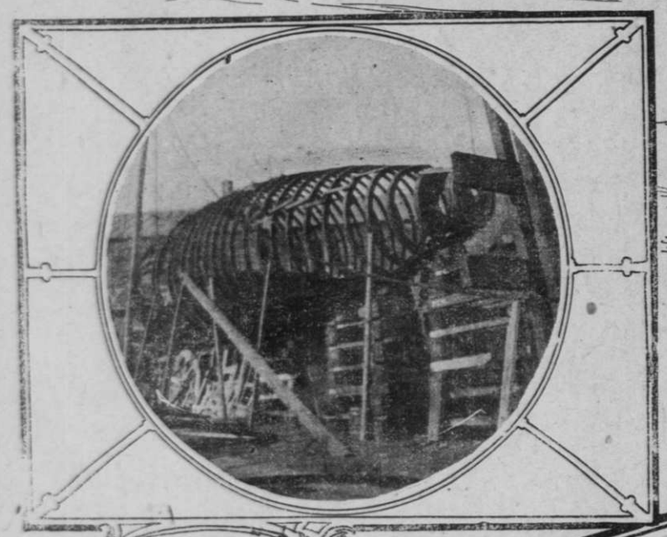
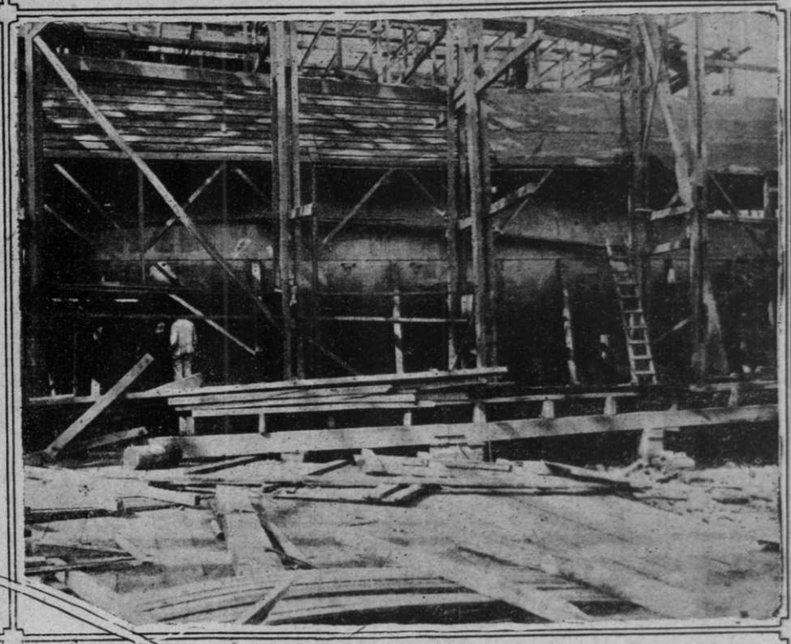
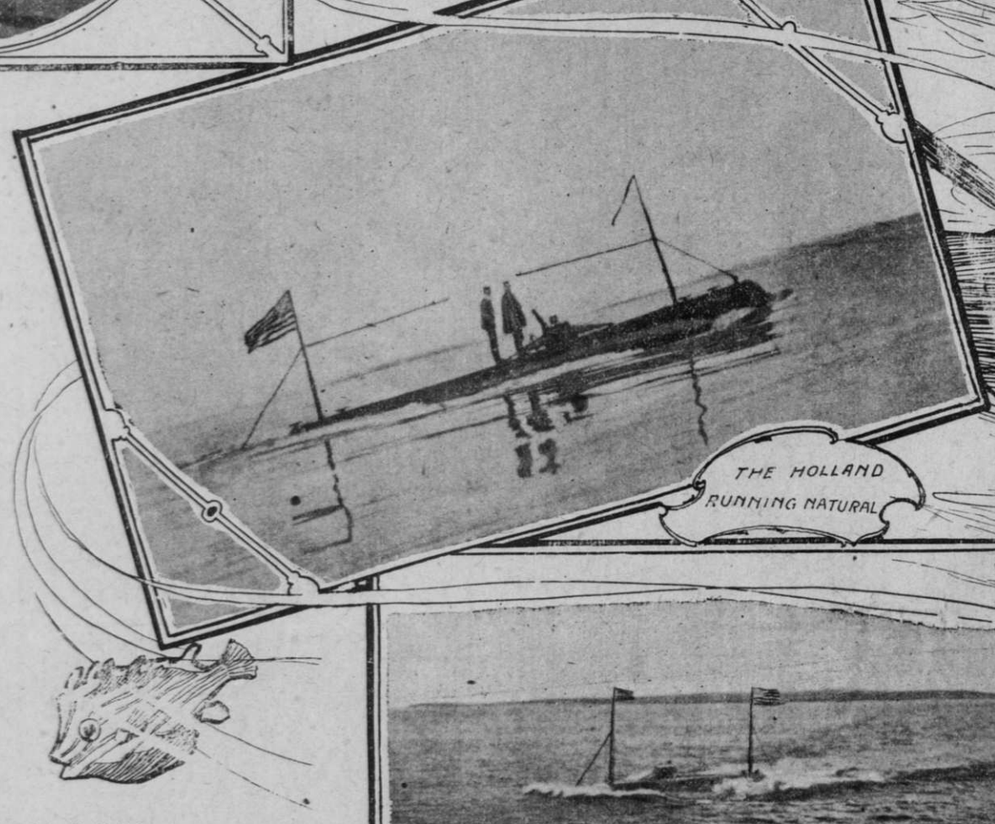
THE BUILDING OF A SUBMARINE BOAT.



