this bridge, which was carried out under Mr. A. Rieppel as chief engineer, presented, on account of the great depth of the valley, considerable difficulty. A special plant operated by electric power was laid down at the site of the bridge, and extensive buildings, including residences for the workmen, were constructed. To begin with, a temporary inclined railway was built parallel to the line of the bridge down each slope of the valley, while a trestle bridge of timber was constructed to carry the railway over the river Wupper, the inclines being worked by separate electric winches. The portions of the bridge extending from the abutments to the springing piers at the main arch were erected first, the piers being built by the assistance of interior staging to their full height and the superstructure trusses erected on falsework and temporary trusses. After this portion of the bridge had been completed, temporary anchorage bolts were attached, which extended diagonally back from the first pier to an anchorage chamber which had been excavated from the solid rock of the hillside. These anchorages were put in to resist the horizontal pull due to the erection of the main arch by the overhang or cantilever principle. One of our illustrations shows this portion of the work completed prior to the building out of the main arch.

The great arched trusses and the superstructure trusses were built out, a panel at a time, without the use of any temporary falsework beneath, and as the overhang increased, the bending strain on the arch was relieved by tying the structure back to the piers. Two of these temporary ties are shown in our illustration, Fig. 2.

Unlike other great arch bridges, such as those at Niagara, Garabit, and Grunenthal, the Mungsten bridge is not provided with hinges at the skewbacks. While the absence of these hinges produces more complexity in the calculation of the stresses of the bridge, due to the reversal of strains, it provides a structure having greater rigidity and offering less difficulty in erection.

We are indebted for our illustrations and particulars to Fritz Müller von der Werra, civil engineer, of this city.



4.—THE MUNGSTEN BRIDGE.

Total length, 1,590 feet; span of arch, 557·6 feet; depth from floor to river, 354 feet.

PROPOSED ARMAMENT FOR OUR THREE LATEST BATTLESHIPS.

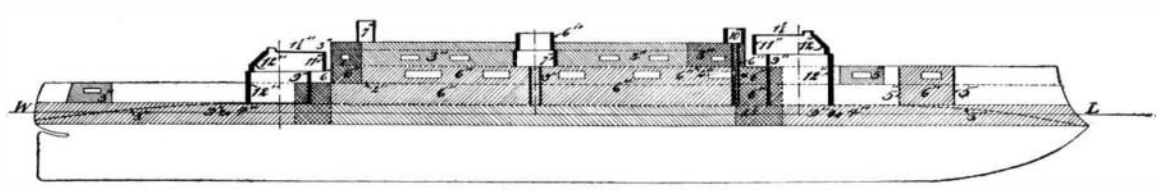
By the courtesy of Rear-Admiral O'Neil, Chief of the Naval Ordnance Bureau, we are enabled to reproduce the accompanying plans, which were submitted to the Bureau of Construction as suggestions in regard to the armament and armor of our three latest battleships, "New Jersey," "Georgia," and "Pennsylvania," authorized by the last Congress. They show the many improvements which are possible on a given displacement as the result of the greatly increased resisting power of the latest type of armor and also as the result of the increased energy due to longer guns and higher velocities.

Our Construction Bureau has never turned out a more creditable design than that for the "Alabama" class of battleships, and we notice that in the successive designs, first of the "Maine" and now of the "New Jersey" class, the Bureau has wisely maintained the general distinctive features of the "Alabama," and merely added such improvements as were possible owing to the general advance which has been made in guns, armor and motive power.

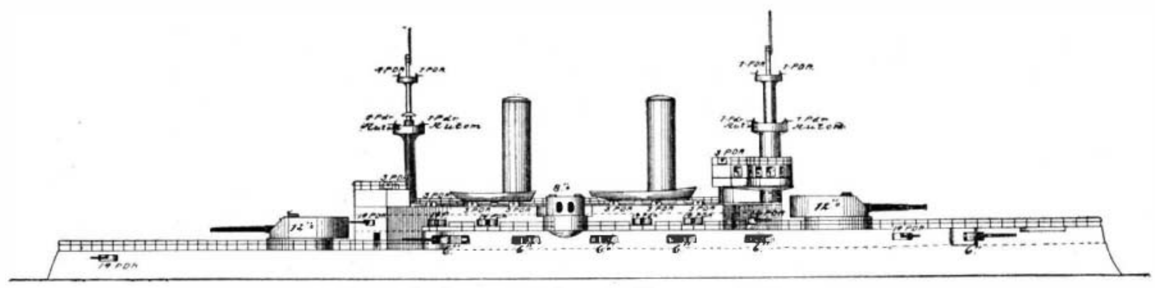
Rear-Admiral O'Neil has prepared five separate plans for the new ships. They all possess the highly meritorious and characteristic features of carrying extremely powerful batteries and being provided with a very complete system of protection. While all of the designs are creditable, we must confess that the first of them, known as type A, of which we present two different views, appeals to us as being decidedly the most efficient, and containing the best combination and proportion of the different types of guns. The five designs are identical in displacement, speed, and in the arrangement of the protective armor. Each plan, moreover, provides the same number of guns of each caliber and the same distribution in the secondary batteries, indeed the only modifications in the plans are those relating to the main battery in which are included the armor-piercing guns and the heavier rapid-fire weapons above 6 inches in caliber.

