Development of our Modern War Fleet

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LECTURE.

Friday, June 8th, 1877.

ADMIRAL OF THE FLEET SIR HENRY J. CODRINGTON, K.C.B.,
Vice-Patron, in the Chair.

DEVELOPMENT OF OUR MODERN WAR FLEET.

By J. SCOTT RUSSELL, Esq., F.R.S., &c., &c.

I DEEM it a high honour that the duty has been assigned to me of laying before this meeting a summary of the new conditions which have arisen in Modern Naval Warfare, and of submitting to you the means we may be able to put into practical use for ensuring English naval supremacy over the oceans of the empire.

I highly appreciate this occasion, because I see in this Institution the most distinguished and the most experienced members of the two noble professions on whom we must always rely for the maintenance of the freedom, power, and well-being of the English nation; for with reference to war I believe no maxim more deeply true than that "Readiness for war means power to keep the peace," and there is one other less known but not less true that—

"Diplomacy makes wars—The army and navy end them."

As there are present members of both services who have fought battles in our past wars, and who will have to take a leading part in our coming wars, I desire to put myself, as far as I may be allowed, in the position of asking you for professional advice and information. I take my own position simply as an elder brother of another profession; and the duty of my profession is not to give you information on matters of war, but to ask you for information to enable my profession to do our duty by yours. Our duty then I take to be this—

"To prepare for your use—The fittest tools for your work."

Therefore I want to learn from you—

"What your work is to be—And how you wish to set about it."

Any information I possess as to the present wants of the naval service and the future fighting of the British fleet, I owe to the long and intimate knowledge I have enjoyed of the views and experiences of distinguished naval and artillery officers, and of men in command of war ships and fleets, not only in our own but in other services. In the Crimean War I am happy to say vessels of my design and construction, ably commanded and ably handled, did good service to our

country, and earned merited distinction for their Officers; and the Officers of successful smaller vessels of those days will, I have no doubt, successfully command our fleets of large ships in the coming war. It is the knowledge of our ablest naval commanders which I aim at possessing; if I ever made a good ship, it was by studying the wants of an able commander, and I have done my best to learn your present wants, and to consider and contrive the fittest means for the execution of your intentions. One defect in my address to this meeting I must apologise to you for. One of the objects of our "further development of our fleets" must be the criticism, correction, and remedy of the errors of the past and the present. Now if this paper had been read in other political circumstances, I might have undertaken the unpleasant duty of exposing the faults and blunders of our present ships of war. But at the present time that would not be prudent, useful, nor patriotic. These faults are well known to you and to me. But this is not a fit time to dwell on them. I will therefore omit this large, urgent, and interesting part of the question, and confine myself to the consideration of the nature of such new work as we shall soon have to undertake and to carry out.

About our existing ships of war I have only this to say, that according to my experience as ship builder, ship owner, and seaman, I have always found that a good captain makes a good ship, and an incompetent captain makes a helpless ship, and I firmly believe that our naval commanders will take what is called a bad ship to sea, and by mastering all her qualities, good and bad, by gaining the complete confidence of all on board, and by the exercise of forethought, foresight, coolness and courage, will make the best of such ship, engines and guns as they have got, and that what are called bad ships, may in good hands, win the victory.

In this paper I shall direct my attention solely to the determination of the objects we should mainly keep in view in the future development of the fleets of the empire, including in "empire," the shores of our colonies, the dominions of the British empire, and the oceans covered by our commerce.

The first question I have asked of your profession is this:—

What is a modern sea fight?

How do you mean to set about it?

The answers I have received have been many and various. But in the end, I think I understand what you mean to do. I think I see the like means to enable you to do it.

I.

A Modern Sea Fight.

Judging from all the information I have gathered from able and experienced commanders of fleets and ships, I think the following epitome illustrates their views and intentions; and, in order to master the subject and meet its difficulties, I have tried for the moment to put myself in the commander's place, and tried to understand his motives, means, and action, and thence I have tried to contrive and invent the means that would best fulfil his aims and achieve his end.

According to all the information I have gathered from the ablest men, the following series of facts are to be dealt with.

The Fight Begins.

Standing on the deck, 24 feet above the water,¹ I see my enemy clear on the horizon. He is seeking me. I am seeking him. We are six miles apart; at modest speed a mile takes six minutes; at that speed we shall meet in eighteen minutes.

What to do in these eighteen minutes is a serious question.

There is not a heavy sea on but an ordinary swell, our ships roll gently; steam steadily; our guns are charged; all is ready.

Now comes the serious question—As we approach shall we fire or not?

Twelve Minutes.

Six minutes have passed, and we are now within four miles of each other, shall we throw away our shot?

Six Minutes.

Six minutes more have passed, we are within 4,000 yards of each other, shall we throw away our shot?

Better reserve all for near and sure fire.

Three Minutes.

We are now end on. 2,000 yards apart. Three minutes of time left.

Shall we continue end on?

Shall we change our course?

Why change our course?

I dare not change my course!

That is the answer to me by an able and experienced commander.

Now I quite agree with our brave seaman that he dare not change his course. It would be weakness. It would be fear. It might be folly.

His orders must be Stand by! Steady! Full speed ahead!

Three Minutes apart.

The three minutes are soon over! The engineer gets all in order for the crash! All in the ship is already made fast! The commander's eye never leaves the enemy. At the end of a minute, he sees the enemy hesitate.

He swerves to port! Port the helm is our order. The ship swerves to port, but is too slow to escape us.

The two minutes are over, he has not been able to get round more than four points. We also have got four points round, we are now full speed right athwart his beam.

Stem on. Stem into him. His side is open to the sea.

¹ My knowing this height exactly, enables me to tell his distance exactly.

Second Stage of Fight.

In this case we have won—and won easily. The weakness of our enemy was—to stay so long and swerve too late.

Suppose he had decided sooner, and gone about sooner, and been clearer, and we had done the same, he might have escaped collision. What then?—Then in passing him I should have delivered into him my entire broadside.

All this would have passed in twenty minutes from sighting, and in six minutes more we should either be once more broadside on or end on—as we were. The second meeting end on or broadside, one or both—unless one of us was already disabled—would be a repetition of the choice between meeting or swerving.

Alteration. First Stage.

Let us now go back to our original position—three minutes' apart, end on. The enemy does not swerve—we do not swerve—we meet full speed, stem to stem.

As there is a sea on and the ships gently roll, stem may not meet stem in perfect line, one of us will stem the other aside more or less. If we are both strong and well made, each may strike the other and rebound—damaged and not disabled—each may go on, discharge his broadside guns, and six minutes after we may be meeting end on or right athwart. Whichever side may win, it seems unlikely that one engagement between two such ships will last through more than three such encounters, or that the time of an engagement will be prolonged. Eighteen minutes to meet and eighteen minutes' close quarters seems a long fight.

It seems to me that the lessons I learn from these data are these—that the first fighting element I have to meet is “greatest strength to strike my enemy with most harm to him and least to me,” that the second fighting element is “greatest gun power”—to throw the greatest number of largest shells into him with highest speed at close distance and in shortest time. These two are, it seems, the first fighting elements which the modern man-of-war must possess.

II.

Our Modern Man-of-War.

The first condition of the modern man-of-war is, that she be fit to fight this battle and sure to win it.

To fight and win we must be—

Speedier, so as to choose our own time and place.

Handier, so as to choose the best bearings.

Stronger Bowed, so as to sink him without being sunk.

With more Gun Power, so as to throw more and larger shells with greater initial velocity at close range.

How to get these fighting points without sacrificing any of the essentials of a seaworthy, sea-keeping, wholesome ship, leads into questions of practical detail. But before going into the details of our

future men-of-war, it is expedient to limit our aims by clearly defining the ends we have in view.

Do we aim at perfect impenetrability of armour-clad ships?

Do we aim at perfect unsinkability of the hulls of our ships?

Do we aim at perfect security of Officers and gunners, engineers and seamen, from risk of life and limb?

I ask these rather absurd questions, because we have had much talk here perhaps and elsewhere, of things called ships which are to be utterly impregnable and indestructible, impenetrable to shot, shell, fire and water.

In reply, then, I hope I may be allowed to assume that neither you nor I, nor any men in power, look forward to, or expect, or will sanction any pretence, of making the ships of the future war-navy perfectly impregnable; such fancies or pretences would be unworthy of your countenance and mere waste of time. No doubt a ship may be made to carry armour 1, 2, 3, 5 feet thick; no doubt guns can be made 100, 200, 300, 500 tons in weight, carrying shot of 1, 2, 3, 5 tons in weight; no doubt gun makers like to be paid for building monster guns; no doubt good blacksmiths like to be paid for rolling and hammering thick armour plates; no doubt also the talk about such big things may frighten our foes if they are fools, and might give confidence to our friends if they are fools. But I feel that I need not refute such follies in this society, because they would not be seriously entertained here.

I begin, then, by assuming that you don't expect me to talk of ships quite impenetrable to shot and shell of all kinds, ships quite unsinkable by shot and shell of any size, bottoms so strong as to anchor peacefully over a mine for the purpose of being blown up with impunity, guns so large that a single shot will sink a fleet, and an interior so large that provision and fuel can be carried for any number of battles all round the world.

If you were to desire me to indulge you in foolish fancies of that sort made for your amusement, I should begin at once with the wondrous round ships of which we have heard so much; I should tell you how if you made a round ship of 100 feet diameter, you might give her 1,000 tons of armour, 1,000 tons of guns and ammunition, and 1,000 tons of coal; if you made her 200 feet diameter, she would carry 4,000 tons of armour, 4,000 tons of guns, 4,000 tons of coal; if you went to 300 feet diameter, she would carry 9,000 tons of armour, 9,000 tons of guns, 9,000 tons of coal; how at 500 feet diameter she would carry 25,000 tons of armour, 25,000 tons of guns and ammunition, 25,000 tons of coal; how all the ships in the world might bombard her for twelve months without doing her serious harm, but amusing her and themselves by waste of powder and shot.

All this you might take in good part if we were met here merely for fun. It might also amuse you to know that I really designed such a gigantic round floating fortress twenty years ago for real use, but I never called that a ship, and I hope you will never consider one of such, or any number of them, as a ship or as a fleet.

I understand, therefore, that we are not here talking of circular

batteries, floating forts, or any of those fancies which fertile imagination may disport in creating; but we are to consider how we may make sure progress, in creating sea-going, sea-keeping, speedy, handy ships, on given conditions of least waste of money, time, and human life, and meant for the purpose of protecting the wide-spread interests of the English race, the empire of the ocean, and the commerce of our large colonial family with the mother country and with the shores of all seas, and for the purpose of dealing summarily with the ships of any enemy who may wish to capture our wide-spread fleets of merchantmen and plunder the wealth they carry, or who may be ambitious of attaching to their own empires, some of that large family of English colonies, and of English dominions, which do so much for the wealth, well-being, civilization, liberty, and progress of human society. That family we must protect at all risks, and it is to the larger question of thus protecting the interests, the honour, and the power of the British Empire, that I have directed my thoughts in preparing to address this meeting of England's protectors.

III.

Ramming Power and Bow Structure.

Since ramming power takes first rank in the war ship, I have carefully examined our own ships and other people's with the aim of seeing what kind of ram or stem will do them most harm and sink them soonest.

I find that cutting them open "across the water-line" is the way and place to do most harm and sink them soonest. The best tool for this purpose is a good upright seagoing stem, having its greatest projection at its own water-line and rounded backwards above and below. This is also a good shape of stem for a sea-going ship.

I do not find that the sharp point or underwater beak often used, is a good weapon. It weakens the ship, gives a lever to the enemy, and makes a small opening instead of a great one. What is wanted, is a stem which is the strongest and at the same time opens up the largest part of the enemy in the most dangerous place. To cut open the water-line above and below, will let in most water in the place to do most harm and soonest sink the ship.

That a nearly upright stem rounded back above and below the water-line, will do most harm is plain from this circumstance, that it cuts across the decks. A sharp point may penetrate between two decks which are watertight, and do little harm, admitting water only on one deck; but an upright stem cutting across two decks, lets water in to fill three decks, and as the entrance of water heels the ship over, more and more of the opening gets under water and much more of the ship is inundated. I should much prefer my ship being pierced by a sharp point than cut open across my decks.

I am also of opinion that our stemming structure is weak. A strong heavy lump of iron called a stem is really a very feeble offensive weapon, because it is not so made as to be in one with all the ship behind. Hence we see that the ship which rams, is often more injured

than the other. I have seen ships that have rammed others at sea come back sinking because their bows and stems were not so made as to give each other due support.

The stem of a ramming ship should be built up quite differently from past custom. Our large single forgings, stopping short in thin iron sheets, are simply useless dead weight, and an oblique collision with an iron-plated ship will simply double the bow round, if not tear it open.

What we want in collision-construction is that the strong thick parts of the ship should grow evenly out of the weaker thinner parts abaft, so that the strain of collision shall be spread over a wide space, and so utilizing the strength of a large extent of good iron. For this purpose the stem must be formed by gradually growing out of the ship's bows in plates overlapping thicker and thicker until they become a thick, smooth inflexible stem, quite different from common patchwork.

The same principle must prevail throughout the whole bow of a ship. The decks must all be incorporated in the interior of the hull with the skin and the stem, so as to form one entire hollow weapon of great strength and homogeneous structure, without the present points of weakness. This, though practicable, requires much skill in order to get most work without weakness and without waste.

By stem and bow strength, I mean not merely on and under water, but up to the summit of the bow. The ship must be too strong for her enemy, not at one place, but all round the bow.

IV.

Precaution and Protection by Casemates.

Although I adhere to the war maxim, that sinking your enemy means saving you, I do not therefore feel myself thereby discharged from any of the responsibilities of my duty to do all that in me lies to save your life, and so aid you in your duty by first doing mine. But I beg to say that my idea of my duty and yours is, that harming the enemy is your first duty and mine, that saving ourselves is the second duty, and that we must not sacrifice the first to the second.

Our first duty being to shell our enemy and to sink him, I must ask you to agree with me in first giving our ship more sea-worthy qualities, more endurance, more speed, more handiness, more sinking power, and more shelling power than our enemy.

Saving power for ourselves, I should give as follows. I should give up all long clear level decks under water, and take exclusively to what I will venture to call—

The System of Casemates.

The casemate system is that in which we take some convenient unit of bulk, having some practical use as its aim and measure. For this end I take one broadside gun as my unit for bulk. That gun wants room to work it. That room may be 12 feet wide by 18 feet, call it

DIAGRAM I.

Diagram of the Cross Section of Armoured Ship with Broadside Big Bore Guns in Casemates.

220 square feet of deck; or if 10 feet will do for the gun call it 10 feet by 22. Height between decks we need not now fix. My first step for safety which I am ready to take, is to divide the whole broadside of the ship into casemates of 12 feet each, and to place in each one its own big bore shell gun. I can so arrange the structure of those casemates that they shall add nothing to the dead weight of the ship, but, on the contrary, give it useful strength.

These casemates will have these characteristics. Entry only from above. They will be water-tight and air-tight. Enemies' shell exploding in one will not reach the rest. Water entering one will remain there, not spread to the others.

This casemate system I do not mean to confine to this gun deck only. Each casemate shall have under it, an underwater casemate containing all shot, shell, charges, and stores pertaining to that gun, and to the ship's company of that gun. During battle no one need leave that casemate but one; that one stands on the upper deck, or at least has his head above it, and sees and knows all he should, and has complete command of his gun and gunners below. Thus we have now a unit of our war ship. We can carry in twenty casemates, each 11 feet by 20 feet, twenty big bore shell guns.

