There is nothing in which improvement is made so slowly as in the speed of our naval vessels, for the reason that we make no advance in building steam-engines, but have followed in a beaten track for many years. We adhere to the old-fashioned boilers that involve the consumption of an amount of coal not suited to a nation like ourselves, since we have no coaling stations scattered around the world like Great Britain, France, and Germany.

We have in this country a man of great genius engaged in the construction of marine engines and boilers, but we are blind to his merits. I allude to Mr. Herreshoff, president of the Herreshoff Marine Building Company, of Bristol, R. I. He is blind also—optically—but gifted with remarkably clear sight as regards the steam engineering of vessels of war.

The Herreshoff coil boilers are to-day perhaps the most famous in the world.

Mr. Herreshoff's last achievement was the Stiletto, a vessel of 28 tons, which developed a speed of 27 miles an hour, exceeding anything ever attained by our fastest river boats.

Although this gentleman has succeeded in obtaining such a high rate of speed, he has received little encouragement from the Government to induce him to adapt his engines and boilers to a larger class of vessels. Engineers generally, both in and out of the Navy, seem opposed to the Herreshoff system, although I have yet to hear any good reasons for their being so; but one of the most able of the profession we have ever had in the Navy, Chief Engineer B. F. Isherwood, is a strong advocate of it.

To obtain the great speed necessary for a commerce-destroyer the steam power should exceed the displacement as two to one; or actually a vessel of 4,000 tons displacement should have over 8,000 horse power.

It has been found almost impossible to supply a vessel of war with a sufficient number of boilers of the ordinary type to drive her rapidly through the water and at the same time give space for a large amount of coal, provisions, ordnance stores, ship's stores, clothing, &c.

This difficulty is obviated in the large merchant steamers crossing the Atlantic, which require only a few days' coal, provisions, &c., and can therefore use the heaviest boilers and as many of them as they please.

It is believed by the best authorities that the Herreshoff boiler will furnish a given quantity of power with less than half the weight of any other type of boiler now in use in this country, especially when combustion is forced to the maximum by blowing air into a closed fire-room.

Second. It can be properly used with a higher rate of combustion per square foot of grate surface than any other type of boiler, owing to its entire freedom from "foaming" at all rates of combustion, and to the impossibility of the heat forcing the water from the metallic surfaces and burning them out.

Third. In a vessel of a given displacement, with a carefully constructed air-tight fire-room and adequate blowers, blowing into it, twenty indicated horse-power can be obtained from each square foot of grate surface during the usual trial test.

Fourth. The Herreshoff boilers can be safely used up to a pressure of several hundred pounds per square inch. In experiments made by Chief Engineer Isherwood he used these boilers at a pressure of 260 pounds, and was prevented from sending the steam up higher only for want of a steam-gauge to indicate a higher pressure.

Fifth. The Herreshoff has much less height than other boilers, which will enable it to be placed below the water line in small vessels, or those

of moderate draught of water—an important consideration in vessels of war.

Sixth. The Herreshoff engine can be safely worked at from five to six hundred revolutions per minute. The high reciprocating speed of piston, in connection with a high boiler pressure, allows the engine to be made exceedingly light in proportion to the power it develops. There is no other system of machinery besides the Herreshoff and the Belleville that would give the power required to develop great speed in ships of war, or the space and weight generally allotted to boilers and engines.

Heretofore we have had no experience with the Herreshoff boiler, using several boilers to supply one engine; but such is my confidence in the ability of the Messrs. Herreshoff that I have no doubt of the success of any plan they may recommend. Their designs are as notable for originality and propriety of adaptation as for their success.

There is only one question that seems liable to arise, owing to the multiplicity of boilers; that is the feeding of several boilers to supply one engine; but that is a mechanical difficulty which Mr. Herreshoff claims he can overcome.

We have now reached a point where the greatest speed is demanded for a ship of war. A vessel making but 15 or 16 knots would be useless as a cruiser in time of war, for such a vessel could catch nothing and could not escape from a superior force.

To gain the necessary speed it is requisite to decrease the weights and increase the power, which can only be done by a resort to the Herreshoff system, in which the boiler does not weigh more than half as much as the Scotch boiler and the engines not more than two-thirds.

