Pennsylvania Railroad was mentioned as the chief mover in the project; but it seems that the failure of the other roads to come to an agreement as to the proper distribution of the expense of construction has led this corporation to abandon the idea of a bridge, and turn its attention to the connection of the Pennsylvania and Long Island Railroads with each other and with New York by a system of underground tunnels.

The accompanying plan and profile of the proposed tunnels is drawn from plans filed in the County Clerk's office by the Pennsylvania-New York Extension Railway Company, which has been authorized to build and operate the tunnels. The line of the tunnel, as shown in the plans, commences at the State line in the center of the Hudson River. As it approaches the Manhattan shore the two tunnels, each of which will be 18 feet in diameter, diverge until they are opposite the centers of 31st and 32d Streets. They extend with an easy rising grade of less than 1.5 per cent to about the middle of the block between Eighth and Ninth Avenues, where the line is level for about 1,500 feet, the surface of the tracks being about 45 feet below the surface of the street. From just beyond Seventh Avenue, the line falls again on an easy grade to a point between Fourth and Lexington Avenues, where the track will be about 60 feet below the surface. From this point to the East River the grade increases to about 1.5 per cent, the lowest level being near the New York side, 85 feet below mean high water and about 30 feet below the deepest level of the river bottom. From this point the ascent is by an easy grade of from about 0.5 per cent to 1.2 per cent, until the tracks come to the surface at Thompson Avenue, about 1½ miles from the East River.

The great central station with its underground "yard" (if that term may be used in this case) will cover more than four large city blocks. It will include all the space between Tenth and Eighth Avenues and 31st and 33d Streets, and between Eighth and Seventh Avenues and 31st and 33d Streets. It will also include a portion of the easterly end of the block bounded by Eighth and Ninth Avenues and 32d and 33d Streets. Easterly from the central station, a third track and tunnel will be added, the three tracks extending below 31st, 32d and 33d Streets, until First Avenue is reached, where they will swing to the north through 30 degrees, and will converge, meeting near the Long Island terminals. From this point the tracks will be carried in a single tunnel, finally reaching the surface at Thompson Avenue.

The construction of the tunnels is not expected to present any unusual difficulties where they extend below Manhattan Island and the East River, the driving having to be done largely through rock or firm material. Beneath the Hudson River, however, where the tunnels, according to the plans filed with the County Clerk, will descend to a depth of 90 feet below mean high water, the line will have to be carried through a soft material, which does not present the proper consistency for preserving the tunnel in true vertical and lateral alignment, especially under the heavy traffic which the tunnels are expected to carry. Of course, firmer material could be secured by tunneling at a lower depth, but this would entail the great disadvantage of steeper grades, with their attendant disadvantages in operating the road. To meet this difficulty, Mr. Charles M. Jacobs, the chief engineer of the company, has designed a special system of construction, in which the tunnel consists of a combined tube and bridge, having great transverse vertical strength, while the load of the combined structure is borne by piers, which are carried down by the caisson system through the underlying silt until firm hardpan or rock bottom is reached. By using this system of construction it is possible to build the tunnels through looser material at a higher elevation, and the grades to Jersey City and New York are kept down to the desired maximum for economical operation.

The great central station will contain twenty-five tracks, access to which will be gained by a broad causeway which will be reached from the street surface by easy grades at either end of it. This causeway will extend across and above the tracks, and easy stairways will lead from the causeway to the platforms.

In the operation of this system electric traction will, of course, be employed for all trains, and incidentally it may be stated that the confidence with which the Pennsylvania Railroad system is contemplating the use of electric motors for bringing trains into its terminal station, should act as a spur to the New York Central and New Haven systems in adopting the same method between Mott Haven and the Grand Central Station. If such power is feasible for one system, it is certainly so for the other. The ventilation of the tunnels will be secured by the passage of the trains, which will act with piston-like effect, keeping the body of the air in continual circulation. Regarding the advantages conferred on New York by the enterprise of the Pennsylvania and Long Island Railroads, it is scarcely possible to say too much. Not only will passengers be brought from any part of the United States without change of cars direct into New York, but the fact that the new tunnels will cross beneath all the north and south lines of the tunnel in Manhattan, including the new Rapid Transit tunnel, insures that travelers will be provided with most excellent facilities for getting quickly from the trunk lines to the immediate street or section of the city which is their destination.