THE SKELETON OF A SUBMARINE

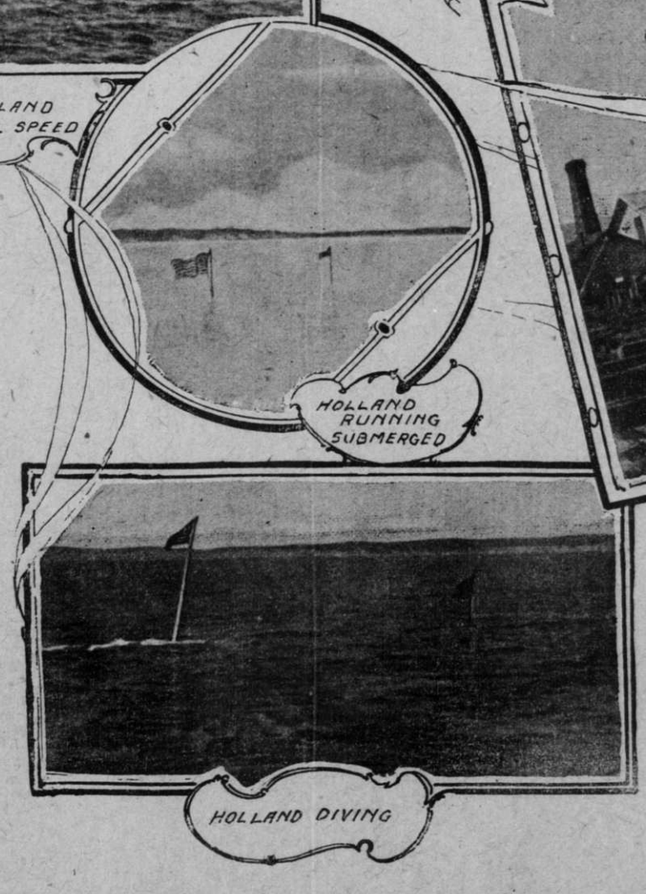




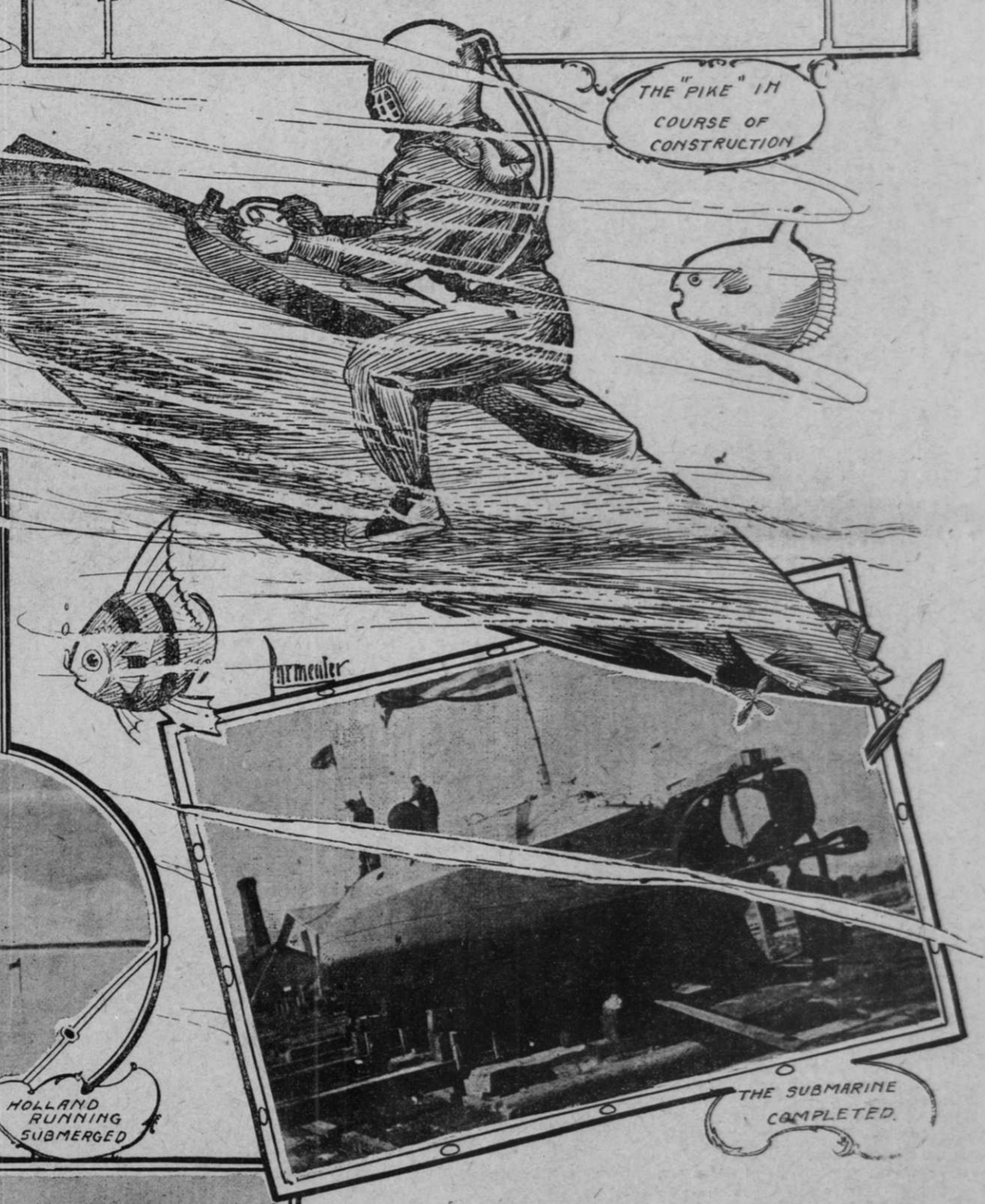
THE HOLLAND RUNNING NATURAL

HOLLAND FULL SPEED

HOLLAND RUNNING SUBMERGED



HOLLAND DIVING



THE "PIKE" IN COURSE OF CONSTRUCTION

THE SUBMARINE COMPLETED.

Two of These Ocean Terrors Soon to Be Launched in San Francisco Bay.

THE submarine boat has arrived. Since the Holland, a submarine boat built by private parties, was purchased by the Government after fulfilling all the requirements that the Navy Department laid down, that department has given contracts for six or seven of these craft, which will soon be active and destructive members of our naval forces.

Two of these submarine vessels—the Pike and the Grampus—will soon be launched from the Union Iron Works, where they are fast nearing completion. Just at present the boats, looking like two huge reddish cigars, buried in a mass of scaffolding, do not suggest their hidden destructive properties. But even when diving in fighting trim the boat makes one think of nothing more harmful than a porpoise, though in reality it belongs among the naval sharks. And like the shark, its work is quick and vicious. And like the shark again, it can remain below the surface long enough to get far beyond the reach of its pursuers.

The submarine boat has been evolved after three hundred years of experiment. During the Revolution, to come to more modern days, one Bushnell of Connecticut built and operated a submarine boat that was a mechanical success, but which made no impression at the time—it was ahead of the world by a good deal more than a hundred years. Now the prominent nations of the world are taking the submarines seriously as implements of warfare. France has provided for thirty-eight of them all told, Germany and Russia are at work on them and Great Britain, after much conservatism and prejudice against them, has five in course of construction.

According to William W. Kimball the principal difficulties met with to-day in designing a submarine torpedo-boat are as follows: "Providing for sufficient stored power of a kind that can be economically expended in driving her when submerged; devising a good method of directing her toward an object constantly changing its position; installing an efficient armament; retaining a fixed center of gravity and fixed weight in spite of exhaustion of stores and movements of weights; modeling her to meet the physical requirements of crushing strains and the tactical requirements of handiness; ballasting and trimming her so that she will have sufficient stability and at the same time move readily in obedience to both horizontal and vertical rudder efforts."