The Herreshoff and the Belleville are the only types of multitubulous boilers which have as yet been applied to sea-going vessels. So far as I am able to judge, the Herreshoff system is in advance of the other, although the Belleville boiler has been carefully fostered by the French Government, while the Herreshoff boiler has received no particular encouragement from the Government of the United States beyond the purchase of some steam-launches, which have proved themselves the best in our Navy.

The experiments made in France with the vessels of war Voltigeur and Milan have removed all doubts as to the feasibility of the multitubulous system of boilers, and the success attained by the Messrs. Herreshoff indicates that their methods have passed beyond the realms of experiment.

Up to the present time France has obtained for two of her vessels of war greater speed than any other naval power, even surpassing Great Britain, the power which claims the highest speed.

The gunboat Milan, built on the same principle as the dispatch vessel Voltigeur, is 303 feet in length, and 33 feet beam, with a displacement of about 1,600 tons. With a draught of 12 feet the Milan has attained a speed of 19½ knots with a developed horse-power of 4,000.

In the Herreshoff boiler this country possesses something superior to the Belleville boiler of France, and it remains to be seen which of the two nations will take the lead in perfecting a safe and desirable marine boiler with a reduction of nearly 50 per cent. as compared with the weight of the Scotch type of engine and boilers, and greatly increasing the efficiency of vessels of war.

As the Milan with a length of 303 feet has attained a speed of 19 knots with 4,000 horse-power, I see no difficulty in attaining a speed of

21 or 22 knots in a vessel 260 feet between perpendiculars with 5,000 horse-power and very much finer lines.

I submitted a plan of such a vessel last year to the Department. It was referred to the board of officers engaged in designing ships for the Navy, who exhibited indifference to the subject.

Much allowance should be made for persons grappling with the difficult problem of how to get but a speed of 15 knots, which seems to have been considered the maximum of United States ships of war, and who with ideas restricted to the contemplation of such slow vessels did not realize the possibility of a speed of 22 knots in a gunboat of 1,600 tons displacement.

It will not do for the United States Government to ignore such an invention as that of Mr. Herreshoff, especially at a time when the navies of the world are aiming at a speed of 20 knots an hour, which is only obtained with Scotch boilers and engines for a few hours by vessels of large size.

The adaptation of a power 50 per cent. less in weight than the Scotch boiler will enable us to use vessels of 3,000 tons as our fastest cruisers; for, if Mr. Herershoff can obtain 27 miles an hour in a vessel of only 28 tons, there is no reason why a vessel of 3,000 tons could not be made to perform just as well. As regards the speed of our vessels, we have made no advance since 1861, when the Seminole and Iroquois could make at sea, in chase of a vessel, 13 knots an hour, while it is not certain that any of the ships now under construction will make over 12; in other words, they will be almost useless for naval purposes.

It is purposed to construct a 13-knot gunboat to carry four guns. Such a vessel could be of no use to the navy, except in time of peace to carry our flag among the islands in the Pacific Ocean, since she could not overtake anything, would be unable to keep the sea, and would be inferior to any enemy she would be likely to meet.

If this gunboat is intended for Chinese waters, she would be almost useless there except in time of peace. In case of any difficulty in that quarter, a powerful Chinese gunboat would be more than a match for her.

No gunboat should be built of less than 1,600 tons, and she should carry seven or eight guns, of which at least one should be of the heaviest type. She should have great speed to compensate for her inferior size, and the manner of obtaining that speed has already been pointed out.

It cannot be doubted that we have made some serious mistakes since we commenced to rehabilitate the Navy, and in my opinion we should take a new departure.

(1) We should consider the probable future requirements of the service.

(2) The class of vessels necessary to fulfill these requirements.

(3) Ascertain as near as possible the method of fighting by single vessels and in fleets, in order to devise a system of classification which will enable us to use our ships in future combats in the most effective manner.

If Great Britain and France were to go to war, they would find it a difficult matter to make an effective formation of lines of battle owing to the fact that they have not adhered to the old idea of constructing their vessels that are to go into line with due regard to that effective support which every vessel of war should expect from her consorts in fleet formation.