We can carry on the other side twenty more. Thus, in a ship's midship body, 220 feet long, we carry forty big bore shell guns. If one broadside of such shells do no harm to our enemy, he must be hard to harm, we have no choice left but run him down.

As to our own protection. If he is run down we are safe. If we miss and he shells us, look at our position. If he aim well and pierce us with one of his four great guns, he may disable one of our guns and harm the gunners. But that is a loss of 1 in 40, not 1 in 4, which is his loss if we harm his gun.

Now this casemate system is all we can do, and should be fully carried out in every ship having big bore shell guns in great force. It must be extended to the boiler-room and engine-room equally. Instead of communicating everywhere, the boilers of a large ship must be shut in all round so that when explosion comes from causes without or causes within, the explosion shall confine itself to that one closed chamber. This I did in the Great Eastern, and thereby I saved the lives of the multitude then on board. Each of the five distinct sets of boilers was entered only from above, and enclosed in a water-tight casemate. A foolish auxiliary boiler, meant to save a little scrap of fuel, and called a superheater, was added to the ship's boilers by the owners of the ship in opposition to the judgment and contrary to the advice of the builder. It blew up, as it should have done, and tore open the adjacent boiler and killed the men in the engine-room. But, thanks to the complete seclusion of that one set of boilers in their own closed compartment, we who were outside, and we were many, escaped, and the rest of the boilers and machinery continued their work unharmed, and took the ship to her destination. It is, therefore, not from fancy but from hard facts that I entreat you to save the lives of your men on board your ships by the means which saved mine—the system of casemates and closed compartments entered only from above.

I have carried out this system throughout the plans of several ships, and I cannot say that I find any disadvantage at all comparable in value to the safety of life and security from sinking, which it, and it alone, can give.

But I am bound to tell you that the planning and working out such a system has one disadvantage. It requires much forethought, foresight, and skill in those who plan it, and much of the same qualities in those who use it. But in this it resembles all other improvements which are new, and to which we have not been practically educated and trained. It requires time to mature its structure, its use, and its users, therefore the sooner we earnestly set about it the better.

These casemates clothed in armour will carry each a great bore gun, and a similar casemate below the water-line will carry ammunition for that gun. The sub-divisions of the ship's hold going down to the ship's floor, and going right across the ship, will form continuations of these casemates, and thus the whole will be one homogeneous structure of wrought iron plate, disposed in the best way, without waste of weight, and each part contributing its full share to strength, safety, and effect.

V.

Strength of Armour and Ship.

Giving up as fanciful all ideas of perfect impenetrability, we go into the plain problem of making the best of what we can have. If I can carry 1,000 tons of armour in a given ship, how shall I best dispose it?

I have so much area to cover, so many guns to protect, so many tons dead weight to carry.

Here the practical problem begins and ends, how to make the most of say each 50 tons of armour.

The gun I have to protect occupies a casemate, having an exposed face of say 100 square feet. If each foot of armour over a foot thick weighs 5 cwt., that will use 25 tons, leaving 25 tons more for end-on and under-water protection.

The question is now this, how shall I best utilize these 25 tons over 100 feet of face, so as to be most enduring. The answers to this are most important :—

1st. What shall the armour be? hard iron or soft? iron or steel? or both?

On this I shall give you the sum of my own experience and of others, as far as I know theirs.

1. Joints in armour are weak places, therefore let us make them the strongest.

2. Bolts and bolt-holes are causes of cracks and giving way, therefore do away with bolts and bolt-holes.

How this may be done? Our system of casemates enables us to do this.

A modern armour plate covers over 100 square feet, in one single piece, it weighs 25 tons. But it is pierced with holes, and its joints

The Cross Fore Bulkhead and Armour.

DIAGRAM II.

Diagram of forward portion of Upper Casemate Deck showing place of Armour and Guns and strength of Structure.

are weaknesses. Struck on a joint it gives in there and flies out at the far-off edges. Struck between two holes it cracks between. Now if we place the whole four edges of the plate on the four walls of our casemate, all four thus supported, become the strongest place in the plate.

If therefore it be true that the strength of everything is measured by that of its weakest part, we have by our casemate system much strengthened our armour.

Next, as to the quality of our armour-plate; shall it be hard or soft? steel or iron?

This question requires careful discrimination. Doubtless the harder it is, like tempered steel, the more it shatters the shot of the enemy. But also we must remember that hard stuff cracks, and so, though the shots of the enemy are shattered, yet later on, our armour is itself shattered, cracks, and falls to pieces.

Our question therefore comes to this, can we get all the advantages of steel armour, and yet protect our armour from crumbling to pieces?

First then we must fasten it to our ship without bolts or bolt-holes; next we must hold it in place by such means that though split by shot, the pieces may still be retained in their places, and do their work as armour.

There are several ways to do this. One I tried at Shoeburyness was an edge binding, where the plates were rivetted in places without bolt-holes, and it certainly resisted better than any of the others. But there is a much better way not yet put into practice.

This way, which I propose should be put into practice along with the casemate system, is to incorporate the armour-plate within the structure of the iron plates of the ship. There need be no armour-plates nor joints visible outside the ship, only the common iron skin quite smooth on the outer appearance of the ship; then the ship itself built, like the Great Eastern, with broad plates at right angles to each other, and forming a cellular skin. The spaces of this cellular skin to be made of such sizes as each to hold a large armour-plate and its backing, and this entire skin and its divisions built up of iron plating two or three layers thick.

By this system of incorporating the steel armour or iron armour inside the hollow walls of the ship's side, the armour would add to the strength of the ship's structure, and the ship's structure would enclose the armour without piercing it with holes and making it crack, and if it were cracked by some extraordinary force, the two or more pieces of the cracked plate would still be secured fast in their place, and would still be there to receive the blow of the next shot, with diminished strength, but not destroyed nor removed. That I think would be the way, in union with casemates, to make both the ship the strongest and safest, and the armour most effective, secure, and durable.

Thus 50 tons of armour gives us protected casemates for one gun of the twenty guns in twenty casemates for the weight of 1,000 tons of armour.

I think that by means of this arrangement we have made the most of our money, weights, and material.

Of course double these weights and cost would give double thickness of armour, but the same methods of application would yield similar advantage in use, should such weight be deemed expedient. But that question comes later, when we settle the size of ship.

VI.

The Man-of-War.—Ship of the Line.

In designing a ship of war, the first maxim I should entreat you to adopt would be, not to allow any of the usual prejudices in favour of or against any particular proportions, shapes, or modes of construction to affect your minds, but to follow out implicitly the conditions and wants of the case and the nature of the work the ship has to do.

1. Let us agree that the ship shall have the shape, proportion, and qualities of a sea-going ship; shall stand up well under sail and roll easily with the sea; shall be dry and handy. We know that these qualities have been completely obtained in many ships of the past.

2. Let us agree that our modern man-of-war must go fourteen knots under steam. This settles the shape of bow and stern; the length of entrance and run, 200 feet.

3. Let us agree that our ship must carry fuel for 3,000 miles, 4,000 miles, or 5,000 miles. That settles whether she is to be 300 feet long or 360 or 400 feet long. See diagram III.

4. Let it be agreed that she must carry 2,000 tons of armour and 2,000 tons of armament and ammunition. That settles her breadth of beam as say 64 feet.

5. It must be understood that the middle body of the ship protected by armour should be adequate to secure the ship when the unprotected ends are shelled.

The result of these conditions, without any choice on your part or mine, give us a—

Ship of the line 66 feet beam, 24 feet draft, 300, 360, 400 feet long, the length of the ship being proportioned to the length of the voyage she can make or the time of her endurance at work.

The entire water-borne weight is 12,000 tons; the weight of ship, equipment and engines is 5,000 tons; armour and armament, 4,000 tons; fuel for ocean voyage, 3,000 tons.

This store of fuel is good for 6,000 miles. Diminished length of 10 feet of ship makes 300 miles diminished length of voyage.

Thus built of 300 feet long, this ship is good for only 3,000 miles steaming; 360 feet long for 4,800 miles steaming; 400 feet for 6,000 miles steaming.

Now on the point whether you would prefer the longer ship, to enable you to seek your enemy further, to follow him faster, to choose your time with more margin in hand; all these are points for your choice, not mine.

Let us now see how we can turn all this weight of carrying power to account. We have 4,000 tons for armament and armour: say 2,000 tons armour, 2,000 tons guns, ammunition, and stores; 1,000 tons

guns and carriages; 1,000 tons ammunition, &c.; being 10 guns of 100 tons, or 20 of 50 tons, or 40 of 25 tons.

I have already said how I should wish to see the armour and protection carried out and the guns placed broadside in casemates. But the question of choice of guns is more yours than mine. I prefer a given weight of large-bore gun firing large shells with high initial velocity at close quarters, breech-loaders, and placed in very simple carriages in armoured casemates, to all the complex mechanism and misplaced ingenuity of firing long, narrow, thin shot, from long distances on a heaving sea.

It will be seen that if this ship, 66 feet beam, were only six beams in length, which we have always reckoned a very moderate proportion in steamships, she would be 396 feet long. But it is objected to length, that it cannot be combined with quick turning or manœuvring power. Now this is true in degree, but in degree only. I can quite undertake that the turning power or manœuvring power of our war-ships can be made such that a ship 400 feet long shall turn round quicker and sharper than our present war ships of 300 feet long. How this is to be done I shall consider further on.

Table of Dimensions.

I. THE MAN-OF-WAR.

(66 feet beam, 25 feet draught.)

Lengths.	Bearing Power.	Steaming Power.
Feet.	Tons.	Miles.
300	8,000	3,000
360	10,500	5,000
396	12,000	6,000

IIa. THE FRIGATE.

(56 feet beam, 25 feet draught.)

Lengths.	Bearing Power.	Steaming Power.
Feet.	Tons.	Miles.
300	7,000	3,000
360	9,000	5,000
396	10,500	6,000

IIb. THE FRIGATE.

(46 feet beam, 25 feet draught.)

Lengths.	Bearing Power.	Steaming Power.
Feet.	Tons.	Miles.
300	5,500	3,000
360	7,000	5,000
396	8,000	6,000

DIAGRAM III.

Diagram of Water-line of High-Speed Ships; showing relation of endurance of Steam Power to Length of Middle Body, the Ends being alike.

$4\frac{1}{2}$ beams long. 300 feet. Endurance, 3,000 miles.

$5\frac{1}{2}$ beams long. 360 feet. Endurance, 5,000 miles.

6 beams long. 396 feet. Endurance, 6,000 miles.

VII.

Gunnery and Manœuvres at Sea.

All my experience of the sea, (and I am very fond of the waves and enjoy their play,) has given me the belief that with our present large guns, very little good is got by complex manœuvres of the gun. To say that the gunner can lay his gun as he used, by peeping through the port and adjust it with all the nice precision of a land gun, is sheer nonsense, and, if I am well informed, all such sea-gunnery is sheer waste.

I have come to the conclusion that the modern ship is the true gun-carriage, and the chief gunner is the man who commands the ship, and that the guns of the ship are laid just as the ship's head is laid.

I beg you, therefore, to go back with me to our opening sea fight. I presume that on entering that engagement, the Commander had four large bore guns laid right a-head in the line of the keel, and that as he kept her head direct on the enemy, stem to stem, so they only received a signal to fire and reload. Being breech-loaders this could be done without deranging the gun, and without loss of time. But I fancy the firing may have been wisely reserved. I presume, also, that the Commander on sighting the enemy, had all his twenty or forty broadside guns laid right across the beam, and at such elevation as the state of the sea rendered most serviceable. Some talk of converging broadsides as useful, I prefer square across the beam. Now the Commander of the ship, standing where he should, sees all that happens without, and guides all that is to happen within, knowing now how every gun lies, and having only two such ways to think of, he is, I think, quite master of the situation.

He has only to see the ship's head right in line with his enemy to fire with certainty, and if he do not give him the stem but pass him, he will surely deliver into him the entire broadside.

Now all this is coolness and courage, and forethought and wisdom, but it requires no tricks of gunnery, and no marvellous, ingenious, costly, complex mechanism of any kind; its sole virtue is simplicity, common sense, and cool courage.

In this case then, and in many others, I call the ship the gun-carriage, and the Commander the gunner-in-chief, and thus I dismiss all bewildering complications.

Being breech-loaders, the guns are at once reloaded without being in any way shifted or altered, and one minute may suffice with good organization. All is again ready and nothing changed but the ship's place, and the Commander is giving the guns the proper direction by the ship's head.

I wish here to say a few words about the ports of armoured ships. The ports of which I made the designs, were made small and narrow; I have lately seen the ports of armoured ships made wide, open, and large; and I have even seen them shaped with funnel-like mouths spreading out wide, just such as I should like to fire into if she were my enemy, for I could not fail to fire my shell right into her central battery, even with my clumsy aim. Now, I have a growing conviction

that we cannot, in our armoured ships, too much diminish the size of our iron-clad ports. Years ago some of us contrived muzzle-pivots for our guns; the principle has been revived, some foreign governments have tried it with success. I can conceive nothing better for an armoured casemate than a closed port and a muzzle pivot, no smoke and no bullets could then enter, and the gun, already laid in an already ordered line, would obey the orders of the gunner-in-chief. On this arrangement I place high value; any of its seeming difficulties are easily got over.

By arrangements such as these, difficulties of gunnery and gun-carriages, and laying and loading, speedily disappear, and the Officer in command may feel that he is in real command of his ship, instead of feeling himself the victim of mechanism and machinery over which he can exercise no control.

What I have here said relates chiefly to the guns in casemates of the ship of the line. I may afterwards show its important bearing on ships of a smaller class. The four chase guns at each end of the ship may have longer range and wider training.

Another Kind of Fight.

There is one way to avoid ramming and being rammed—"running away."

There are cases in which running away might be wise. You are stronger than me, I am faster than you; I run away, you follow, and I escape.

But though I may seem to you to run away, and you follow, I may choose to fight you as I run. I may have good armour end-on, though I may have none broadside (or little). I may also have good guns end-on. In this case, though you have also good guns and plenty of armour, I with more speed, am a match for you.

This may be a good reason why I seem to run away. I may fire directly into you without changing my course. I by speed can keep nearer you or farther off. I, as I go farther, may use vertical fire, falling on your decks. Thus with little armour I may match you by speed and good armament and simple armour.

VIII.

Other Kinds of Ships.

If we have war-fleets at all, should we have any but the most powerful ships, with most speed, most great bore guns, most complete armour, most endurance at sea?

I must confess to you that the deeper I go into the question, the more I come to the conclusion that the first-rate war-ship, though the most costly, is the best worth her cost.

I much prefer one strong ship to two weaker ones.

For the naval strength of our great empire, I can see no war-engine comparable to a fleet of ten or twelve ships of the line; all identical each to each in every point and quality; all seaworthy, fast, and enduring; all with many large bore guns, and complete unsinkable

hull and armour; all able and ready to go round the empire and fight whenever they can find an enemy, quick and handy.

Among other possible ships, are ships of the same length, of less breadth only, and having the same qualities. These we may call frigates, and their only difference is—wanting complete armour.

By “complete armour” let us agree that we mean a middle body with all in it protected, and long enough to sustain itself and the fore and after ends of the ship.

By “partial armour” let us understand:—

I. Two transverse sections fore and aft, protecting all decks, engines, and magazines from end-on fire; call that the lowest degree of armour.

II. The next degree should add to this, armour for magazines, engines and boilers, and an armour deck covering them.

The higher degree let us call complete armour. I should give as a rough estimate—that the complete armour being 2,000 tons, the 2nd rate armour would be 1,000 tons, the 3rd rate armour 500 tons. Now we see that the addition of the complete armour, as compared to its lower degree, is only a difference of 1,000 tons, in a displacement already of ten or eleven thousand. So I conclude that the advantage preponderates for complete armour in the larger classes of men-of-war.