The distribution of the armor is in every way admirable, and is far more complete than anything that has yet been attempted in any of the navies of the world. In the first place, there is a complete waterline belt 8 feet in depth, which extends from stem to stern. It is 9 inches thick at its upper edge and carries this thickness for a depth of 4½ feet, from which level it tapers gradually to 6 inches at the lower edge. This belt maintains these thicknesses over that portion of the ship extending between the 12-inch turrets, and at its extremities transverse bulkheads, 9 inches in thickness, extend diagonally inward to meet the barbette armor of the 12-inch guns. From abreast of these barbettes to the stem and stern the waterline armor is gradually reduced to 4 inches in thickness. From the top of the waterline belt to the level of the upper deck, and extending forward and aft, as shown on the plans, the sides are protected by 6-inch armor, at whose ends are diagonal walls 6 inches in thickness, the whole forming a complete central casemate or redoubt, within which are placed ten of the 6-inch rapid-fire guns. Every 6-inch gun is further protected on both sides by splinter bulkheads 2½ inches in thickness, and each of these separate casemates is closed at the rear by bulkheads of 2½-inch steel. The 6-inch guns in the bow of the vessel on the main deck are each protected by a complete casemate 6 inches in thickness on the outside, and with walls 5 inches thick in the interior of the ship. These casemates, like the main central casemate, extend from the protective deck clear to the upper deck. Above the central 6-inch gun redoubt there is another complete redoubt of 3-inch steel, within which is carried a battery of twelve 3-inch 14-pounder guns. There are also two 14-pounders on either bow on the main deck, just abaft of the 6-inch bow guns, while two others are placed on either quarter near the stern on the berth deck, all four of these guns being also protected by 3-inch armor.

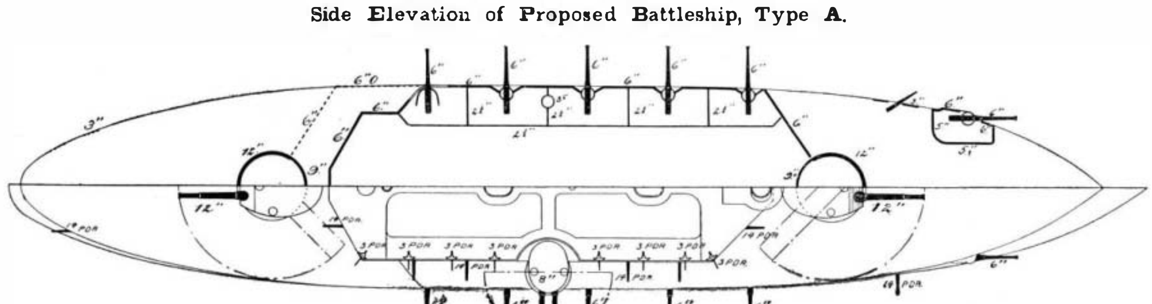
The deck protection is also very complete. A protective deck, which is 2½ inches in



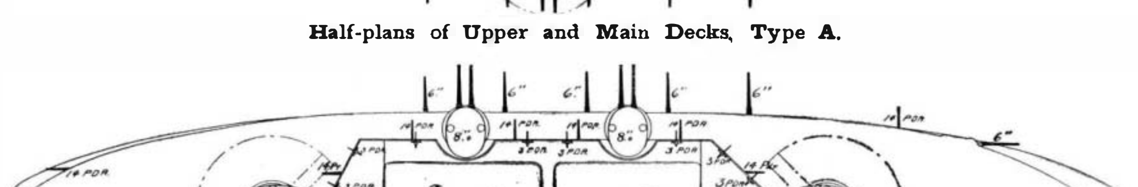
Armor Protection for the Five Types of Battleship.



Side Elevation of Proposed Battleship, Type A.



Half-plans of Upper and Main Decks, Type A.



Half-plan of Type B.

ALTERNATIVE PLANS FOR THE PROPOSED BATTLESHIPS OF THE "NEW JERSEY" CLASS.