For many years Great Britain and France went on building iron-clads and cruisers without regard to future uniformity, and those vessels, built at an early date, although apparently fitted with powerful batteries, would be so inferior to-day as line-of-battle ships that in case of war they would probably not be employed.

We should endeavor to avoid the mistakes which have been made abroad. We have the examples before our eyes, and should not fail to profit by the labors of the most skillful naval architects in the world.

I do not hesitate to say that we are making a mistake by building so many different classes of vessels at the outset, without knowing whether any of them will meet the requirements of a cruiser of the present day. Four of our vessels, at least so far as I can judge from late articles published in a leading newspaper, are severely criticised by a large number of naval officers. Whether these reflections are all merited or not I am not prepared to say, beyond the general expression that a vessel which cannot make 16 knots an hour is unfit for cruising and in time of war would be laid up.

In the great interest in naval affairs now manifested by the country, the general idea seems to be that we should build a number of cruisers at once, without apparently reflecting that we need a class of vessels to protect our coasts and harbors. A man puts locks upon the doors of his house and buys a revolver to protect his property, but the United States Government takes no steps of any consequence to guard our seaboard cities with their hundreds of millions worth of property at the mercy of any foe who chooses to invade our coasts with heavy iron-clads.

For every cruiser that we build we should construct a double-turreted monitor of the Monadnock, Miantonomoh, or Puritan type, only they should be built strong enough to resist modern ordnance, for these are the protectors upon which we must rely in time of war.

In former days, when wooden hulls were our floating batteries, our vessels would seek the protection of forts when hard pushed; but times have changed; our forts will need all the assistance they can obtain from iron floating batteries to enable them to hold their own against foreign ships of war. By the aid of properly-constructed iron-clads our forts could maintain themselves, but without them, as experience has shown, the massive masonry once considered impervious to shot would crumble before the blows of the newly-invented ordnance, and the apparently impregnable earthworks would be battered down without ceremony.

A fleet of the modern type will always have the advantage over a fort. After battering one portion of the works, a fleet can change its position or retire temporarily from action to repair damages, renewing the attack when it is thought proper to do so. This, however, could not be done if the fort is backed by a fleet of iron-clads running about and attacking the enemy at all points.

No nation can dispense with forts, but it is better to depend upon a navy to protect our coasts, instead of maintaining so small a force of iron-clads as we have at present. Every year we should construct three or four double-turreted monitors, no matter if we do not build any cruisers in the mean time.

Great Britain, with not one-fifth the extent of coast to protect that we have, has ever depended on her navy rather than on forts, and feels as secure to-day as when the Spanish armada was knocked to pieces by a squadron of inferior force.

Take it as you will, though forts are indispensable, nations with a long line of coast and many harbors, like ourselves, must depend upon

a navy to protect its shores and guard its cities against the contributions that would be levied upon them by a victorious enemy.

We do not require the massive iron-clads such as are constructed for European navies. We want nothing better than the double-turreted monitors, such as we already possess, with greater thickness of iron, and with the heaviest rifle guns that can be mounted upon them. Two of these monitors, fitted with rams and torpedoes and properly handled, would be a match for the heaviest European iron-clad that could reach our shores.

At the last session of Congress $100,000 was appropriated to build a torpedo-boat. A single torpedo-boat would be useless except as an experiment. Since 1860 the world has been continually experimenting in regard to the torpedo, and from the experiments something must have been evolved that can be exploded under a vessel's bottom so as to sink or disable her.

I have seen enough of torpedoes to know that two or three hundred pounds of gun-cotton exploded under a ship, no matter what her size, is bound to sink her or place her *hors de combat.*

What we want are swift vessels from which torpedoes can be fired. It is difficult just now to decide upon the merits of the different forms of torpedoes. The Fish torpedo is evidently the favorite, although no device of this kind has made more failures than the Whitehead.

Yankee ingenuity, if stimulated by the prospect of a sufficient reward, would no doubt soon give us a superior torpedo. Mr. Ericsson has invented a torpedo which, if properly fostered by the Government, I think could be brought to perfection.