The second class of armour-clad is the frigate. Its two bulkheads give it complete end-on protection. Its casemates limit the dangers of the exposed side. Its low armour over magazines, engines, and boilers secure its vitals even from broadside fire, while its ends save all within from raking and sweeping fire. It is narrower and cheaper than a first-rate.

Now this class must be the fastest of all. It must be able to follow and catch any ship it wants to get hold of. It must be able to get away from vessels able to sink it. It must be able to return to us before our enemy can follow. It must be able not only to chase with effect, but to be chased with impunity; its chase guns and its two bulkheads give it this power.

III. Whether this class should be classed as corvettes, and a smaller class called sloops should be employed chiefly as intelligence ships, with no powers at all except that of running away from armoured ships, is a question I must leave to others. I would rather omit such ships altogether from the fleet, and include them and all others under the general head of *Special Service Ships*—mortar-boats, torpedo-boats, under-water boats, monitors, turret-ships.

I doubt if much good is got by going down from ship of the line to frigate. It is cheaper and less wide, that is all.

But we may want a ship of less draught of water, and greater speed than ourselves, to form the flying squadron of the fleet. If we are taking charge of some sea—The Mediterranean, the Indian Ocean, the North Pacific, the Australian Ocean, the West Indian Seas—we want ships to be everywhere, to watch everything, to deal with smaller enemies, and to protect our own smaller interests; we must have a sort of ubiquitous ship—something like the German Uhlans, which I used to

see on the outlook, all over France during the war. It seemed to me just what we must do with ships in seas when we have to make war.

IX.

Ships for Exceptional Service and Special Duties.

Mines and Shells.

The question of torpedoes, mines, and under-water attack is one which no Commander of a ship and no constructor of a Navy can neglect, but it is also one which has attracted much more attention by nervous excitement, alarm, and fear, than by real force as an instrument of Naval war.

As ever since the beginning of the Crimean War I have given much study to the question of under-water warfare, allow me very shortly to deal with this matter as it regards fleets. There are many engines of war which are quite as dangerous to the enemy as to us: mines and explosives generally are of that nature; shells and explosives generally are of that nature. I will try to put all I think useful to you in that matter into few words.

From my own personal knowledge and experience I can tell you thus much. If you are my enemy and lie near my shores in smooth water, I can, with a very small ship or gunboat, do the following things to you:—

1st. I can fire large explosive shells upwards which shall fall vertically downwards through your deck and explode in the midst of your ship.

2nd. I can send these same shells horizontally above water and strike you horizontally about the water-line, above or below.

3rd. I can send these same shells down below water, right under the bottom of the ship, and there explode them at the same moment at which shells are descending and exploding from above.

Now all these things I can do with certainty and not without risk, if you allow me; but I need not add, that you are a fool if you allow me.

Allow me to say that I think these are much more matters of fright than of fight. Rockets frighten savages more than bullets. Greek fire was a grand cause of alarm in old times.

I should make myself well acquainted with all such matters if I were a Naval Officer. I should amuse myself with them, and make my men quite familiar with them, and able to use them to frighten the enemy, but I should not trust to them as an instrument of serious warfare.

The one answer to all is—destroy your enemies before they get near you. That easy task I leave to you. That every fleet shall be composed of a different class of ship, charged with different kinds of duty is now plain—that is a matter of naval strategies on which I need not enter. But I have no doubt that it will be the duty of the numerous classes of small vessels of the fleet, to see that no small ships of the enemy come near to the main body of the fleet so as to shell them either above water or under water, torpedo-wise or otherwise.

If great ships allow little ships to come near them and shell them they deserve to be sunk. A torpedo-boat is as easy to sink as any other boat, if not easier.

All I have to say in the matter of ship-construction is this—that every ship of war must be planned with full knowledge of the fact that the shell is the engine of naval warfare. That it must be thrown out in whatever direction will give best effect, and that protection must be afforded against shells from every direction in the manner we find to be most effectual.

In every case there remains only this one rule of war—

“Sink him first.”

There is no other.

X.

Gun-Boats.

I rank the gun-boat, with one big bore gun, as the class of war vessel next in importance to the ship of the line.

There is this important distinction between them—the fleet of large men-of-war is ready and able to go to any of the seas of the British Empire, and there to win a victory over the fleets of any of the enemies of our power or our commerce. But the fleets of small ships must be *localized*, they must be already in the place where our interests lie. They cannot carry coal to steam thousands of miles. They cannot accompany the ocean fleets, they must precede them. Local flotillas of our modern gun-boats I consider as a good school for the future training of the crews and officers of the Imperial Navy. In our great stations in the Indian ocean, in the Australian seas, at the Cape, in the West India Islands, as well as near our own homes, there should be completely organized flotillas of the smaller classes of war vessels, in good harbours and well-protected stations, to which in case of war our large men-of-war fleets might be dispatched with the highest speed, and find these fortresses and their local flotillas ready to join them with perfect equipment, and ably manned and commanded.

The question of the construction of this class I consider to be one of the highest national value. I venture to call it—

The Unit of the Fleet.

It is the smallest ship, but it carries the large bore gun, equal to that in the largest man-of-war. The reason I do not follow the common course of placing a small gun in a small ship is this—that the bore of the gun is not settled by the size of the ship that attacks, but by the strength of the ship it has to conquer.

As our unit has to attack the largest and strongest ship, it must have a gun fit to fire a large bore shell with a high initial speed, otherwise little bore guns against strong ships are worthless.

The next point of importance in this unit of the fleet is that the gun-boat shall be the gun carriage. It needs no other. The boat built with a strong thick iron bow will be the gun carriage, and

the water in which the boat floats will take the recoil, no other is needed.

The gun boat being the gun carriage, must be cleverly handled by an able gunner and a clever commander. Therefore also the manœuvring power of the vessel must be made a first object of design and construction. Ordinary screw propelled boats have many disadvantages in handling them. These the ingenuity of England must be asked to remedy. It is to be remedied in several ways, and a little experience will soon show which is the best.

Assuming that this one-gun vessel is taken as our unit, and that her gun has 15 inches bore, and 18 or 36 tons weight, the vessel herself will have to be not less than 25 feet beam, and probably more than 150 feet long. But with that short length, she will neither have high speed nor endurance of fuel for length of run.

Calling the one-gun boat the unit, I think it very important to have another class, which I will call the twin-gun boat, because she will be able to mount two of these big guns, one fore and the other aft, and she will be able to go with equal speed either way, and be capable of manœuvring equally well either end foremost. She will have to be longer, and she will be able to make a longer voyage with a greater store of coal, and though she has more length than the unit, she will manœuvre equally well, from being able to stem either end foremost at full speed with full manœuvring power.

But with these qualities, let it not be forgotten that a single large shell sent into her centre by a first-rate man-of-war sends her to the bottom.

In this respect therefore two units are better than one twin.

In conclusion, I think a few hundreds of such gun boats all round our coasts would make good seamen gunners of us all.

Conclusion.

If I may now venture to sum up the conclusions to which I should desire the present discussion to lead us, they are the following:—

1. That the construction of ocean fleets of men-of-war, able to keep the sea, in all the stations of the empire where British rule and British interests require protection, is a matter of national as much as professional interest.
2. That the creation of a new fleet or fleets as distinguished from the maintenance and repair and restoration of existing fleets, is a great national act rather than a matter of ordinary administrative routine.
3. That the creation of an ocean fleet or fleets is not to be accomplished without a great national effort, in which the industry, the commerce, and the financial resources of the country, as well as its professional abilities, must all be brought into cordial and patriotic co-operation.
4. That a standard Naval gun of large bore and light weight, breech-loading, and so arranged as to fire through a small closed port, and worked by simple means, is a desideratum in the Naval service.
5. That a system of Naval casemates, enclosing broadside-guns, having steel and iron armour, the armour so incorporated with the

ship's side as each to contribute to the strength of the other, offers great security against shot and shell, and much safety against ramming and sinking.

6. That a similar system of division and subdivision, in the compartments of boilers and engines and in stokeholes, coal bunkers, and tanks, offers the best security against dangers from within and without.

7. That a speed of 14 knots should be the normal speed of an ocean fleet, and that a minimum steaming power of 5,000 miles, should be the normal endurance of the steam ships of the fleet.

8. That improved manœuvring power in screw men-of-war, is a desideratum, which may be accomplished in several ways, and which deserves to be made the subject of study and invention and trial for use in the service.

9. That a large and powerful sea-keeping man-of-war, and a small quick one-gun boat or twin-gun boat, are the two most important units of a navy.

10. That the large squadrons of the fleet should be ready for service in every sea of the British Empire; while the small vessels should be localized in well defended Imperial stations—placed where the most important interests have to be defended.

11. I submit that a man-of-war can now be constructed with a speed of 14 knots, an endurance of 5,000 to 6,000 miles steaming, the sea-going qualities of a sailing ship—easy, stable, and handy, carrying 20 to 30 big bore broadside guns of 15 inches, all under complete armour, and an over match for any existing man-of-war, under 396 feet long, and able to turn round quicker than existing and shorter ships.

12. I also submit that we should adopt the one big bore gun boat and the twin-gun boat with high speed, exceptional turning power, and speedy reversional power, as the unit of our flotillas of small men-of-war.

The CHAIRMAN: After the very interesting lecture we have heard, and the instruction we have derived from it, I hope there are many gentlemen present who will contribute to our information. Even if they do not agree with the lecturer, their criticisms will doubtless give us still further information on this interesting subject. There are one or two points I should like to hear something more about. One is as to the strength of these casemates to resist the explosion of a shell. It would resist, perhaps, water, but would it resist the explosion of an enemy's shell that came in from above?

Mr. SCOTT RUSSELL: It will, not without injury to itself, but it will not injure those that are around it. It will be bulged a little, but it will save those above it. I have been in a ship where a large explosion of this kind has taken place.

The CHAIRMAN: I should also like to know how the casemates are to be ventilated, for we know the difficulty of getting men to work in places where there is little or no ventilation; and also, as each gun-casemate has its own magazine in the casemate immediately under it, how is that casemate-magazine to be lighted, ventilated, and preserved from explosion?

Admiral Lord DUNSTON: Perhaps Mr. Scott Russell will kindly explain what seems to me at first sight a difficulty, but which is probably no difficulty whatever in the mind of an engineer. Mr. Scott Russell proposes to interpose between what we may call the two skins of the ship—the armour plates. Now, as I conceive the building of an iron ship, the two skins are here and there connected together, and that connection gives them very much of their strength. So far as that place is

concerned where the armour plate is put in, it appears to me that the two skins will be separated. That is to say, I believe the lecturer did not propose that the armour plate should form any connection whatever between the two skins. I see I am right in supposing that the plate is not to connect the two in any way, therefore, as it appears to me, the two skins are separated, so far as that plate is concerned, without any of the usual strengthening pieces to keep them together. Probably Mr. Scott Russell will also explain whether, as might suggest itself to some people, there is not a loss in presenting to the enemy ordinary plate iron as the *pièce de résistance*, instead of the armour plates. As it is now, the enemy's shot will come into contact with the armour plates; under the proposed plan, the shot are to strike upon the ordinary iron plates, or possible iron plates. I think I understand the lecturer to say two or three thicknesses together, but still, of course, they would be a frail protection against shot. Those are two things that no doubt come within the knowledge of an engineer, but which, to a lay observer, seem to present a difficulty. There is another point of naval engineering of which I do not pretend to know anything at all, but in diagram III one sees that whereas the midship portion varies 100 per cent., one being 100 feet, and another 196; in every case the run and the bow preserve the same length. That, of course, runs a little counter to one's ideas of naval symmetry, but I suppose there is an answer to that, and no doubt the lecturer, when the time comes, will favour us with it.

The CHAIRMAN: As Mr. Reed is present, we shall be very happy to hear any remarks he may wish to make.

Mr. E. J. REED, C.B., M.P.: I really am unable to respond in any manner, such as I could wish, to your kind invitation, after two hours' sitting in a close room on a very hot day. If the discussion is adjourned, I shall then be very happy to take part in it; but the paper has so many points with regard to which I must respectfully differ from the distinguished lecturer, that I should not think it fair to him or to myself to enter upon a discussion unless one had a reasonable opportunity for stating the contrary view.

Major-General ALEXANDER, Royal Marines: I should like to be permitted to ask the manner in which the lecturer proposes to protect the guns within the casemates from diagonal fire. I understand perfectly it is proposed to protect the guns and gunners from direct fire by armour plates of certain thickness, but I was unable to catch the modes in which the guns and gunners were to be protected from diagonal fire, which fire, I apprehend, would be as dangerous to the efficiency of the vessel as that which would be absolutely direct. There is one part of the lecture which we have just heard, that deserves special attention, and that is where such stress was laid on the great necessity for organising and localising not only our colonial defences, but the shore defences of our own country. For if we reflect upon this question, I think it will be found that everything of the kind resolves itself into a question of money, and if we leave until war breaks out, all the organisation that becomes necessary for this particular kind of defence, an enormous amount of money will be necessary and at the same time the work must be inefficiently performed. I am interested in this matter, because some fifteen years since I, in a humble manner, endeavoured to bring forward that particular question, and to show the desirability of separating the coast defence of this country and the colonial defence from the system of a sea-going navy. It has always appeared to me that the necessity exists of having very large vessels, in order that certain sea-going qualities may be obtained, and that a certain power of coal-carrying also should be gained, both of which are utterly unnecessary in a coast-defence vessel. But by organising a special fleet for that purpose, we are able at once to arrive at greater speed, greater defensive power, and greater gun power, and at the same time we are able to separate the organisation, and have a force of officers and men totally apart from those required for more special service on the ocean. I think that is really one of the most valuable parts of the paper. Perhaps it is that I am less capable of entering into the construction of the ship proposed, and of seeing the many valuable points in connection with it.