In the Pike and the Grampus it is thought the most correct and easily handled dimensions have been approximated in making them in length 65 feet all over, diameter 12 feet and displacement 120 tons. Too great length has been found an obstacle to good work, probably because they require space for generating power to furnish a speed which can be obtained only at the expense of handiness. A section of the skeleton of a submarine boat in its early stages of construction much resembles a series of hoops waiting to encircle a cask. The same section in a later stage, when the metal plates have been riveted outside the hoops, resembles, looking through the interior, a view through an underground railway tunnel. The submarine boat is built entirely of metal; the hull is circular, in cross section, and is divided by two water-tight 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.

When the boat is running on the surface the motive power employed consists of a 160-horsepower, single-screw, four-cylinder gasoline engine, which is capable of giving the destruction-dealing little craft a speed of eleven knots. The lines of the Pike and the Grampus have been designed so that there shall be a minimum of resistance when they are running at the surface. In coming to the surface to make an observation, the only part which is visible is a circular conning tower, two feet in diameter, of heavy armor steel, practically impossible of penetration.

In time of action, in leaving a safe harbor, the boat would probably "run light," with several feet of the top showing above the surface of the water until it should reach the location of the enemy. Then, with the opening of the valves, the water would rush into the ballast compartments, and the boat would sink until simply its small turret would be visible. The boat is then in fighting trim. The masts which the boat carries are for purposes of observation only, and are taken off, along with all their exterior apparatus, when the boat is in war trim, and in this condition, in a moderate sea, it is impossible to observe the vessel at a distance of even a half-mile. Though the man of war should finally sight the boat in one of her few seconds of remaining above the water for purposes of observation, and train its guns upon the spot where the little ocean terror had been last seen, there would be nothing to shoot at. The boat has plunged, and at the very moment is stealing beneath the water, still closer to her enemy. A score or more feet of water is more efficient than any armor plate ever devised. An unbroken moving stretch of water presents to the battleship no target.

The radius of action at the surface is about 1000 knots, and the storage batteries, which are located above the double bottom and below the axis of the vessel, have sufficient capacity for a speed of eight knots on a five hours' submerged run. This speed is given by a 70-horsepower electric motor, which also renews for the vessel her store of power for submerged work and makes her radius of action—i. e., the distance she can move from a base of supply—an unusually wide one.

The radius will, of course, increase slightly with decrease of speed, and vice versa; in other words, a boat can be kept in fighting trim at full speed for about six hours, and at the varying speeds of a coast defense fight from sunrise to sunset. A boat must draw from her stored power from the beginning to the end of an action.

Consequently all this power, and more, may be needed when in action, since while within range of hostile gun fire she must be always ready to dive, and must therefore be constantly sealed up. She must be able, moreover, to move on the surface hundreds of miles to a field of action and be ready for work on arrival.

Above the storage batteries are the series of air flasks, in which air at 2000 pounds to the square inch pressure is stored for the purpose of keeping pure the living spaces of the crew. A supply of air has not been by any means the hardest problem which the inventors of the submarine boat have had to solve. It is a comparatively simple matter to keep in storage a sufficient quantity of compressed air to enable a number of men to live aboard a boat without inconvenience for an indefinite period of time. Safety valves are provided to prevent the pressure in the vessl from exceeding that of the atmosphere.

The turret or conning tower, which often for a few seconds in a fight makes a dark speck on the face of the waves, is just large enough to enable a single man to pass in and out and take observations. Here the captain stands when above or below the surface and steers the boat, and not far away from him is stationed the man who manages the ballast tanks and a pair of horizontal diving rudders at the stern, by means of which the submersion of the vessel is achieved. 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 order to dive a submarine of practical design takes in water ballast until the remaining buoyancy can be overcome by the action of the horizontal rudders; then the boat is steered under as she moves ahead.

In the submarine boat there is practically no side to make her roll in a seaway, and the Pike and the Grampus when in diving trim in a seaway will not roll at all, although they are both almost as round as bottles. It is probable, however, that the crews of both vessels will experience a feeling most unusual, not to say curious, as they slide down the comb of a sea. The hulls of the boats are built of steel of great strength, so that the boat can dive if necessary to a depth of four hundred feet. It would be possible to have the craft remain under the water a week, provided the compressed air held out. It is not necessary, however, that the boat should often descend to such a depth as above mentioned, it being only necessary to comfortably clear a deep-draught battleship's keel. The new vessels are also provided with a device for keeping the boat constantly in diving trim, whether in fresh or salt water or in any mixture of the two. For keeping the boat submerged at desired depths use is made of the trimming and ballast tanks above described, and the control in this respect is very satisfactory. In the forward compartment besides the air flasks are a gasoline tank of 850 gallons capacity and one of the trimming tanks. Gearing is provided for driving the propeller direct from the gasoline engine or connecting the engine to the main motor, accommodation being effected by means of suitable clutches.