At a later date we hope to publish full plans both of the terminal and tunnel construction.

NEW SUBMARINES FOR THE UNITED STATES NAVY.

The acceptance by the United States navy of the submarine torpedo boat "Holland," and the determination of the government to build half a dozen new boats of the same type of somewhat enlarged dimensions, marked the successful culmination of a long series of trials and disappointments which had attended the efforts of the inventor, Mr. Holland, to produce a successful submarine vessel. The "Holland," which was the first really successful boat constructed on the inventor's principles, is the sixth experimental craft which he has built. His first attempt was made in 1871 with a small vessel 3 feet by 2½ feet in cross section and 14½ feet in length. This was followed by a larger craft, built in 1897, which was 31 feet in length by 6 feet in diameter. It was driven by a 15-horse power engine and carried a crew of two men. In this vessel we see the first attempt to discharge high explosives, the Zalinski gun being fitted for the purpose of throwing dynamite shells. Then followed another craft 16½ feet long which met with various mishaps. The fourth boat, 40 feet in length and about 8 feet in diameter, was destined to bring Mr. Holland's invention more prominently into notice than any of his previous craft; and it was used in experimental tests which gave valuable data for future work.

On March 3, 1893, Congress authorized the construction of a submarine of the Holland type, and the contract for the hull and machinery was let for $150,000. Although the contract for the "Plunger," as she is called, was signed in 1895, the vessel is still uncompleted. She is in some respects a considerable departure from the Holland type, being very much larger (85 feet over all) and having a submerged displacement of 165 tons. For surface navigation she was to be provided with a triple-screw engine, and when submerged the vessel was to be driven by a single electric motor. Subsequent changes, however, have been made in these plans, and we understand that when the vessel is finally completed, she will conform generally to the standard Holland type.

The sixth Holland submarine, which was built at the Crescent Shipyard, Elizabethport, N. J., is 53 feet 11 inches in length, 10 feet in diameter and has a displacement of 74 tons when submerged. When on the surface she is driven by a single-screw, Otto gasoline engine of 45 horse power, at a speed of 8 knots an hour. When submerged, she is driven by an electric motor of 50 horse power. Her armament consists of a torpedo tube which lies approximately on the longitudinal axis of the vessel and a dynamite gun which is upwardly inclined and is intended for the discharge of high-explosive shells when the vessel is at the surface. The "Holland" was first placed in commission October 12, 1900. So far, she has been used mainly for training purposes, and in experimental tests by the Holland Company. Useful data has been gathered from her which will be incorporated in future vessels. On June 7, 1900, Congress authorized the construction of six more submarines of the Holland type. Of these two, to be known as the "Grampus" and the "Pike," are being constructed by the Union Iron Works, San Francisco, Cal., and the other four, known as the "Adder," "Moccasin," "Porpoise" and "Shark," are building at the Crescent Shipyard.

On the front page of this issue will be found a sectional view, showing the new type of Holland boats, as they will appear when submerged. The side being broken away, it is possible to see very clearly the method of constructing the boat and the arrangement of the various parts of her machinery and fighting equipment. The dimensions are as follows: Length over all, 63 feet 4 inches; diameter, 11 feet 9 inches; displacement, submerged, 120 tons. The motive power consists of a 160-horse power single-screw, four-cylinder, Otto gasoline engine, which is capable of giving the craft a speed of 8 knots on the surface, and a 70-horse power electric motor, which gives the vessel a speed of 7 knots when awash or submerged. The hull is circular in cross section and is divided by two watertight bulkheads into three separate compartments. There is also a thorough subdivision of the bottom, and every precaution is taken to localize any injury to the hull which might threaten the buoyancy. In the forward compartment is a torpedo tube for the discharge of 45-centimeter Whitehead torpedoes. The tube is placed with its muzzle in the nose of the craft and its axis inclined somewhat to the longitudinal axis of the vessel. The muzzle of the torpedo tube is closed by a watertight door, which can be lifted from within for the discharge of torpedoes. In the same forward compartment are a series of air flasks, a gasoline tank of 850 gallons capacity, a compensation tank which will be filled with a sufficient amount of water to compensate for the loss of weight due to the discharge of the torpedo, and one of the trimming tanks.