Captain PRICE, R.N., M.P.: The lecture we have all listened to with so much attention has travelled over such an innumerable range of subjects that it is quite impossible for any one person, within a very short space of time, to reply to more than one or two of the different points. I think the point above all others which

Mr. Scott Russell has dealt with, and very rightly, is the irresistible power of the ram; and I should like to say one or two words about that. I think that the shape which he gives to the bow of his vessel is not one that is unanimously accepted in the service. The prevailing feeling, I think, at present is that the bow which he has discarded—the snout under water—is that which is generally preferred. But he, as a ship builder, tells us that he does not think it is a safe form, and he has given us his reason—that he thinks it can be easily wrenched off. I hope Mr. Scott Russell will not think it is a personal remark, but I was going to say the line he generally takes is this, that he comes here as a ship builder speaking to naval officers, and he says, “If you only tell us what you want, we can do it for you.” My point is this, if it can be shown that naval officers prefer that particular kind of bow which I call the underwater snout, I have no hesitation in saying that Mr. Scott Russell, on his own showing, and other ship-builders, can build a vessel in the particular form that I say we want, and without any danger to the structure of the vessel. That is my point. Now, I just want to say, in one or two words, why I think that form of bow is to be preferred. Taking Mr. Scott Russell’s own diagram of a ship, of the bow of the vessel that is to attack that ship, is something approaching to a straight line or slight curve, it is very obvious that if this vessel happens to be rolling a little towards the ship that is attacking her at the time she is struck, she will strike a portion of the vessel very likely above the water-line, and will not run the chance of damaging her under water half so much as if the ram bow of the vessel formed a line somewhat similar to the section of the vessel that is to be struck. There is another point. We cannot always assume that the blow struck will be sufficient to sink the vessel. That depends a great deal upon the way the vessel is built, but it may do her a considerable amount of damage. It may damage the vital portion of the ship, and I want to ask where are the vital portions; are they above the water-line, or are they not rather below it? If the ship is struck in any part under water, the chances are not only that a very large hole will be made, but that the engines might be displaced, the boilers might be burst by the concussion, and certainly such damage would be done to the ship as that it would be rendered *hors de combat*. One other little point in connection with that. Naval men are trying to find some means of quickly stopping the rent made in the side of a ship by the blow of a ram. It is very necessary, of course, that that should be done, and a certain amount of success has attended the effort of naval men, both in our own and in foreign navies. Now would it not be very much easier to stop a rent so get-at-able as one would be above the water-line, than to stop one very much below the water-line, where it cannot be so easily got at? Those, I think, are the points deserving attention in the ramming-bow. Another very important point that the lecturer touched upon was that of gun-boats. Now that is such a large subject that I won’t go very much into it, but I wanted to make one remark about the power of directing those boats. Mr. Scott Russell and others have advocated that, in certain cases, with small gun-boats, it might be as well to dispense with the ordinary gun-carriage and the training power of the gun, and to build the gun, so to speak, into the ship. I do not think that that is a bad plan at all; but I would say in the navy, as far as I have seen, there has not been sufficient attention paid to the power of directing the fire of the guns, not from the gun itself, but from some of the points of the ship. It is a very difficult point indeed, and it is one I am not quite sure whether I might not say should be taken up by the constructors of ships in conjunction with gunnery men. Then as to the vertical fire. Mr. Scott Russell raised a smile in one or two quarters when he mentioned that, and so far as the sketch on the board is concerned, where we appear to see a gun-boat shelling with vertical fire a ship broad-side on to her, I think it would be quite a useless expenditure of powder and ammunition. But there is one way in which I think vertical fire might possibly be of use, and that is where a ship is running away from a superior vessel. We cannot arm all our vessels with mortars, because we expect that they will be running away, but I think it is the only case in which vertical fire from one ship against another can possibly be of any use; and the reason, I think, is when one ship is chasing another, you can get the range very much nearer; it does not alter very much. We all know the familiar expression that “stern chase is long chase,” and when one

vessel is chasing another they are both brought much upon the same line. The direction does not vary much, but, more important than that, the distance does not vary so rapidly as it does in any other position that the ships may be in. I was very much astonished to hear the lecturer rather appear to pooh-pooh the power of the torpedo. I think, rather, we ought to make up our minds, and I am sure we have had quite lessons enough, that the torpedo is a very fearful instrument of destruction, that it is by no means such an easy thing to defend yourself against as the lecturer seems to think. I am not alluding to what we have heard lately in the Danube so much as to what occurred some years ago in America. We had ample illustration of the power of the torpedo in the American war. I am speaking without book, but I think there was something like thirty or forty vessels destroyed by the torpedo. I was only the other day reading a book on submarine warfare by Mr. Barnes, an American, and one sentence came upon me with great force. Speaking of offensive torpedoes, he said that throughout the whole of the war, events went directly to show that in no single instance where a torpedo boat was sent to attack other vessels did she meet with failure by reason of the guns of the enemy. It was the case that in one or two instances torpedo boats were badly made, and they sank themselves. We know one submarine boat was sent out, which sank herself two or three times, and all the crew; but in no one instance was a torpedo boat sunk by the guns of the enemy that she was sent to attack. That is a very important thing. I believe myself, that it would depend upon the pluck and nerve of the operator. Of course torpedo boats will only attack at night, and if we have only the big guns of the vessels being attacked to depend upon, it is quite impossible, or, practically speaking, it is impossible, that you could sink a torpedo vessel, however well you might see her, before she got within range. All this shows me that what we want in the navy to decide on this point really is, experience, and experience means money. By experience I mean experiments. That is a thing we have not had enough of, simply because we are not allowed enough money to conduct these experiments. If we only saw by a vast number of experiments what was really wanted, then we should be in a position to come here, as naval men, and inform Mr. Scott Russell and other eminent shipbuilders and artillerymen, exactly what we want, and I have no doubt they would be quite able to carry out our requirements.

Commander CYPRIAN BRIDGE, R.N.: I should like to say a few words, not with reference to the scientific part of the questions raised by Mr. Scott Russell, but upon what I may call the naval part of the questions. I take it, and I have no doubt many of my brother officers do, that a man of Mr. Scott Russell's eminence and well-known reputation, coming here to lecture chiefly for our benefit, is a very high compliment to a service which, judging from the newspapers I have seen since my return to England quite lately, has not had very many compliments paid to it. Great as is the advantage that undoubtedly accrues to the naval and military service from the fact of such eminent men coming to lecture in this Institution, still there are some compensating disadvantages; and one compensating disadvantage is this, that it very often goes abroad from this Institution that things are not going on well in the Navy. About the Army I know nothing. What really is the case? For instance, there was one thing which I made a note of, and I am quite sure nobody will be more glad to hear it than Mr. Scott Russell; and that is, he spoke about the concentration of fire. My honourable and gallant friend Capt. Price spoke also about its not being sufficiently attended to—about the concentration of the fire of a single ship being in the hands of a single individual. Now Captain Price is a far greater authority than I can pretend to be, and he knows, even up to the time he last was afloat, considerable attention was being paid to it, and considerably more attention is being paid to it now; and I mean to say the Captain of a ship has now absolute control of every gun in the ship. He can direct that every gun be laid right a-beam or on any bearing, and at any elevation that he desires, and he himself can fire every gun in his vessel simply by pressing down his little finger, he being in such a position where he can see the enemy's ship, and where no single individual on board ship except himself can see the enemy's ship. Not only is this the case in the large ironclads, but in the gun-boat of which Mr. Scott Russell spoke, and which he suggested should be actually the gun-carriage, so that the gun should require no carriage of itself, but simply the boat in which it is embarked—that, to my certain

knowledge, has been in existence—the system of firing the gun and directing it—for three or four years. When I was in the “Cambridge,” under the command-in-chief of the Chairman, one of the lieutenants there had devised a scheme for steering the vessel, and directing and firing the gun by the command of one individual above. And that entered into one part of the regular course of instruction, and was carried out every day that that gun-boat was sent to sea; that is, at least, four years ago. From leading articles, very often founded upon lectures and discussions that take place in this Institution, it often appears that even people whose business it is to look after the service of the country do not do so as satisfactorily as they might. I was reminded of this by Mr. Scott Russell’s allusion to gun-boats. Now, I doubt whether there are half-a-dozen people in this theatre who can be aware of the efforts that are being made to put the country on a proper footing—with reference to the defence of its colonies—those members of our empire which are just as much members of our body politic as our limbs are of our own body—I say I doubt if there are half-a-dozen people in this theatre who are aware of what is being done at all events by the present government (I cannot speak of the last government, I only speak of my experience in the last year or two, and I have no means of information which is not open to all the world), that there are at least two colonies some thousands of miles apart, for which a special class of gun-boats has been constructed quite twelve months ago. And in one colony, the land on which the stores of these gun-boats are to be deposited, was purchased, or made over, by the Colonial Government to the Imperial Government, at all events in 1876. So that shows that we are not quite so badly off with regard to the people at the head of the service doing their duty towards the colonies, as we are supposed to be. I quite agree, and no doubt many others will agree, with Mr. Scott Russell in his estimate of the power of the torpedo; and he applied a very correct epithet to it when he called it a “bugbear.” I think Captain Price a little misunderstood him when he assumed that the lecturer thought that that vessel which is shelling the large one literally upon all sides, would be destroyed by the power of her guns. I take it he meant that she was to be destroyed before she got within range of the guns, and although those numerous losses did actually occur in the American war, still we must remember how it was that they did take place. One occurs to me, that of the “Tecumseh,” in Admiral Farragut’s action at Mobile, where nearly 200 men were lost. I think that is the number put down in the “butcher’s bill,” returned after the action. That vessel was destroyed, as I was told, by two American officers who took part in the engagement, because the Captain of the “Tecumseh” chose to go exactly where he was told not to, where Admiral Farragut was perfectly aware that if the vessel did go, she would be blown up. I think that tends to corroborate the view taken by Mr. Scott Russell of “Sarve ‘im right!”

Major BAYLIS, Q.C. : I rise to move the adjournment of this debate. We have had a most interesting lecture, and we are most anxious to hear what Mr. Reed may have to say about it, and therefore I think it would be well if, at this stage, the discussion were adjourned.

The motion having been seconded by Captain SCOTT, R.N., the meeting was adjourned to Tuesday, June 12th.

ADJOURNED DISCUSSION.

Tuesday, June 12th.

ADMIRAL OF THE FLEET SIR HENRY J. CODRINGTON, K.C.B.,
in the Chair.

Major BAYLIS, Q.C. : It is my privilege, Sir, or rather my duty, to speak first, on one of the most important subjects connected with the naval supremacy of Great Britain, viz., the best ships to be built, and secondly the best mode of destroying the best ships of the enemy; and I feel naturally diffident, amongst so many distinguished scientific persons and naval and military officers, in saying a word on the subject. On

Friday last I came here as a listener, but I was so delighted with the lecture which was read and illustrated by Mr. Scott Russell, that seeing so short a time was then left for that which is most important, the discussion on the lecture, I moved the adjournment. With reference to torpedoes, I think Mr. Scott Russell will admit that they are very dangerous implements of warfare, and that we must take great care that they do not run against our best ships, and we must take the best means of running them against our enemy's ships. He said he considered they were rather a scare, that is that it only required vigilance to get out of their way, but still they are (as is admitted by all) a most formidable means of destruction to the largest and best found vessels that ever sailed on the ocean; that being the case, I am afraid there will be found persons rash enough to take command of a torpedo ship if there is an object to accomplish. By your indulgence I will now also venture to mention a few topics which occur to me. The subject of gun-boats has been to myself a matter of very deep interest for many years. I recollect very well when Mr. Laird built some gun-boats for the Dutch Government, useful boats in shallow waters, boats that could not be approached, and could easily run out of shallow harbours, and boats that were a very great protection to the coast, probably much more so than those batteries which have not the power of locomotion—it always seemed to me that gun-boats were what we ought to have. I ventured then to consider that they were indispensable, or would become so, and still think so. Now we have heard from our able lecturer that he recommends gun-boats, and he recommends that there should be two guns, one at each end; and that there should be large vessels which should be speedier, should have stronger bows, be handier, and also capable of endurance. He has suggested to us that the more endurance a vessel has, in other words the more fuel she can carry, the longer she can last out, the more she can play with the enemy. With regard to the gun-boats he has made an excellent suggestion that we should have gun-boats in different parts of our colonies available for the protection of their coasts, and ready to assist the larger vessels when they go there. There is a curious fact which has happened, and which will be no doubt the subject of discussion in this institution, that although in the first instance the Russians were successful off Ibraila against the Turkish monitor on Saturday last, they made, it is stated in the newspapers, a similar attempt with six launches, and were not successful, by reason it is said of the advice given by Hobart Pasha in placing boats with chains round the monitors. I would draw your attention to one fact, that although the attack was repulsed, one vessel did, I understand, strike the monitor, but not in a vital part. It comes, therefore, to this, that it will require, in addition to the various onerous duties of the commander of a vessel, a further increased vigilance to encounter this secret foe—a foe the worst of all he can encounter. I know the heart of a British sailor exists in a British commander, that he would fight an enemy openly, he cares not whether he takes his ship against a fortification or against a ship double his size, but what he does fear is the torpedo, and, therefore, the subject of the torpedo, and the way to avoid them, is one of the most important questions of the day in connection with the subject matter of this lecture, "The development of our Modern War Fleet." We had a lecture lately from Mr. Donaldson on that subject, and I see also that the subject announced by this institution for the next Naval Prize Essay is one analogous to the present, viz. "Great Britain's Maritime Power, how best developed as regards—1st, fighting ships—2nd, protection of commerce—3rd, naval volunteers, or supplemental force—4th, colonial and home defence; the classes of armament, and description of the vessels needed, and the organisation required to secure a powerful and economic Imperial Naval Force." Having made these remarks, I hope that I shall have accomplished my object by a revival of this important discussion, though I am afraid you will consider I was rather rash in coming forward as I did in the presence of so many distinguished officers and men of science, but whom we now hope to hear.

Mr. JOHN A. WELCH (Naval Architect to the Colonial Department): I should be very glad to make an observation or two on the subject of gun-boats. It may not be uninteresting to this meeting to know what has been done by foreign navies with regard to the supplying themselves with heavy-armed gun-boats. I will first allude to two small twin-screw gun-boats that were built to a Chinese order in 1875. They were vessels, improvements on the steam-launch class which have been

in use in our navy, and to make them better sea-going boats they were constructed 87 feet long and 26 feet beam—253 tons O. M.—drawing 6 feet of water when fully loaded. They were armed each with a steel gun of 16 tons, 10-inch bore, and threw the same weight of projectile as we throw with our 18-ton gun. These little boats were tried under steam, and developed 200 indicated horse-power, attaining 8½ knots. They were remarkably handy, making their half-circle in less than a minute, which is remarkably good. Those boats were to be sent to China, but the guns were not sent in them. They had their carriages and slides and 300 rounds of ammunition, preferring to make up the weight which could be carried, with coal. They proceeded on their voyage under sail and steam, and, without stopping on the way, they arrived with great success at their destination, having been navigated by officers of our own service. These were the first small vessels of that type that had crossed the sea, or had made such a journey. The next class is a larger class of vessel, built to the order of the Argentine Government. Four of them were built in this country. They were 105 feet long, and 30 feet beam, 416 builder's tons, with a draught of water of 7 feet 6 inches when fully equipped. These were the first vessels built to take a 26½-ton gun. They were also tried under steam, and realised 9½ knots with 400 indicated horse-power, and also proved remarkably handy—that was their best feature. There was a stipulation that there should be so many rounds fired off from the heavy guns, and six rounds were fired at sea. The vessels stood the test remarkably well, not the least damage being done; a point on which some doubts had been entertained. They proceeded under sail and steam, and arrived at their destination, Buenos Ayres, having started from here in January, 1876. I mention that to show that small vessels, heavily armed, have been built for foreign governments, and have arrived safely in a foreign country, showing that they must, to some extent, have been sea boats, although not of the best type possible. But, taking the whole of the circumstances into mind, they were remarkable for their handiness, for the power of working and fighting heavy guns, retaining the original idea, I think, of making the vessel virtually the gun-carriage. The broader the boat was, the steadier she became, and altogether I consider they were a great success. I also wish to show what has been done in that respect since gun-boats were introduced into the navy of the steam-launch class ten years ago, and also the "Alpha," "Beta," "Gamma," and "Delta" gun-boats lately built for the Chinese Government that we have heard so much about since last January. I have had great pleasure in listening to the paper, and though it is almost presumptuous in me to offer any observations, still I think that in a great many respects we have fulfilled Mr. Scott Russell's ideas, although some of the ideas have yet to be fulfilled by a vessel, I believe, that has not yet been designed. Mr. Scott Russell stated that he would like to have a 15-inch naval gun 15 feet long. You will observe we have already fitted 10-inch guns and 11-inch guns in the small gun-boats I have described. He would then make those gun-boats strong in the bow, so as to be practically a bow of armour. With regard to that, special care was taken in the vessels for the Argentine Government. The gun was a disappearing gun, and of course it had to fire over a part cut away to allow the depression to be obtained. That was made of thick plate; and this expedient was adopted: that whereas the beams would have the edge strips under, as a usual rule, they had them on top, and of an extra width for increased strength. We doubled the beams under it, and between those beams and under them fitted a strong iron girder, so that should those vessels be used as rams they would give a good account of themselves. Mr. Scott Russell mentioned that there should be no means of adjusting these vessels except by the officer in command, who should be able to do so by the rudder alone. That point was also carried out. The officer in command could go under shelter. A covering house was built, fitted entirely for the purpose of manoeuvring the vessel, so that everything was done under cover.