The central compartment contains in its double bottom the main ballast tanks and a circular compensating tank. In the rear compartment is the four-cylinder gasoline engine, which is rated at from 160 to 190 actual horsepower. Steam has been found impracticable for under-surface running, because of the waste and gas caused by the use of coal. In these engines, which have given great satisfaction in the first Holland boats, the distribution of the cranks and the timing of the valves and igniters are so arranged that the operations in the four 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.

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 crew of one of these boats consists of seven men, although there is space in the interior for twelve if necessary. The duties of the crew of a submarine boat are so severe that the men must be relieved frequently, and although a submarine can be perfectly lighted and perfectly ventilated she will be uninhabitable for long periods owing to the cramped quarters.

The armament of a sixty to eighty submarine may be made very efficient against any ship within the close range that the boat could work. The Pike and the Grampus are armed with automobile torpedoes, which in delivering, the conning tower must show at four hundred yards from the ship, but even then the ship could hardly sink her before the torpedo was effectively placed. The muzzle of a torpedo tube for the discharge of 45-centimeter Whitehead torpedoes, used by the United States navy, is placed well up in the nose of the craft. The muzzle of the torpedo tube is closed by a water-tight door, which can be lifted within for the discharge of torpedoes. Three torpedoes are the equipment of projectiles; they may be eleven feet eight inches in length and contain hundreds of pounds of explosive matter. These are the deadly things which shooting up from their hidden quarters beneath the surface and going true to the mark would often make the enemy's fleet the less by at least one fighting ship.

A compass or gyroscope may be used in steering the boat when submerged or else some method may be made use of in obtaining, by means of a camera-lucida, a reflected image of the object steered for. All attempts at lighting the water ahead by strong electric arc lights have proved futile and without taking observations from the surface for a few seconds when moving at speed there is no known way of steering for an object whose speed and direction cannot be predicted, as for instance, a hostile ship in action.

Submarines have yet to be tried in action, but it will be found that with relief crews they can occupy indefinitely a position required by an enemy for blockade or bombardment and by moving beneath the surface up to the very teeth of a battleship and dealing her a death blow in the shape of a torpedo or forcing her to move away, thus demonstrate that the submarine is a craft that neither gun fire nor torpedo practice would stop. Blockades and bombardments would be almost impossible with properly manned submarines in the defensive. In attacking ports they will be useful in countermining the protecting mines and in entering unseen to destroy ships, drydocks and buildings. It may be that such craft will cross the ocean some day, for the shape and accouterment of the boats are such as to make them entirely seaworthy.

In making an attack on a battleship the submarine will approach on the surface to within about one and a half miles and then suddenly plunge and leave nothing but a few ripples to indicate where it had gone down. After running for a mile beneath the water, all the time approaching the hull of the floating warship, it would be driven upward and for a few seconds remain above water. In these few seconds the man in the turret would take an observation, a torpedo would be fired and the boat would dive again immediately, oblivious of the guns that would probably be trained upon the spot where she disappeared, and not come to the surface again until well out of the way in some entirely unlooked for spot. The vessel can come to the surface from a depth of ten feet, make an observation and dive again completely out of sight within ten seconds, in which space of time it would be practically impossible for a warship even with her rapid-fire guns and a knowledge of the submarine's position, to land an effective shot.

With no idea of where the submarine will next appear, combined with a feeling of uneasiness which is sure to prevail when such a boat is in the neighborhood, it will be seen that the submarine is destined to be a most potent factor in coast and harbor defense. The best submarine that can be built at present will not be a fast boat, must be more uninhabitable than surface craft and of limited time endurance while moving in fighting trim. With the provision that can be made on a battleship for carrying one of these submarines, it is not at all improbable that they will become equally efficient for offensive work many thousands of miles from their home station. As their cost is comparatively insignificant—about thirty could be built for the cost of a battleship and the crew of one battleship could man nearly one hundred submarine boats—they will form an inexpensive and most efficient means of defense for about thirty important cities on or near our Atlantic and Pacific seaboards. Among the western cities near which they would be useful are: San Francisco, Los Angeles, Astoria, Seattle and others. And there are numerous ports in Cuba and the Philippines which at some future date are sure to require protection. Though the submarine boats have yet to meet opposition of various kinds, and from various sources, there is a probability that at no very distant day they may play an important part in the coast defenses of the United States.