The central compartment contains in its double bottom the main ballast tanks and a circular compensating tank which will be noticed in our engraving between the two sets of batteries. Above the double bottom and below the axis of the vessel are located the storage batteries. These are charged by the gasoline engine running the electric motor as a dynamo when the vessel is at the surface. Above the storage batteries are carried the torpedoes, which are 45 centimeters in diameter by 11 feet 8 inches in length; and in the same compartment are a series of air flasks, in which air at 2,000 pounds to the square inch pressure is stored for the purpose of keeping pure the living spaces of the crew. In the rear compartment is the four-cylinder gasoline engine, which is rated at from 160 to 190 actual horse power, at from 320 to 390 revolutions per minute. Its net weight is 1,300 pounds. Its length over all is 9 feet 7 inches, and its total height above the crank-shaft center is 5 feet 6 inches. In these engines, which have given great satisfaction in the first Holland boat, the distribution of the cranks and the timing of the valves and igniters are so arranged that the operations in the four cylinders alternate; so that while one is on the expansion stroke the other three are on the suction, compression and exhaust strokes respectively. By this arrangement the engine is perfectly balanced and vibration is reduced to a minimum. The fuel consumption of the first engine proved from measurement to be 0.88 of a pound of gasoline, of 0.74 specific gravity (Baumé scale).

In the construction of the vessels care has been taken that all portions of the exterior of the hull shall be free from projection of a kind that might be entangled by ropes or other obstacles when submerged. The lines of the vessels have been designed so that there shall be a minimum of resistance when they are running at the surface. The radius of action at the surface is about 400 knots, and the storage batteries have sufficient capacity for a speed of 7 knots on a four hours' submerged run. Gearing is provided for driving the propeller direct from the gasoline engine or connecting the engine to the main motor, accommodations being effected by means of suitable clutches. The submersion of the vessel is achieved by means of ballast tanks and a pair of horizontal driving rudders at the stern. For keeping her submerged at desired depths, use is made of the trimming and ballast tanks above described, and it is claimed that the control in this respect is very satisfactory. The air supply and ventilation are secured by means of compressed air stored in the tanks referred to, while the gasoline vapors from the engines and, indeed, all noxious gases are carefully excluded by suitable devices, while safety valves are provided to prevent the pressure in the vessel from exceeding that of the atmosphere. Provision is also made for automatic control of the rudders; for the purpose of preventing the vessel from taking excessive angles when diving, or coming to the surface, and also for keeping the boat submerged at the desired depth.

In spite of the difficulties attending the whole problem of submarine navigation, it is generally admitted that the Holland boat has come as near to mastering them as any craft of the type that has been built. Just what the French have done we do not know with any degree of accuracy, but they appear to have made some successful long-distance trips without detection, although this is nothing more than the Holland type is claimed to be capable of doing. We understand that a trip of several hundred miles down the Atlantic coast is shortly to be undertaken. Although its fighting powers can only be determined in actual war, it is agreed among naval experts that the submarine will have a decided value as forming part of a system of harbor defense. Certain it is that a fleet of them would have the effect of causing a blockading fleet to retire at night-time much further from the mouth of a harbor than it would were no such machine as the submarine known to exist.

The Current Supplement.

The current SUPPLEMENT, No. 1356, has a number of articles of unusual interest. "Discoveries in Mesopotamia," by Dr. Friedrich Delitzsch, is accompanied by most attractive engravings. "Missing Links" is a lecture delivered by Prof. Thomas H. Montgomery and is especially reported for the SCIENTIFIC AMERICAN SUPPLEMENT. "Recent Experiments with Sound Signals" is by J. M. Bacon. It is a most valuable paper. "Nicaragua or Panama" is by a former Chief-Engineer of the Panama Canal, Mr. Philippe Bunau-Varilla.