MR. SCOTT RUSSELL: You mean the gun is manoeuvred by the rudder.

MR. WELSH: The gun itself is not touched; we manoeuvre the vessel in order to get the training, we make the vessel the gun-carriage generally. So that that suggestion has been carried out. Mr. Scott Russell also alluded to the one big bore gun in the bow, and said that the vessel must be handier than any boat in the service. I believe that advantage was also claimed for these vessels. Their handi-

ness was remarkable. On one occasion we had the Director of Naval Ordnance on board, and he expressed himself delighted in that respect. He took command, and said "I want to strike a certain object," and he saw in what way the vessel would be obedient to his will. I fully agree with Mr. Scott Russell that in some respects we have not paid as much attention to these gun-boats as we have to the larger ships. He alluded to a duplicate-gun gun-boat—so I understood it—that is with one gun in the bow and one in the stern, exactly the same size, and the boat to go as fast astern as ahead. Now, if Mr. Russell meant a paddle vessel, his paddles would be too much exposed to think of having a paddle-wheel vessel to do his service; and with regard to screws, it would be impossible to get screw vessels that would be able to go astern as fast as to go ahead; so that Mr. Scott Russell must have a new design in his mind in making that observation. I quite agree with him that two kinds of vessels are required for the Royal Navy. We want to have fast vessels to take up a position; and we want also handy vessels, so that with two classes of gun-boats we should be well suited in that respect for all the service that may be required of such vessels, and I hope and trust that out of this discussion that conclusion may be arrived at.

Admiral Sir SPENCER ROBINSON: I regret very much the absence of Mr. Reed,¹ as I should have liked extremely to have listened to any observations which he might have made on a subject which, I know, has occupied a great deal of his attention, and if he had been here and had been disposed to speak upon the matter, I should not have ventured to offer any remarks myself, notwithstanding the great interest I feel on the subject. I have always been in all these matters much more of a learner than a teacher, and I confess that from no one have I learnt more than I have from Mr. Scott Russell. I had the misfortune of not being able to be here when his paper was read, and I do not feel in any way qualified to criticise any of the remarks he has made. I should only wish, from the little knowledge I have, to supplement in a few words some of the observations which he made, as I feel perfectly certain that though I did not hear all that he said, the general tenor and substance of his remarks has been known to me for several years. He always has started with this one remarkable assertion or proposition, that, if what naval officers want to conduct a naval action, is known to the naval architect, the naval architect can invariably supply them therewith. In that proposition I need not say I must entirely agree, and it is especially with a view of explaining or throwing some little light upon the wants, as I consider them, of naval officers, in carrying out a naval action, and of what should constitute the navy of this country for carrying out a maritime war, that I venture to speak a few words. What I think, what I know Mr. Scott Russell thinks, and I have seldom heard any thoughtful man express any other opinion, is this: Great Britain, to carry on a maritime war, not only wants single ships, but she wants a fleet, and the construction of the fleet is the great object that the naval administration of this country ought to have in view, and this principle I hope that all those who wish well to their country, or can influence its naval administration in the right way, will take also into their most serious consideration. A single ship, however perfect, let it be the "Inflexible" or let it be the smallest gun-boat of the Alpha class, any single ship cannot in any way whatever represent the necessities of this country in naval warfare, nor can it represent the weapon which a naval officer on general service will have to use in destroying those ships of the enemy it may be his duty to destroy, or in making those attacks upon an enemy's fleets, fortresses, or positions, which it may be his duty to make. The country wants ships which shall in their various ways perform those services of assault and defence through which a naval warfare must be carried on. When I come to reflect upon how naval warfare is to be carried on by this country, I admit the subject is so large, the features are so enormous, and present so many sides and difficulties, that within the limited time allowed for any one of us to speak in this Institution, or indeed in any verbal discussion whatsoever, wherever it may take place, I think it would be utterly impossible to exhaust the subject, to suggest everything that should be suggested, and to meet all the arguments against such

¹ Mr. Reed, owing to a previous engagement, was unable to attend on the day fixed for the Adjourned Discussion.—*Ed.*

and such propositions, which would naturally occur to those who heard the subject, and whose minds were fixed solely or particularly on some of the necessary points of naval warfare. But we should all agree in this, that a fleet is, in fact, what we want; that a fleet must be composed of ships of various classes; that no single ship alone will be adopted for naval warfare under the circumstances of the development of science, and the means of destruction that now exist, and that every ship must act in combination with other ships; she must be the unit round which other ships congregate, and when we have got the ship and her satellites in attendance upon her, of the right size, sort, and stamp, then we have got the one unit of force capable of doing its duty in what may be called single action. But I think if you cannot admit so much as that, you must at least admit this, you must say that the whole fleet of Great Britain must be so constructed, that each unit of its force shall be composed of ships of various classes, attended by others, larger or smaller, as the case may be, and that the concentration of these ships and their attendant satellites will alone constitute a fleet calculated to destroy anything that may come upon the surface of the sea. It must be remembered that the whole object of naval war for Great Britain is not, for instance, to go to anchor in a river or a bay and there remain, exposed to the attack of torpedoes and of electric mines, and various other destructive agencies, though that is one portion of the duty the British fleet may have to perform, and we know the means employed for destruction in the case of a ship at anchor are extremely formidable, and can only be met by an equally formidable use of the same sort of attacking force as the ship is exposed to. No one can doubt, for one single moment, that when large ships are compelled to anchor in roadsteads, or rivers, or narrow waters, they must be attended by vessels of the *Thorncroft* type, we will say, or of any type that will bar the advance of the insidious torpedo, whether of the *Whitehead* or ordinary type, or any other engine of destruction that acts at a distance over or under water, and be ready to destroy them; while the large ship will be there to protect and co-operate with her satellites to overcome the serious opposition of batteries and heavily armed ships, to aid in a landing, or to prevent the assemblage of troops, destined, perhaps, to threaten our various possessions. I said it was impossible to discuss how naval warfare should be carried on within the limits of any speech that any man could make, or even within the limits of a very long lecture, and I have experienced gratefully the patience and temper with which this audience will always listen to remarks upon the subject, but I have some sort of conscience, and I cannot for one moment think of inflicting upon this distinguished audience the very many important remarks that occur to me, as to the way in which this naval warfare must be carried on. I have only indicated, in support of the very able lecture Mr. Scott Russell has given us, how necessary for our purpose it is that we should have not single ships, nor ironclads, nor gun-boats only, nor unarmed ships only, but that we want a thorough and comprehensive navy or fleet; but as to the parts of that navy and the details of the ship composing it, I really would not trouble this meeting with saying what they should be. As a general scheme there must, no doubt, be large and small ships, swift and heavily armed vessels must act in combination with others of different types, to secure the due execution of such services as are vital to our interests as a nation. I certainly cannot overlook this fact. Supposing this country is engaged in a naval warfare, and expeditions are about to leave foreign parts which I will not mention. I will not say anything which could be construed into an offensive remark with regard to any foreign power, but we will suppose that it suited some naval power to make an attack upon any of our dependencies; that attack must be frustrated, and can be only frustrated by having ships that can be at sea, remain in the track of those ships that may be entrusted with that expedition, and through the power of our gun, the weight of our armour ships, the speed and coal-carrying power of these large monsters which are so expensive, and which may be destroyed easily, our fleet must have the power to remain in those seas where you may want to fight, where the very existence of this country may have to be decided, and where we may find it necessary, in certain latitudes and longitudes, to repeat, with different weapons, indeed, but with the same results, the glorious actions of the past. For this purpose, your big ships, heavily armoured ships, swift ships, ships of great coal-carrying power, are as much or more wanted than your

gun-boats or torpedo vessels. It is therefore only the simplest idea of not throwing all your eggs into one basket that makes me say: Stand by a fleet, and do not be satisfied with single ships, however perfect. Let that fleet be the point to which you will gather up all your strength to fight that battle which will decide, perhaps, national existence; but for a thousand other purposes you will want all the small vessels, all the swift launches, everything that has been described. It has been sometimes said that the whole navy of Great Britain ought to consist of gun-boats, or torpedo boats, or things of that kind. I am sure this meeting are much too intelligent to approve of such a course, but I have often, in the course of my official life, found that things, reiterated and stated again and again in the columns of a newspaper, weigh upon the minds of those who have to decide how the navy shall be constituted, and how naval warfare ought to be carried on. I say it is absolutely indispensable for this country not to be led away by the false theories that are continually put before it, but to maintain a fleet composed of large and small ships, powerful and swift ships, and others whose whole power and object should be simply to make a dash with a mine to explode it under the bow or stern of a ship. I do not know whether I have correctly followed what Mr. Scott Russell has said, but as I said before, I have so often heard him urge this point with intelligence, argument, and wit, that I do not think I can have mistaken him. I conceive it is sound in principle, and without in the least pledging myself, or any body who has to act in this matter, to the details Mr. Scott Russell thinks it necessary to establish, in order to obtain what both of us aim at—a powerful fleet, I am certain I am not running counter to what your lecturer has said to you, but am rather supporting his views, and also that those views are sound, and will recommend themselves to the sentiments and to the opinions of all who have done me the honour of listening to me on this occasion.

MR. STIRLING LACON: This being a scientific meeting, I wish to put myself in order by stating that six years ago, while sitting next to the Chairman, I whispered in the ear of Sir George Sartorius that science had got command of the ship, and that practice and common sense were driven before the mast. I know little of science, but I wish to illustrate, by what has come under my own observation, what it is that I meant by science running ahead of and taking the precedence of practice. When I was in the Baltic I twice passed through the Russian fleet of thirty-three pennants (great and small), which were about to be reviewed by the Emperor on the same day, whom we afterwards met in his magnificent yacht coming from Cronstadt.

When we were three miles from the fleet we were overtaken by a first-class frigate steaming at full speed, with her anchor still hanging from the bows, not fished, not catted, and I ask what would have been thought of this in the old days of pure seamanship? The North German officers, with whom I had a good deal of conversation, appreciated this fact, as I trust it will be appreciated by our own naval men.

Captain R. A. E. SCOTT, R.N.: Mr. Scott Russell's very admirable paper has more distinctly brought before us than has yet been done, the necessity for a large ocean fleet; a fleet which will maintain our empire on the sea, will keep our commercial ships free from the attack of the enemy, and whose duty will of course be to destroy that enemy. Without her commerce, England would be entirely crippled; her commerce is in fact her legs and her body, and it is for the protection of that commerce that we must have a powerful fleet. I think Mr. Scott Russell has done well in separating the ocean fleet from the inshore flotilla for the protection of our own coasts and for those of our colonies; every day the distinction between these two fleets is becoming more decided, and every change which is now taking place is tending greatly to our advantage. With respect to our iron-clads and large cruisers; it would be a very great mistake to place such valuable ships under batteries, for there is almost a certainty that they would be blown up; as their thin decks would be very soon driven in by the plunging fire of large guns. I think this would be a contest in which there would be very little honour to be reaped, in return for the very great deal of danger incurred; in fact more than one vessel might thus be lost without producing any result. Some of you, I daresay, remember the attack made by our wooden war ships on the forts of Sebastopol. It was very good

perhaps as showing what our sailors were ready to do, but what was the result? Our vessels could really do nothing then, but in the present day, against batteries armed with powerful shell guns, our vessels would have no chance of success. England, as regards torpedoes, has really pushed forward the invention of the fish torpedo more than any other power, and in the use of gun cotton she has found the means of protecting her vast shores with certainty. Happily there are on our own coasts a number of intrepid sailors always at hand, and quite capable of handling these dangerous weapons. To do so with success, requires the skill, dash, and coolness, which are the very characteristics of our race, or, at any rate, they were the characteristics of the old Norse kings from whom we are in part at least descended. We have therefore developed the very weapons that could be employed with the greatest advantage, and would fully bring out all the skill and pluck of our fishermen, sailors, and coast population. These men, armed with a few torpedoes, would very soon be enabled to give a good account of any vessels that might approach near enough to bombard our shores. A successful attack would be practically impossible were our very large flotilla of tugs and river steamers capable of acting as rams, torpedoed, or gun vessels, to be organised. Now that organisation does not exist, and the only thing that does exist for our defence is the coast artillery brigade, which is not in connection with the coastguard crews and their stations, or with the Coast Volunteers; nor are there any telegraphic communications between the coastguard stations, or with head-quarters. If the enemy were on the coast to-morrow I do not know whose duty it would be to keep him from landing. It would doubtless be somebody's duty to fight him after he had landed; to but in the organisation for keeping the enemy off our shores we really seem have made no progress. A remark has been made about the discussions in this Institution getting abroad, and other nations becoming aware of our defects. In reply I would say that they know them far better than we ourselves do, for we take the greatest possible care to show all novelties in our dockyards and arsenals to foreigners, thus enabling them to compare these improvements with their own. If I wanted to know the defects of England's vessels I should go on board a German, or some other foreign vessel, to ascertain them by comparison. I will give an illustration of my meaning. Looking over a German vessel at Portsmouth, in company with her commander, I went into the question of her armament and its preservation from deterioration, a subject in which her men as well as officers took the greatest interest. I asked the commander how he managed to keep his gun gear in such capital order, and in reply he said that he cleaned his gun deck with warm water and was careful to keep it dry and to see if the working gear underneath the guns was in good order, and I found no rust whatever upon them. I could not but contrast this with what I saw on board our own war ships—where the men were scrubbing away with sand and water, covering the gun carriages with these and destroying the gear of the slides; in addition to which there were men polishing their cutlasses with brickdust, to the detriment of the gun carriages and gear upon which the cutlass points were rested. Another instance of our backwardness was given to some of us who had the pleasure of listening to Mr. Donald Currie's admirable lecture when he showed that there were no telegraph lines to the Cape; and said, it was not dispatch boats that we wanted, but rather a telegraph, which could send information a great deal quicker. He showed also that although we had some very large iron-clads, still if they got disabled at long distances from England there were no means of docking and repairing them. This serious defect has since Mr. D. Currie's statement here, received much attention. I dare say some of you remember that more than a year since a Government official said in this Institution that the merchant navy was of no use for purposes of warfare—an opinion which being dissented from was afterwards very much qualified. Subsequently we heard that the buying up of the fastest steamers of our merchant fleet would at once enable every port of an enemy to be effectually closed. That was however going to the opposite extreme. But the wise course is, take the merchant navy as it now exists, and for new ships, to use every effort to obtain additional strengthening bulkheads, and those water-tight divisions that many of us think are as valuable in merchantmen as they are essential in war ships. Mr. Scott Russell, in asking for discussion upon his proposed cellular construction, may

say, if naval men will only point out what is required, that then it is sure to be carried out; but I reply, naval men have continued to insist that the first point to be considered in a ship is unsinkability, and consequently her bottom must be divided into numerous cellular spaces. The torpedo has done much to effect this result, but as you already know, the "fish" is a dangerous weapon to those who use it, however skillfully it may be handled. The fish torpedo will run about 250 yards at 25 knots, but if required to run a longer distance, it must go at a much slower rate. It is propelled through the water by double compensating engines, worked by highly compressed air, and though the lecturer does not consider it a very formidable weapon for ocean warfare, it will run about a thousand yards at a slow speed. At the end of seven or eight hundred yards, however, it commences to diverge from a direct line. I think there is a source of danger in the way in which those torpedoes are (as I am informed) straightened when they are a little out of truth, as there is a tendency in metal to return, after a time, to its original shape. I think, therefore, it will be found that torpedoes which do not go accurately when first tried in the canal, and have to be straightened, will, after being some time on board ship, resume their original curved running on being discharged.