Much time and expense is required in the invention of torpedoes, and private individuals cannot be expected to undertake the task of perfecting these devices without Government aid.

Our country has done little to encourage inventors in this line, and no one in the Navy has yet devised a torpedo deserving of consideration. Even the Torpedo Station has not developed a desirable device, and there is little doubt that this great factor in war must be perfected by some one outside the Navy who can find time and money to devote to such an enterprise.

I am satisfied that for short ranges the Ericsson torpedo is the best in the world, but it is susceptible of improvement.

What we require to fire such a torpedo from is the fastest vessel in the world—something that torpedo-destroyers cannot overtake. For this purpose should be built a steel vessel on the Ericsson plan, 150 feet long, with a quadruple expansion engine. This vessel could attain a speed of 30 miles an hour, and would be the perfection of a torpedo-boat. It would only be necessary to devise means to protect her boilers and crew against the shot from machine guns. The great velocity of the vessel would insure her safety except from a chance shot from the heavy guns of the enemy.

It can be imagined what a terrible effect five or six torpedo-boats like the above mentioned, issuing from port under cover of darkness, would have on the blockading force of an enemy.

Even iron-clads, if aware of the proximity of such formidable antagonists, would be very cautious in approaching our coast after sunset. No enemy's vessel would dare anchor at night in one of our outlying bays.

It must not be imagined, however, that torpedo-boats will do away with the necessity for heavy ships and heavy guns; for, after all, torpedoes are but adjuncts in war, although powerful ones. Ships and

guns will be likely to win in the end, and means with which we are at present unacquainted will eventually be found to evade the attacks of torpedo vessels.

To complete the organization of a navy every factor going to make up the whole should be carefully studied and introduced.

There will be no difficulty in finding officers and men in the Navy to run all the risk required to be incurred in torpedo vessels. Blowing up a ship is a hazardous enterprise, but our civil war furnished an illustrious example of the readiness with which this can be accomplished by a determined will and a clear intellect.

I would recommend that twenty torpedo vessels, not less than 150 feet in length and having a speed of 30 miles an hour, be constructed as soon as possible. It is a cheap mode of alarming an enemy, and the moral effect cannot be overestimated. These vessels, of course, should be designed by the Messrs. Herreshoff who, with their quadruple expansion engines, would have no difficulty in obtaining the necessary speed.

Mr. Herreshoff claims that the same kind of engines and boilers used in his small vessels can be successfully employed in the largest cruisers required by our Government.

I do not think any British constructor of the present day would undertake to build one of these ocean greyhounds and use the compound engine, for it has been demonstrated that unless the ship is nearly filled with engines and boilers (in which case she would be suited only for carrying passengers) she could not attain the desired speed.

The present sea engine will soon be superseded by the triple and probably the quadruple expansion engines which are now being introduced into the fast passenger ships built in Europe.

I am informed that the present naval engine and naval boilers are to be used in the vessels now being planned for our navy, and I venture to predict if such is the case that we will attain very little better speed than in the vessels of the Atlanta class. The so-called "improvements" we introduce into the engines of our naval vessels are generally ideas that have been discarded elsewhere. This was notably the case in the building of the Chicago, Boston, and Atlanta. An able article published some years ago in a British periodical exposed the fallacy of the "improvements" in these vessels, and predicted their failure should they be built according to the plans.

When we see the great advancement in the steam engineering of British merchant vessels and note how rapidly obsolete machines disappear from sight, we cannot anticipate anything but failure when ideas that have been discarded by naval architects in Europe—ever alive to the improvement of the speed of vessels—are adopted in our ships of war.

It is necessary for us to be ever on the alert to keep pace with the improvements in Europe, and we should take advantage of the costly experience of other nations which reach us without expense, for although our people have in former years exhibited great ingenuity in designing vessels, yet at present we must go to England and France to obtain many improvements in the rapid propulsion of the larger vessels hereafter to be classed as commerce-destroyers.

I witnessed in Newport during the past summer the successful working of the Naval War College; and although unable to attend the lectures, I was satisfied from the daily reports I received that the college this year was even superior to the last, although that season was a very