SCIENTIFIC AMERICAN

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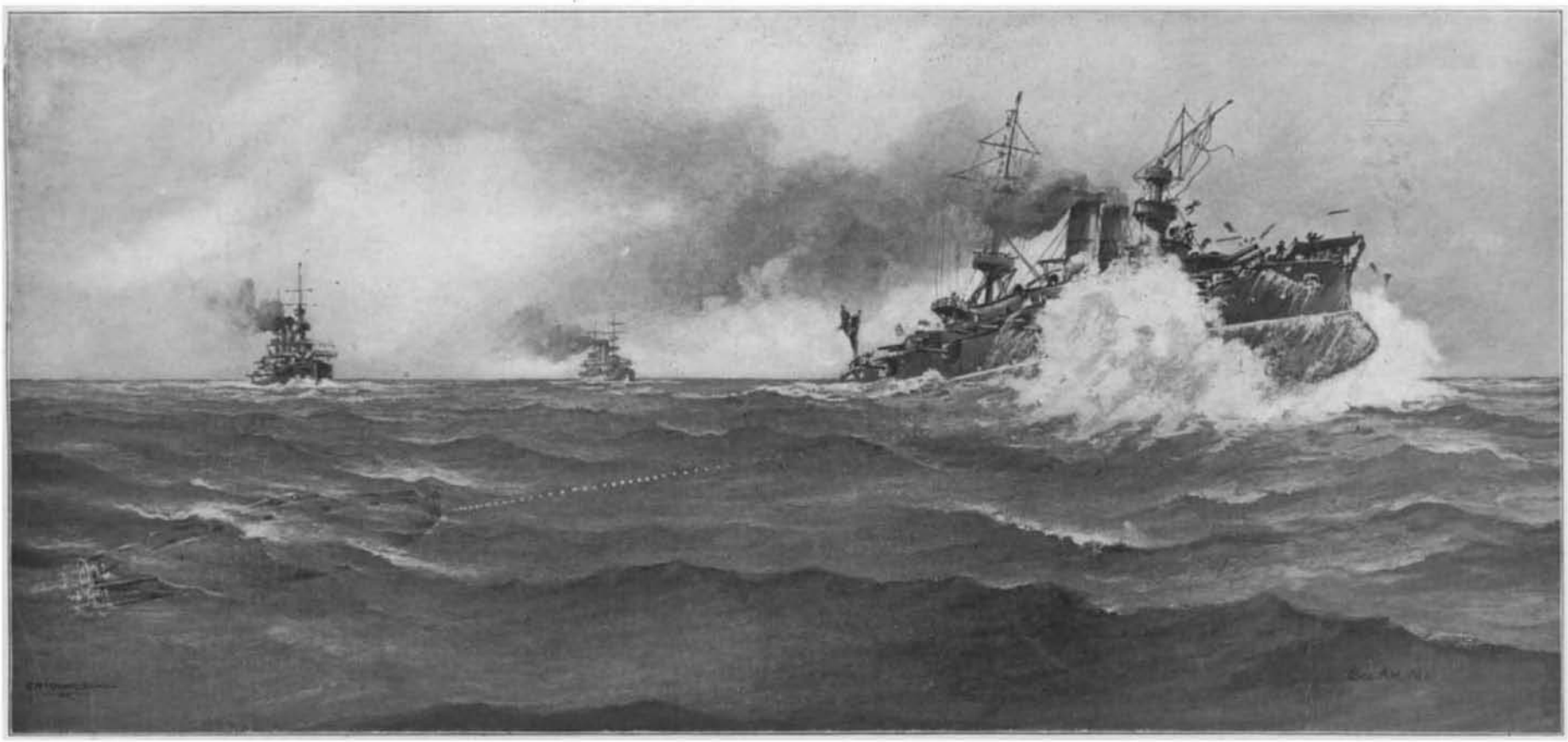
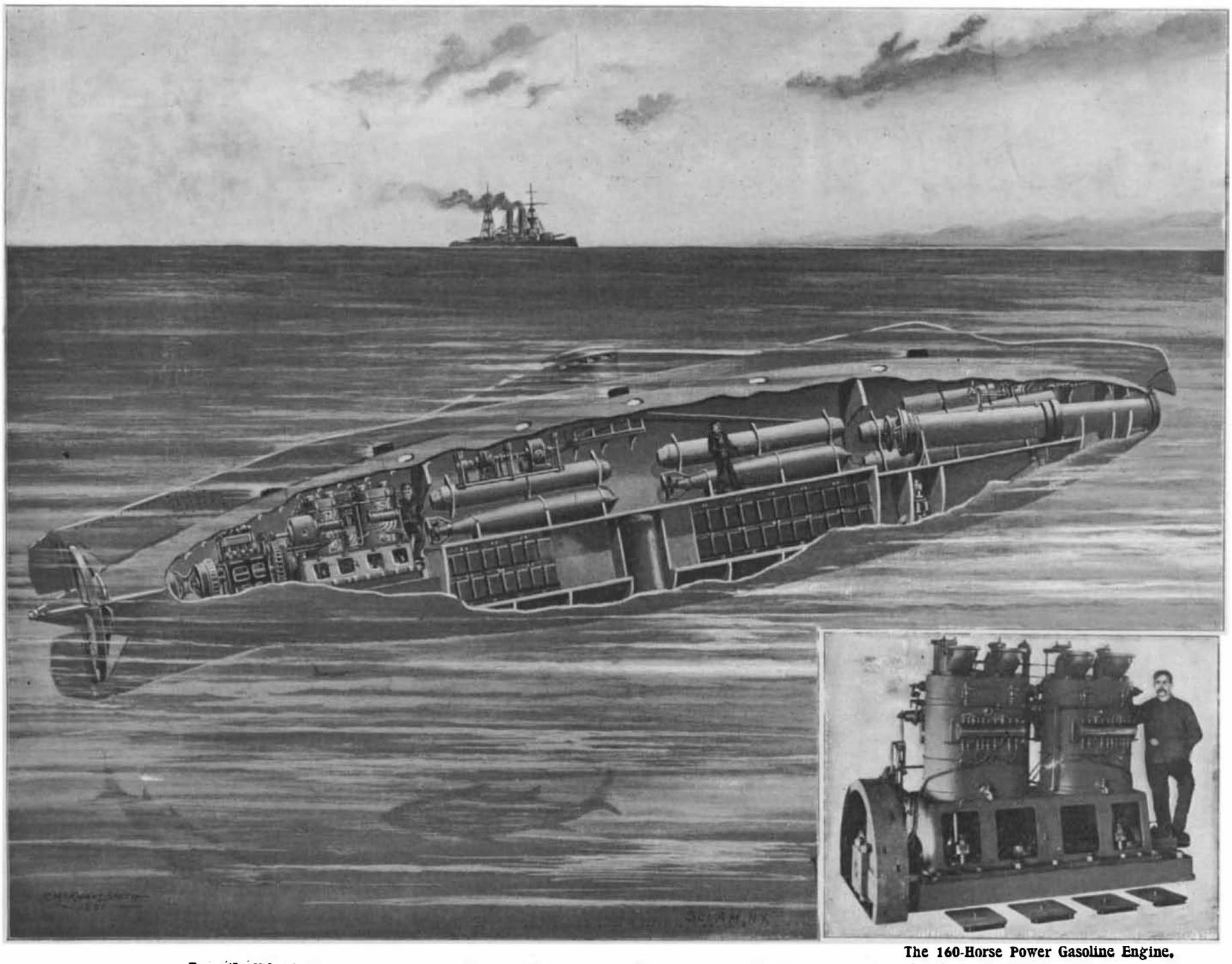


Method of Attack.



The 160-Horse Power Gasoline Engine.

Length, 63 feet 4 inches. **Diameter,** 11 feet 9 inches. **Displacement,** 120 tons. **Speed at Surface,** 8 knots. **Speed Submerged,** 7 knots.

NEW UNITED STATES SUBMARINE TORPEDO BOATS.—[See page 427.]