Besides the fish torpedo, there is the spar torpedo, which from its simplicity and the large charge it can carry, is a very valuable weapon for general use.

Our merchant shipping carry at the present time some capital life boats, and any of these, or the lighter gigs, could take one of these spar torpedoes, and if the fellows had coolness and pluck, and their ships fired off a little powder to mask the direction in which they were going, there is no doubt that the boat might dash in and, as a rule, give a very good account of their enemy. As bearing on this point, I may tell you of an attack upon the "Excellent" just as it was told me. Captain Singer was in command of the party on board, and one of the gunnery officers, the commander, I think, of the "Vernon," was leading the attacking party, using the spar torpedo. The crew on board watched and waited, keeping the strictest look out, having boats patrolling all round their ship; these boats pulled backwards and forwards and continually spoke each other. The wind was from the "Excellent." The skilful officer in command of the attacking party looked out for his opportunity, and after a time got to know exactly when the patrolling boats neared each other, and then, seizing his opportunity, he dashed forward, ran his boat past the patrols and struck the "Excellent" fairly before any of the defending party could cut him off. In this case there was the gunnery ship herself watched in every way, and yet with her skilled crew and all her appliances she could not prevent the spar torpedo from being run against her. If a vessel so ready could not prevent this, what fate might be anticipated for the ironclad that foolishly ventured close to a guarded shore or came near an enemy's port? We must, in my opinion, no longer think of taking ironclads into narrow waters; the time for this, I think, has altogether passed.

There is another weapon which I believe there will be an opportunity in this theatre of your shortly hearing something about, namely, the rocket. I will only say that this rocket can be made to go under water, carrying at least as large a charge as that of the fish torpedo, over which it would have the advantage in cost and in simplicity, and it can be easily carried in any vessel with comparative safety. Before addressing myself to the details of Mr. Scott Russell's plans, I wish to add that I have known a great many good effects to result from our discussions here. I do not quite like to mention the instances, although some have resulted in valuable modifications of various ships and their armaments. I venture to recall to your mind that the Duke of Somerset and others of our highest officials have spoken very strongly of the value of this Institution, as affording a means of examining and discussing important inventions, &c., and thus enabling our Statesmen to make use of the information for the public benefit. This benefit was apparent in the case of the guns with which we were going to arm our navy some years since; I allude to the breech-loading guns. There was a lecture given here, followed by a discussion, the Duke of Somerset being in the chair. It was said by those who supported the breech-loader, that all the navy wanted in addition to the breech-loader was a gun or two that would penetrate armour plates. If you turn back to the discussion on the subject, you will find that it was strongly urged that the Armament of the Navy should mainly consist of guns

more powerful than the breech-loaders, and a short time afterwards the 100-pounder smooth bore guns were adopted, and subsequently heavy rifled guns, muzzle loading; and to the Duke of Somerset we are greatly indebted for the improved iron gun carriages now on board our vessels, carriages which have been, I believe, copied by all other nations. A great deal has been said about the superiority of our guns. Now in China the other day, as I was told, the French admiral said to the English admiral, "You think your guns are better than mine, come to sea with me for a couple of days." Our admiral replied that he would go with pleasure if he might take his gunnery lieutenant. This being agreed to, he was on the French ship during her two days' firing and exercising. The guns were fired at from two to four thousand yards with the greatest accuracy; and I suspect that on his return our admiral made rather a strong report on this subject. As the costly armour of our ironclads is put on to withstand an enemy's guns, we on our side ought to have the very best weapons we can get, so as to destroy his armour and sink him as soon as possible. With regard to the 36-ton gun which Scott Russell advocates, we have heard that a number of gun-boats have been built lately, each to carry three 64-pounders. I do not know what stations those gun-boats are intended for, but the Chinese have the "Alpha," "Beta," "Gamma," "Delta," armed with 38-ton guns, and therefore capable of opposing any ironclads that might come to attack their ports. How we are with our lightly-armed gun-boats to beat off heavy war ships, I cannot quite see. With respect to Mr. Scott Russell's mode of mounting his standard 36-ton gun and making the vessel the means of pointing it, I feel quite sure he makes a great mistake. I have tried to point guns by means of the helm, but always found that just as the man was going to fire, the ship gave either a slight roll or lurch, or else a swing, and disturbed the aim. To point and fire a gun fixed in the bow, she must keep advancing, otherwise she cannot fire. To remedy this defect in part our 18-ton gun-boats are arranged to give their guns 25 degrees of training on each bow, but that is not enough, because the gun-boat can only fire when it is approaching an enemy. What you should do is to make any new gun-boats a little larger, so as to admit of their heavy ordnance being given a wide arc of training, using appliances as simple as possible. I quite concur with what Mr. Scott Russell says as to simplicity, and I think I can illustrate its value and show that I have not been wrong in asserting that all our guns ought to be worked on one uniform system and by the simplest machinery. We can work guns up to fifty tons weight by hand appliances, but I do not think we can go beyond that with advantage; in fact I think properly rifled 40-ton guns would be fully equal to doing our naval work. The 38-ton ship guns are now being worked by hydraulic machinery alone; although there certainly has been some attempt to work them also by hand. In the "Thunderer's" after-turret there are two 35-ton guns mounted and worked on the hand-machinery principle, which would never have been carried out but for the support of the former Controller of the Navy. In the foremost turret are two 38-ton guns, but if anything happens to their machinery the crew would have to get outside the turret to load. How the different operations are to be efficiently performed in action, should the hydraulic machinery get out of order, I cannot tell. You may however say that the hydraulic machinery will not get out of order; possibly not. There was a great hurry a little more than a fortnight since to get the 80-ton gun to Shoeburyness. There it lay on the Arsenal wharf, and there was the magnificent 100-ton hydraulic crane ready to lift it, but unfortunately the crane would not move. With all the talent of the Arsenal, for four days nobody could discover what was the matter, so the gun lay a fortnight before it was lifted from the wharf into the barge alongside. That little incident shows how dangerous it is to trust mainly to gear in which the failure of a valve will at once place the gun *hors de combat*.

Mr. Scott Russell says he wishes to have everything as simple as possible, yet that he will muzzle-pivot his proposed 36-ton gun. To muzzle-pivot you have to lift the whole weight of the gun by the breech. Has Mr. Scott Russell considered the enormous power that is needed to lift continuously and rapidly through small spaces a 36-ton gun; does he know that it would take a height of 14 feet to give the usual elevation and depression with the 36-ton gun, and if the slightest thing goes wrong with this elevating gear he could not use his gun at all; but supposing the gun to

get a heavy shot in the muzzle, then in all probability the concussion would break the lifting gear, and the breech of the gun would fall down. Mr. Scott Russell says that he would make the ship the gun carriage, and would keep broadside guns pointed abeam; but just as the enemy was passing abeam, there might be no opportunity to fire, either your friend might be in the way, or your own vessel might sheer off a little and disturb the aim. You would not have nearly enough training in these narrow casemates. You would also lose the opportunity of firing to the best advantage in a sea way. If you can train your gun so as to be able to point forward or aft, you would be enabled to place your ship so as to be tolerably steady instead of having to fight when rolling heavily in the trough of the sea. Mr. Scott Russell appears to have some doubt on this point; but how does Mr. Scott Russell propose to arm his cruisers? He intends to have a bulkhead forward and another bulkhead aft, so that the crew would have no protection abeam. I think even on his own showing this arrangement is wrong. Mr. Scott Russell speaks also of having lighter guns to fire only ahead. I think, as a general rule, that a ship advancing to ram would not fire; the time she would fire her guns would be after having attempted to ram, perhaps while rubbing along the side of her enemy. I doubt very much the value of letting off broadside guns by electricity, for I think you are very likely to fire all your broadside guns at the wrong moment. I have conversed with a great many practical men on this subject, and I have considered the question carefully myself, and so far as I can gather, when good practice is made is, when a good captain of a gun is looking along one of the centre guns; but when the captain of the ship placed above the battery gives the signal, he is very likely to mistake the time of the ship's rolling, and to miss with every one of his guns. With respect to Mr. Scott Russell's mode of plating, some of you who have watched the recent experiments at Shoeburyness have long known that our cast-iron projectiles generally crack, or break up on impact. Recent experiment has shown to what this is due; when the shot is cast in sand, the head is cast in an iron mould and chilled, consequently its particles are in a very strained condition. Hence, recently, in passing through a 4-inch plate, the projectile broke up; falling against a 10-inch plate it failed to penetrate. This projectile would, under ordinary circumstances, have penetrated not only a 4-inch plate, but a second, third, and fourth 4-inch plate if teak had been interposed between the plates, because the wood would have absorbed the vibration, and placed the shot in a condition to penetrate the next plate. There seems no doubt that the shot are destroyed by vibratory reaction from blows, and Captain Grenfell recently brought to notice the fact that when steel plates were fired at at Spezzia they did not crack at first, but a singing noise was heard, and soon afterwards the plates cracked from the vibration. The hardness of the steel seemed at once to stop the projectile, and the tremendous blow broke it up entirely. There is a very valuable principle shewn by this experiment, viz., that if we have a strong plate, say four or even two inches thick, it will crack the cast shot, and then if we add an inner plate of eight inches thick, and place it at four or five feet on the inside, it will stop the shot altogether; and with this distance between the inner and outer armour plate, you might have a torpedo striking the outer part, and exploding upwards between the plates, and do no more injury. That is one possibility of using armour in the future; and it seems to me that if we cannot do something towards the improvement of the system of putting on armour, we should not go on building large ironclads which are so difficult to keep at sea, and so excessively costly in their repair.

Captain GARDINER, R.N.: I should like to ask Mr. Scott Russell if he will kindly tell us how he proposes to give light and ventilation to his casemates.

Captain J. C. R. COLOMB, R.M.A.: I wish to make a few short remarks. With regard to the casemates, I presume, though each of them has a magazine belonging to the gun, below, they are not sufficiently strong to resist an explosion of that magazine. There is no doubt about the casemate principle, but it is a matter of detail that in multiplying the number of your magazines you multiply your danger, and render necessary an increase of your complement by as many magazine crews as you have got guns. Mr. Scott Russell laid down four qualifications as necessary to win—speedier, handier, stronger bowed, and more gun power. I would really like to suggest that there is possibly one other point, and that is a—*protected pro-*

peller. I say that because it is a very serious thing that the fate of a ship having so many valuable lives in it, and costing £500,000 or £600,000, should all hang upon a propeller, and might, as we know, be brought up by very small and insignificant means. My attention was directed to this some five years ago in a small steam yacht of my own, when fishing on the West Coast of Ireland, I found one night, through a bad look-out, while steaming about ten miles an hour, I was suddenly brought up short. We could not make out what it was, but in a very few minutes I ascertained that I was brought up by an old net having got entangled in the propeller, a net so rotten that if you held it in your hand it would fall to pieces. I laid that fact before the Torpedo Committee, and Lord Otho Fitzgerald, in a discussion which took place here on Mr. Thornycroft's paper, alluded to the fact that the smallest rope-yarns or nets would paralyse the action of your propeller. In order to support my suggestion to Mr. Scott Russell, that the protection of the screw is a vital question, I have given a good instance connected with peace, and now here is another that was mentioned in this Institution by Sir William Hall, in the discussion that took place on Mr. Donald Currie's paper. "The 'Victor' on the West Coast of Africa was towing a collier when the screw was fouled by the hawser; they could not clear it, and with the assistance of "the 'Bristol' it took 18 days to clear the screw, and they drowned a diver in "doing it." So much for peace experience. I will now take one more of war experience. We have heard a great deal about the lessons to be learnt from the German war, and we have heard of the military arrangements which produced the fall of Paris, and we fly away with details, and I think are a little apt, as Sir Spencer Robinson pointed out, to forget general principles. There was a small naval occurrence that happened during that German war, nowhere near the Coast of Europe at all. It was an action fought between a German and French gun-boat off Cuba. The French gun-boat, the "Bouvet," was furnished with everything that Mr. Scott Russell lays down. That is, compared with its antagonist the "Meteor," it was speedier, handier, and had nine guns to the "Meteor's" three. How the action was brought about is very instructive, and I have not seen it mentioned in our country except by one magazine. It took place just outside the neutral waters of Cuba, and it occurred in this way. Perhaps Mr. Scott Russell had this case in his mind when he drew our attention to what was likely to happen in regard to naval actions. About 1 p.m. the "Meteor" observed the "Bouvet" coming down as hard as she could steam, and fire was opened at 2,200 yards. The "Bouvet" intended to ram the "Meteor," and the "Meteor" intended to ram the "Bouvet," and what happened was this. The "Bouvet" struck the "Meteor" a little to the port-side, and for a few minutes the two ships, as described by a German writer, were locked in a short embrace. In that position the "Bouvet" fired her broadside guns into the "Meteor," and I may mention the "Meteor's" portside was stove in, and that her foreyard was carried away, her mainmast sprung and her mizenmast went by the board. They were in this short embrace for a space of time not long enough to board, and passed each other. The "Bouvet" tried to turn, but the "Meteor" managed to bring her guns to bear before she did completely turn, and with one of her guns she planted a shell in the boiler of the "Bouvet" which immediately put that vessel out of action, and there she was at the mercy of the smaller vessel. Just, however, as the smaller vessel was going to take advantage of her crippled antagonist, her own screw fouled, and she too was utterly powerless and helpless. Now that action lasted over two hours: it was just over neutrality bounds, and the result of the two hours' fight was to place both vessels *hors de combat*. The lesson to be learnt from that I think is this, that had the "Meteor" possessed a protected screw propeller, she most certainly would have taken the "Bouvet" or sunk her, though she had three times her gun power, with greater speed and a larger screw, and therefore I venture to suggest to Mr. Scott Russell that the propeller is a question worthy of being most seriously considered. With regard to the general question, Sir Spencer Robinson has rendered it quite unnecessary to repeat all the remarks I was going to make, but I think the question of ships cannot be settled simply and entirely as a question between naval officers and naval constructors. I say so with all deference, and for this reason, that I think that the imperial interests that arise from our geographical position, the strategic arrangements of a gigantic empire like ours,

directly influence the whole question, and that it can only be approached first of all as a principle, as to what you expect of your navy, and what you require your navy to do. Once you have that settled distinctly by the country, and by the House of Commons, I am quite sure your naval constructors can certainly give the empire the ships, and the implements that the naval officers require in order to do, not what the country wants at the minute, but what our imperial position requires that we should do. The fact is, it appears to me, that the country is grossly ignorant of our imperial naval requirements, and catches at any straw to escape from deciding what our navy will have to do in war. I think, when the ordinary British public talks about any one of the magnificent ships, it imagines it should be equal to each and all of these duties; that it should be able to attack any fort; that it should be capable of ramming any iron-clad; that it should be able to skirmish along a water line 15,000 miles long; that it should be equal to keeping station off a neutral coaling port for months; that it should be capable of keeping stations at the crossings of the Equator for months; that it should be capable of defending locally, Singapore, St. George's Sound, &c., &c., and the Colonies of Great Britain, which are sixty times her size; that the same ship must be equally capable of blockading the Amour, or blockading the King of Dahomey, or of keeping station 3,000 miles from its coaling stores. That is the British public's ordinary idea of a ship; and then it must, besides all this, be capable of defying torpedoes in the Danube, or at the mouths of the Nile; I mention this because I do not think that naval officers and constructors are having a fair chance. I do not think that our country, great as it is, at all understands what are our imperial necessities with regard to our navy. The misfortune is this, that though we are a great, and we must always be a great naval power, we think more of the army than of the navy. We shall not have the lessons of experience reaped by others in a great naval war. No great naval war can take place without our being in it. The wars that have recently taken place have been purely military, the whole mind of this country is becoming purely military, and I do think this is a danger, because all our practical experience is gained from military warfare. But when a great war comes this country must sink or swim according to the way in which she is prepared—not as a military nation, but as a great naval power—to meet it.

Rear-Admiral Sir JOHN COMMERELL: You have heard what Captain Colomb has said the nation will require us to do. All I can say is this, whatever the nation may justly require us to do we shall endeavour to do to the best of our ability. With regard to the vessel proposed by Mr. Scott Russell, there is one question I should like to ask him, and that is, if he proposes the guns to pivot entirely in the port, or whether he intends us to have a certain space in the port to enable us, when we are not engaging the enemy at close quarters, to see what we are about; it appears to me that the port that he has described in the casemate will leave us almost in a state of total darkness, and I do not think the men inside would see what they were doing. I believe in action the great point is that every officer and every man in the ship shall know pretty well when he will be called upon for work, and what work he will have to do. As to the gunboats themselves being carriages for the guns, I am afraid that would not answer. In advancing up rivers you would have no doubt to engage an enemy on the banks, and at any attempt to turn to port or starboard, the current would catch the bow, and the chances are, would take you on shore. At the same time I would infinitely sooner see the size of the gun sacrificed to a certain extent if we had a good gun carriage, so that the gun should have a fair angle of training. I cannot understand myself another point mentioned by Mr. Scott Russell, and that is that in his gun-boats he would have a stern fire as well as a bow fire. It appears to me that if both these guns are to be without carriages, simply pointing right ahead and astern, when you are advancing against your enemy, you would always have one half of your armament out of use, and if you were retreating you would have the other half of your armament the same. I should like to get an answer to these questions.

Commander W. DAWSON, R.N.: The meeting will, I think, separate with some disappointment. We came here on purpose to hear naval architects discuss some very important points of naval architecture, and unfortunately we have not been gratified. There were some points that I should have liked to have heard discussed

with reference to the shape of the proposed midship section, whether it is to be a V, a U, or an O? and as to the length of the ship, whether it is essential to go back to extreme length for a good fighting vessel? I am not going into these questions, for I want to direct attention to the offensive powers of ships. The purposes for which ships of war are built, are to damage and destroy by any means hostile vessels and fortresses rather than themselves to merely passively keep out destructive projectiles. Unfortunately the various offensive powers of ships have not received the same attention as their defensive resistances. Mr. Scott Russell, in wishing to avoid the torpedo "scare," has perhaps gone a little too far in overlooking the important auxiliary part the torpedo will play, offensively and defensively, in general actions. If Captain Bridge was present to-day, I would say to him that if the enemy had on either quarter two Harvey towing torpedoes, four or five Whitehead torpedoes on each broadside, one or two spar-torpedoes on each bow, and if the hostile ironclad was so armed in addition to her guns and to her ram, and met another ironclad similarly prepared for action, the ram would probably not be brought into action at all, and the battle would be decided by artillery or torpedoes. Then with regard to the ram, there is a very wholesome respect for the ram in the form now used in the British navy. It has had the honour of sending one of Her Majesty's ships to the bottom, and has nearly sent several others to the same destination! The highly effective character of the ram as at present shaped will account for what Mr. Scott Russell saw at Portsmouth, namely a sheathe to protect British ships from destruction by British rams. But there is one point with reference to rams, on which I have a strong opinion that we are going on a wrong tack. If only one third of the ships of the British navy are to be furnished with rams, which third ought it to be? My impression is that it ought to be the smaller vessels. Pit a short gun-boat like the "Ready" against a long ship like the "Northumberland," and let both stop firing and try ramming. Which of the two vessels would be more likely to ram the other? Why the short "Ready" gun-boat ought to sink the long "Northumberland," being much the handiest vessel. If that be so, then, in my judgment, all the small ships of the navy should be armed with rams. I see, with some little regret, a very great friend of the navy, a very celebrated yachtsman, advocating our fitting out gun-less rams. My experience of exceptional vessels is that they are sure to be in the wrong place at the right time. Gunless rams will be sent up the Baltic to attack a fleet, and instead of ships they will have stone walls to attack, what then will be the use of these gunless rams? What again would be the use of gunless rams when attacked by gunboats who shelter themselves from such attacks in shallow water? What would be the use of gunless rams in attacking vessels protected by torpedoes? What superiority would a gunless ram have when contending against a fully gunned ram? I was surprised that so intelligent a friend of the navy, an artilleryist too, should have given way to the torpedo scare, so far as to have been frightened out of his guns. All these arms are necessary, and artillery most of all. Mr. Scott Russell has drawn attention to the offensive armaments being exceedingly weak in proportion to the size of our ships. We have ships of some 9,000 tons displacement, carrying only 140 tons of ordnance. Is that floatation necessary? We have a ship of 11,000 tons displacement, carrying only 320 tons of ordnance. Is that floatation necessary? Would not such a ship be more fitted to fight an enemy if she could substitute for some two or three hundred tons of defensive armour that weight of offensive ordnance? Mr. Scott Russell has also drawn attention to the advantage of our going back to the good old custom when every ship in the navy carried guns of very much the same type, capable of penetrating not only vessels of her own size, but the sides of any enemy, however large the hostile vessel might be. We have had, in the last week, an illustration of what I two or three times pointed out in this theatre as a possible occurrence. We have had a British ship—one of the most splendid frigates in existence—and a splendid corvette, sent out to the other end of the world to protect British interests. These two British frigates have fought, not sister ships as they were designed to fight, but a wretched little Peruvian vessel of about one fourth their size, and armed with guns, I venture to say, about one-seventh the weight of those used by the two British ships. What is the consequence? Do the British ships knock the wretched little Peruvian gun-boat into lucifer matches? No, they do nothing of the kind,

and, as I have often pointed out in this theatre, they could not do it, for the simple reason that they have been sent to the other end of the world furnished with guns which cannot perforate the armoured sides of the little Peruvian. British corvettes and frigates are almost inoffensive when called upon to attack armoured gun-boats like the "Huascar." I do not think that British corvettes, sloops, or frigates, ought to be without armour-piercing guns; and without rams, so as to be placed in such a position that any wretched little ironclad shall be able to stand up against their sterns. The guns of wooden ships are not only too small, but we deliberately selected for the British navy that gun which we were officially told gives *decidedly the lowest velocity*, and therefore the weakest blows. Mr. Chairman, I congratulate you, who so kindly came forward on one occasion when occupying a very prominent position to countenance me when I brought the weaknesses of British rifling before the naval public, and I congratulate the Royal United Service Institution, that happily that system of low velocity rifling is now a thing of the past. We shall no longer be able to say of British guns that they give the weakest blows, and fire the weakest shells, and are of small endurance. Whether the system of rifling which has replaced the French stud rifling is the proper system, is another question; but it is a matter of very great congratulation to this Institution, after the discussions we have had in this theatre, that at last the British authorities see the necessity of British guns being able to fire such projectiles as will do the greatest amount of destruction to the enemy, and the least amount of destruction to their own guns; and that will perforate the enemy's ship. Those are the points in the offensive values of ships of war to which I venture to call attention. Our time is short, and had we not been disappointed of our naval architect friends taking part in the discussion, I should not have ventured to have placed these thoughts before you.

Mr. THOMAS MOX, Assoc. I.N.A. *First.* I would epitomise the work of the last eighteen years in the Royal Navy in the words, "Down to the water's edge"—and—"Back again," and I congratulate Mr. Scott Russell for having given the final touch in bringing us back to a wholesome amount of freeboard, and, I think, the sooner those "low flat things" are improved off the face of the water the better.

Secondly. I think that Mr. Scott Russell is quite right in choosing what I would call the *chisel* form of stem for ramming. We engineers always prefer the chisel if we are going to cut into anything, and it is a far better form than the weak under-water ram now used.

Thirdly. I would suggest that this form of ram should be placed at both ends of the ship.

Fourthly. This country possesses a great source of "strength" and of "weakness." Our "strength" consists in the immense amount of inventive talent which we possess. Our weakness consists in the persistent neglect of that inventive talent by every Government which we have.

Mr. SCOTT RUSSEL: I almost feel that my work has been done by the many able men who have given this Institution and myself the great benefit of their opinion on the different points which I raised, far more for the purpose of getting their opinions than of giving out any opinions of my own. Nevertheless I was quite willing to commit myself to some definite statement or other, otherwise I do not think I could have got you to come out as you have done, and give me such precise statements; some, I thank you very much, helping me in the points in which I am strong, and others helping me equally by showing me the points in which I was weak; I am therefore equally grateful both to those of you who strengthen me by strengthening my right opinions, and to those of you who strengthen me by showing the weakness of my wrong opinions.

Now the Chairman was kind enough at the outset to say a word on the subject of the ventilation of the casemates and elevation of the gun. The strength of the casemates was also alluded to by Lord Dunsany. On the point of ventilation of casemates and the lighting of casemates, which was raised later in the debate, allow me to say that that is a serious point to which I have given very serious consideration. If you will allow me, I will not ask you to enter upon any particular plan of mine for ventilating the casemates, but I will simply venture to say this to you, that when we get together for the purpose of doing this, I have no doubt we shall find excellent

ways of doing it. I have already quite matured a method of doing it, and unless we had thoroughly matured a method of doing it, I would not have recommended it to you. But I do not want you to approve of any of my methods. I only want you to say this with confidence, "We will have these casemates properly lighted, and we will have them properly ventilated, and we will have them done in the best way we can discover of doing them; and if Mr. Scott Russell's way happens to be better than other people's, we will take his, and if it is not, we take the other people's." I think that is a much better position for me to take with you than for me to say that "I have a beautiful plan of ventilation—better than anybody else in the world, and if you will only listen to me and my plan of ventilation we shall be all right." I won't say that; but I think I may say to you, that if I had not thoroughly found out how I could with perfect certainty, simplicity, and safety, in the middle of a battle, secure a complete ventilation and lighting of those casemates, I should never have come here and proposed their existence.

Next as to the elevation of the guns, lifting the centre of the gun, and as to all those difficulties, I entirely agree with you that all the difficulties were there, and when I came here I had got over them all, but I said, It will never do in this short lecture to go into every one of them. I said to myself, "I shall find Captain Scott there, and they all know that Captain Scott can make a gun do anything he likes: and we have only to say to Captain Scott, 'Now, Captain Scott, this gun is to be big bore, she is to be breech-loading and muzzle-pivoting, she is to keep out the enemy's shot and shell, she is to be close, and you are to find the way of handling her.'" Now I come to you and say, if Captain Scott cannot do it and gives it up, then I am all ready. That is my mode of working the guns on the pivot system. Captain Scott's first, and when he fails, mine. As to the elevation of the gun, I quite agree with Captain Scott, I quite agree with the Admiral in the chair, that we must provide both for laying the guns and for elevating them. We must do that. But I must come back again and ask you seriously to consider the point I have put, which is not my point, but the point which most experienced officers have put to me. I was talking in all I said to you about laying the guns in a permanent manner during that particular engagement only of *broadside guns*; and for the purpose of handling a large ship and a powerful broadside in the dreadfully short engagement which will decide sinking or gaining a victory, I do not think you can leave to individual gunners the doing as they like at their discretion with the guns used for broadside purposes; and therefore I think you ought to make up your mind, before the engagement takes place, what is to be the general lie of all the guns, and what is to be their mode of acting together, and then allow me to say I would call the eight other guns of the ship by—if you like—the old-fashioned name of "chase guns," that is to say, I propose that every ship of any considerable size shall have four bow guns and four rear guns. The rear guns are not for running away; the rear guns are for decoying your enemy to follow you into the place where you want to be followed, and taking him into a scrape he does not understand. That is what I put the four rear guns for, and I think they would be extremely useful in a scrape which I need not tell you about. Four bow guns, parallel to the keel as a normal position, and four rear guns parallel to the keel as a normal position. I think these four of the greatest importance for close and distant action; and remember that this ship of yours that we describe is not only to run one ship, but is one of, say one dozen, who are ramming at least another dozen of similar ships, and I do not think, unless you are in a position to handle the whole ship with a perfect certainty that each gun is doing what you want, that you can fight that battle and win it; but I may be quite wrong.

Lord Dunsany asked whether the casemates which I described were guarded against oblique fire. That only shows the difficulty there is in a lecture in going through the whole of an enormous subject; but I think you will see first of all, there is in the great central part 2½ feet width. (See Diagram II, which shows the fore-armoured bulkhead giving complete protection against oblique fire). Then I am here drawing you the space of the casemate, and there is each casemate with its one gun. Allow me to make an explanation. In one part of the paper I say, "each casemate with two guns in it"; in another I say, "each casemate with one gun." Allow me merely to say that I considered those two points very seriously,

and I beg you to consider them very seriously. I have looked into the question of having one gun in each casemate, and that has many advantages in point of strength; it has also advantages in point of safety. Then there is another point, I think the companies of two guns will get on better if you have a stronger company at a gun, and two of them, because the supernumeraries can be on the one gun when they are off the other gun. Therefore, in the beginning of my investigation I arrived strongly at the opinion that it was desirable to make each casemate double the breadth, and to have two guns acting together in one casemate. I was only driven out of that by the questions of strength and safety, and coming to the question of greatest strength, with a given weight and the best protection with safety, I came then to the conclusion myself, but I do not at all say it is the right one, that it was better to have the one gun in each casemate than to have the two guns in one casemate. I beg you to seriously consider that, because none but a practical seaman can settle that question; but I will tell you what settled it in my own mind—the question of security. The Chairman and Lord Dunsany put a very proper question to me, viz., as to the strength of those casemates, and whether what I proposed to have might not lead to a certain source of weakness. I am much obliged for those observations, because they readily lead to a serious point. This ship is a ship we will say of 10 casemates to a side, or 15 casemates, that is to say, you have a ship of 20 or 30 broadside guns. This battery is considerably more, in every case, than half the length of the ship; but when it comes to this end (see Diagram II), I have there an armour bulkhead going right across the whole end of the ship, and at the other end is a similar bulkhead, so protecting the entire ship in its centre against any effect of oblique or chase fire. It is by enclosing them all within each, first, its own armour, and secondly, the two end bulkheads of armour, that I render these casemates perfectly unassailable to oblique fire. About the question of strength Lord Dunsany said a very wise thing: he said if these ships were made like common ships, full of little bars of iron, which take the place of our old frames, if they were full of these little angle iron bars, that then there would really be no support given to the plate of armour, and that the structure of the ship and the armour plate would not at all aid each other in strength. That is perfectly true, and, therefore, what I propose in this matter is simply this—the “Great Eastern” is one of the strongest of ships, and in her sides the elements of strength are placed at about 9 feet apart from each other, both lengthways and vertically. Now, here I propose that from casemate to casemate there shall be 11 feet, and that vertically it shall be 9 feet, and, therefore, those casemates that I am showing you are exactly the material construction of the “Great Eastern.” This wall is nothing but a similar bulkhead; this wall is nothing but the two great longitudinal bulkheads that constitute the strength of the “Great Eastern,” and, therefore, the casemate is made of nothing but the iron deck below, the iron deck above, both of which are necessary parts of the ship; those cross bulkheads which are necessary parts of the ship, and go from the longitudinal bulkhead to the outside; and, therefore, six sides of the casemates are only the six large integral elements of which the ship is built. Then, in order to give these due strength, we plant on each side of these a single large plate of armour, which covers the whole, and which end where these powerful buttresses begin, and, therefore, the whole force expended on this plate is propagated through these to the whole body of the ship, and each plate has as its reinforcement the whole body of the ship; therefore there is no doubt whatever that by that method you can convey to the plate the whole strength of the internal body of the ship. I did not show, because it would complicate it, that the knees of the ship would come in at each of those corners (Diagram II), and every one of those plates would here be fitted by a great knee, and that corner would be upheld by another great knee, and then above and below and up and down there would be all these knees coming in to support the whole of this armour plate, so that that armour plate is really in the strongest position in which it can be placed.

Captain Price said, with regard to the form of the bow, that he liked the spear. Well, I should think a soldier would like the spear, and equally the gentleman who was an engineer said he preferred the chisel to the spear. With respect to ramming the ship, Captain Price also mentioned what had occurred to myself as a most serious consideration, that poking a hole below the water gave a greater power of

inundating the ship with water, than of course poking a hole above the water or near the surface. That is quite right, and I had already seriously taken that into consideration, or I should not have proposed it to you, and therefore I merely call your attention to that drawing, and to request you to notice that if a spear cut into the bottom of that (Diagram I) below the armour plate, which was his intention, it would find itself in a watertight compartment, which either would be already filled with fuel, or if the fuel was taken out would be replaced by water ballast, and that the poking a hole into that ship at that place with his spear would do her no harm whatever. And the only reason I ask you to believe that is, that when the "Great Eastern" was speared in like manner by a rock big enough to tear in her a hole nine feet wide and eighty-three feet long, it went into the compartment, and she continued her journey to America as if nothing had happened, and came back from America as if nothing had happened. I advise my enemies to take a spear prow, but I advise you as my friends to take that chisel, which chisel will open up the side of the ship, and across several decks, and so not only admit water on several decks instead of one, but will cut up so much of the strength of the ship by severing all these decks that you will do infinite constructive harm to the ship at the same moment that you inundate three decks with water instead of one.¹ Those are my impressions. In regard to torpedo boats, I perfectly admit the good policy of England building torpedo boats, and perfectly admit the good policy of England furnishing her fleets with better torpedo boats than anybody else has. I entirely agree that the fleet shall be surrounded with every kind of vessel. I may also say I do not undervalue a vessel with a turret in it for going up a narrow winding inland channel, so that the ship may be keeping her own course, while her gun is always lying on the enemy on land; and I do not say a word about pivoting guns or against guns in turrets, because there are special services for which I entreat you to build turret ships, because they are better than any other, and there are other uses for which I entreat you to use guns with the greatest possible sweeping power and the greatest command over every direction; only I say, use them in the discriminating places for which they are wanted, and do not for a theoretical, or exceptional, or fanciful mode of application, sacrifice the great element of a broadside gun, namely, destroying your enemy, when you come to close, fierce, deadly contact with him. In regard to very small gun-boats, I think there is a great difference between what I would call a squadron of gun-boats, because it would be my intention, if we made those one-gun boats I have stated, to use a number of them together. I think I should send out, if an enemy were getting troublesome, not one of those gun-boats to meet him, nor two of them, nor three of them,—I think I should send out twenty altogether, and sending out twenty gun-boats altogether to act on the same enemy, especially if he was a big fellow, I do not think that any more manœuvring power is necessary than that of a clever captain in

¹ The author of the paper has since received the following letter from a distinguished naval officer:—"Dear Sir,—I was pleased, when reading a leading article on your recent lecture at the U. S. Institution, to find that you advocate "straight stems for war ships. Ten years since, in an article on ship-building, which I published in the *Mechanics' Magazine*, I stated that for strength, security, and means of offence under any circumstances, they would prove superior to all others. In another article on the Navy, which appeared in a leading magazine a few months since, and which excited favourable comments from the *Times* and other sources, I again alluded to the subject. It is possible that I may again write on the Navy, as I am not satisfied with the present types of war-ships. By a singular coincidence, in another paper, which was also published in a leading periodical, I took your view of torpedoes. Certainly, recent improvements appear to have made them more manageable; but I still look on them as liable to be dangerous weapons of offence, unless it be from negligence when at anchor.—For defence, with the aid of electricity, their power will be great, and should this country unfortunately be forced into war with Russia, the tactics will have to be greatly changed from what they were in 1854-5. We then had no fear of such enemies, although several were fished up off Cronstadt and other places. Trusting you will excuse my addressing you,—I am, &c., &c."

a handy boat; therefore I request you to draw a distinction where you think it necessary; make your little boat with a large bore gun, one that is to go in a numerous fleet and attack a big enemy, and put big enough shells in the guns to sink that big enemy, and do that for your general purpose; but if you want very delicate manœuvring guns in gun-boats for special purposes, by all means build them for those special purposes, and give them special names which shall indicate that they are meant for that special purpose and not for another. The one thing I confess I should like to feel in a little steamer, if I was going into an enemy's country, would be to feel that I had only first to get near him and then to take my own quiet time of pointing my gun at him, and to feel that if that shell got into him he went down and all was right. Major Baylis said torpedoes certainly were a great danger. Now I entirely agree with that. I am very sorry any one should think I did not imagine they were a great danger—I know that they are very serious dangers and ought to be looked after. But really, after all, I can say nothing to you about torpedoes but this—Let a fleet be composed of all the proper arms that ought to compose a fleet in correspondence with what Admiral Robinson so wisely said, and then let it be distinctly understood as between you and me that the great way of meeting torpedoes is this, to sink the torpedo boat first, and that there is no other way of getting rid of it. I think that is the maxim we ought to keep in view—whether you think a torpedo boat is the best thing to sink another torpedo boat, or whether you think that a very handy quick gun-boat, with a great big gun firing into the torpedo boat, is the best way to sink her, is a matter which I must leave entirely to your choice who have got to go and do the deed and have therefore the right to choose your weapons, but I would choose the guns.

Mr. Welsh gave us a very interesting account of these Chinese gun-boats and the Argentine boats, but I merely call his attention to this, that for an English Navy I should like longer boats, I should like faster boats, and I should like boats drawing more water, able to keep the sea, and coaled for a tolerably long voyage. All these little shallow-water short boats are capital things, but I entreat you to consider that though they are capital things for rivers, for harbours, for local protection, for drilling men in gunnery, still you must draw a marked distinction between local special services of that kind and such a fleet of gun-boats as must be made to accompany our fleet of large ships and assist them in their operations. Now these are totally different classes, and I think a fleet, in order to be fit for all its uses, must be composed of both, and therefore, as I said before, the small vessels which are to protect the empire abroad will have to be sent out there and be ready for the work there a good while before the big vessels are called upon. But I think it would be a grand thing to feel that there was a great fleet of our gunboats out, we will say at Sydney or some such place, and that there were a couple of great fleets out somewhere in the Pacific, and that some fine morning, when we heard that somebody or other had sent ships somewhere or other to do something we did not like, that we then had nothing to do at home but say first to the ships of the largest class of the line, "Ten of you please get ready and go to-morrow to that place;" and that they should be accompanied by two classes smaller than themselves, but able to steam the same distance; and if that fleet were to leave on the instant, without anybody knowing where she was going, and go out there and find an assemblage of gunboats and good sailors in our colonies and other parts of the empire all ready, and wanting nothing to squash the enemy, except our presence with these large ships; I think people would feel that that was an empire of which they had reason to be proud, and in the government of which, they might place infinite confidence.

Admiral Robinson has been kind enough to go into this matter very seriously. He admits that what is wanted in a fleet is that there shall be some standard ship, and some standard unit of a gun-boat, and some standard gun to that; each standard composing an integral part of a fleet shall never be called a fleet until it is surrounded by all the several ships which belong to a fleet. What these ships are you can easily sum up, but they are first of all our great ships of war; frigates not so heavily armed, which will accompany them, and which will be able to deal with all the enemies of a weaker sort than those with which these have to deal; then you have transports and despatch vessels and cruisers, and you have all those classes which are necessary to form a fleet. Now there are so many clever mechanics and ship

builders in England who have no work to do, and there is so much iron in England just now that nobody knows what to do with, that this seems to me a happy moment for you professional men suggesting to the country that as we are at perfect peace at present, now is an admirable opportunity to make ourselves perfectly ready for war against anybody in any part of the British empire. Admiral Robinson, I think, has done us great good by his kindness and his courage, for I am told it wants a great deal more courage for a naval officer to speak out on land than it does to sink his enemy at sea. I do not know whether I am right. We want then, according to Admiral Robinson, a fleet, not a ship, and we never should expect to build a ship which will go everywhere and do everything. We build a fleet of ships for general larger purposes, and we build flotillas of special ships for special uses; that is plain practical wisdom.

Captain Scott has been kind enough to grasp the whole question, and he also says that he took into consideration how to build, not ships, so much as a fleet, in order to protect our commerce all over the world. He has also backed my maxim that the way to get rid of torpedoes and other enemies is to sink them first; and he knows, as I do, that the rocket is a weapon; that the shell, in several shapes not generally known, is a serious weapon; that these are not to be neglected; but though they are not to be neglected, we are not to make them a scare to ourselves or to our friends. I agree with Captain Scott, that if you can get simple mechanical appliances that won't go wrong, to help you to work your guns, to help you to steer and manœuvre your ship, you will be most unwise to neglect such help, but I think you would be most unwise to trust for the fighting of your great ships solely to the perfect working conditions of the terribly complicated apparatus of which you and I have heard a great deal too much. And let me simply say to you that the first stroke of your bow on the enemy, or of his on you, will give a little twist to this bulkhead, and a little twist to that bulkhead, and will poke up a little bit of iron of the ship this way, and buckle down another bit of iron in the ship that way, and I will tell you that nine-tenths of the horrible complications of machinery which I have seen proposed, not to say executed, for your war ships will be utterly useless on the first slight contact with your enemy. Though I am an engineer, though I believe in machinery, I advise you not to believe in clever tricks of mechanism that I or anybody else teach you,—and be sure of this, first, make your rudder and your steering gear and everything belonging to it so that your crew can steer without any engine or machinery; secondly, have your guns so arranged that they can be worked without a steam-engine being in good order, or the hydrant press being in perfect condition, or without all the lines of the mechanism being mathematically true,—take care that you can work with your own crew your own guns. And if you ask me the reason why more strongly than any other I lay such weight on having a breech-loading gun instead of a great muzzle-loading gun worked by steam-engines, I tell you why, because I have seen big breech-loading guns handled by two or three little fellows working at the breech of the gun in such an exquisite and rapid manner as no machinery of hydraulics or steam in the world could accomplish. But in order to do that it must be breech-loading, and a handy little breech-loading gun fifteen inches in diameter will be worked by half-a-dozen Jack tars, and say in half the time that any of your great guns can be worked. Therefore I entreat you to keep to the simplicity of all the mechanism on board a ship, to keep in reserve, to be handy, some very simple mechanism which, when you are very tired of firing so many guns at your enemy, will come in and give you a little relief. In the ships I have shown I have divided the weight pretty nearly thus:—I have divided as nearly as possible the 4,000 tons' weight of armament, taking 2,000 tons' weight of guns and ammunition and 2,000 tons' weight of armour, and I compelled myself to make the best I could of that; and I have done so by the arrangement I have now shown you. By going a little further I could have 3,000 tons of armour and a corresponding increase in the guns. I think that is of great importance, because you see there will be a far more powerful armament in that ship I have shown you, in regard to her weight of armour and the weight of the ship altogether, than anything you have yet been familiar with. Therefore with regard to guns, I think, that for this close fighting,

which must be the accompaniment of ramming, a big bore light gun and a large shell with a high initial velocity, is something you ought on no account to deviate from. I have no knowledge of firing by electricity, but if you ask me how I meant to fire from these casemates, I will answer you. I intended that at each casemate there should be a small hatchway opening up on the upper deck. In each of these you have loaded your gun, and in each there is a gunner standing below ready on the slightest hint to fire his gun. He is standing there at his work, and the commander is standing along this line and sees all the captains of the guns who are looking out at him for the signal. I fancy he is standing here, and they are all ready, on the instant of his giving the signal, to fire each his own gun. If you do not approve of that, you no doubt will prove a better way of doing it. There is a way which is very well known, namely, firing by electricity. I do not know, only, I say again, use electricity for what it is fit for, but do not trust to it, and do everything with your own men as much as you possibly can.

With regard to the shot being broken by double layers of plate, I quite agree there are very serious points of that kind coming up now. I have the whole side of the ship along that battery three feet thick for strength (see Diagrams I and II), independent altogether of armour, and therefore that three feet thick encloses every one of those large armour plates as it were in a case, and whether you divide that into two or three—whether you fill up the interval by wood or not, do it which way you like, but there is no doubt whatever that you can in this manner combine the strength of the armour plate with the strength of the materials of the ship. But there was one very excellent criticism given, which was this: it was said, "If the plate of your ship is as you say outside the sheet of armour, then, when the shell comes, the first thing it will do will be to damage that part of the skin of the ship." That is just what I wanted it to do. I wanted it to go through and damage that part of the ship, and hammer that iron, which it does, into a little buckle; but having done that, it has done no harm whatever to the ship or the strength of the ship; it has altered none of the fastenings, because no support is derived to the plate from that part of the plate: all the support to the particular armour plate is derived from those buttresses along with those knees which I spoke of, and I said to you that every one of those outer plates of the skin could be battered by half-a-dozen shells, and the cells inside would all remain perfectly water-tight, and no harm would have happened, and it would still form an enclosure which would grasp the iron plates all round, and so prevent the portions of it, even if it had been split, from tumbling and falling away, and would keep every one of them in their places, so that as long as there was material to be broken, the material would be there and would require force to break it.

I think it most important that the propeller should protect itself. I cannot go into that method now, but I wish you would have a paper read here by other people on that subject, and if you would just say that what you want is a propeller capable of protecting itself, I think I could show you how a propeller may be made not only to protect itself, but to make its enemy very uncomfortable. The propeller I do not think is to be made to protect itself by putting any nets around it. I disapprove of all such complications; but I will only tell you I have seen a kind of propeller, and used it for practical purposes, which no ordinary and even no extraordinary process which I can understand would render useless, and I think that is well worthy the consideration of this meeting, and I shall be ready on such an occasion to give you such a propeller if no one else does.

Then another point with regard to propellers, I think most serious, it is this, that your screw propeller is a bad propeller sternwards. Why not say, "A ship of war must be able to go as fast astern as ahead?" Why not say so? And then when you have said so, why not call upon people who have made such things their studies to put it into execution? I assure you, handling a ship as I have had to do, which goes forward and backward equally well, is one of the greatest pleasures in life, and you can make such a ship do anything you like. Such vessels have been made, only at present we are in a very serious difficulty, we are in a sort of curious entanglement about screws. I do not know if you have seen our double screw war vessels. I dare say you have seen them with great big beams sticking out through the water in the most unmechanical manner to grasp the screw. I am sure an old ship-builder never

would construct a vessel with big beams going through the water in order to grapple a distant propeller and keep it in its place. It would, I am certain, be easily entangled by cables, or injured easily in collision by clever enemies, and I entreat you to get rid of such an arrangement, for it is an abomination and a danger. I will only, in conclusion, repeat the old maxim that "ships good for everything are good for nothing," and apologise for taking up so much of your time.

The CHAIRMAN: I am sure, after this lengthened lecture and debate, there can be very little doubt of Mr. Scott Russell's cleverness, and his ability to instruct us. We are very much indebted to him, not only for the amusement he has afforded us, but for the good solid instruction we have gained, and I am sure the meeting will join with me in thanking him very much.