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Eveuing Meeting.

Monday, April 3rd, 1871.

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Ross, J. C., Lieut. R.E., Bengal.

THE ATTACK AND DEFENCE OF FLEETS.

By Captain P. H. COLOMB, R.N.

I.

The CHAIRMAN: I call upon Captain Colomb to address the meeting on the subject of the "Attack and Defence of Fleets." But previous to Captain Colomb's commencing, I wish to call attention to a notice that has been put up. In these societies it is necessary that we should observe the rules that are laid down for our guidance; and one of the rules here is, that in the discussion after the lecture, *ten minutes only can be allowed to each speaker*. I, therefore, hope that gentlemen who may wish to address the meeting, will confine their remarks within that time.

Captain COLOMB: The subject I have undertaken to illustrate in to-night's paper is one of extreme importance at the present juncture. It is not only desirable that we should find ourselves prepared with some definite views on naval warfare in the open sea, when carried out with the ships and weapons now at our command, but it must never be forgotten that the views we may form will, and do, actually govern the nature of the designs produced by our architects, and the disposition of guns and other weapons on their floating carriages. It would therefore be a culpable error for any one treating of the attack and defence of fleets, to confine himself to questions of manœuvring merely, as though ships were, like men, of an unchangeable type. Writers of the past on the subject of naval tactics, such as De Morogues, Père Hoste, and Clarke, of Eldin, might well be excused if they thus treated their science. But

such a method is no longer permissible. Writers of our age, who assume in some sense to lead opinion, must remember that we stand at the cross roads of naval warfare; we are no longer hedged in by impassable barriers on the smooth highway of progress. Many roads are open to us, and we have to make a selection, guided by a not much better trail than the Indian hunter finds in his forests. I am the more anxious to press this point forward, as I believe we are not sufficiently alive to the fact that the current view on the attack and defence of fleets is the foundation of all design in naval *matériel*. I say I think we are not sufficiently alive to this fact, because I cannot believe, were it otherwise, that we should rest content with certain instinctive ideas on the subject of future naval war, and make almost no attempt to formulate our instincts, and separate where possible the chaff from the wheat. If I were to make the assertion that the designs of our ships arise more out of instinct and tradition than out of any comprehension of how they are liable to attack, and how they are capable of defence, I should at first raise a feeling of incredulous surprise in the minds of my audience. Yet I do make the assertion, and think that a few sentences in explanation will entirely remove the incredulity, while they will strengthen the surprise. Consider for a moment how you could rebut my assertion. What sort of arguments would you use, and what sort of facts would you produce to sustain the counter-proposition that our ships were designed to deliver certain specified and approved attacks, and to offer certain distinct resistances? You would be constrained to rely on the general proposition that the ships were designed to use their guns, and perhaps their rams for attack; and their armour for defence against guns. Beyond this you could not go; and you will observe that it is a very small step. The gun and the ram are presented to your view as possible weapons, because they are both traditional; you cannot build a war ship except on the supposition that she is to use both or either of them. On the other hand your instinctive desire for protection from shot has given you armour plating. In what respect you have advanced beyond instinct and tradition can only be proved by ascertaining whether you appreciate the relative values of the two weapons provided, and have designed your ship in agreement with that relation. Take an illustration from the infantry soldier, which is temptingly apposite to the case in hand. He has two weapons, his rifle and his bayonet. Their relative value is established and known, and no projector would be mad enough to sacrifice one iota of the known value of the rifle to the problematical value of the bayonet. But who can say of any ship in our Navy in which the two weapons are combined, that her gun-power is properly sacrificed to assist her ram as the superior weapon, or that her ram-power is judiciously curtailed to admit of increased ordnance? For clearness of expression, I am leaving out of consideration the third weapon—the offensive torpedo—which it will be necessary hereafter to treat distinctly; but is not my assertion, even in the case of any single ship called upon to attack, or defend herself from any other single ship, quite borne out by the elementary considerations I have adverted to?

If we go a step beyond the single ship, and glance at the preparation

mado in our ships for combined attack, or combined defence, we shall light upon a complete abnegation of any such idea.

But returning to the single ship, and avoiding the confusion of the double weapon in the same ship, think what is ascertained as the best method of carrying ordnance? Is the "Monarch" or the "Hercules" the more powerful ship? or would the 5,000 tons of the "Monarch," and her four 25-ton guns, fall victims to the attack of five lightly clad ships of 1,000 tons, each carrying a single 25-ton gun?

Then if the ram be alone considered, what are the relative values of speed and turning powers for attack upon a willing adversary, or for compulsory defence? May speed be judiciously sacrificed to turning powers, and to what extent? Or must speed be secured at all hazards, and turning powers only considered afterwards?

If we are not depending on tradition and instinct, then categorical answers are forthcoming to all these queries. But if no such things are extant—which is unfortunately true—and if besides, very little effort is exerted in the attainment of true solutions, then my position remains unassailed and unassailable.

Now, what I want you to observe in all this is, that while we are very apt to think that the ships and weapons presented to the naval Officer for his uses in a complete state, cause him to take particular views of attack and defence, and give rise to his speculations on the subject; yet the converse of this is the case. He first forms views of attack and defence, and these find expression *afterwards* in material products. It is the abstract gun, ram, and torpedo, which form his original ideal of warfare; the concrete weapons do no more than modify views already outlined in his mind. If his original ideal is crude, unthought out, above all, if there are diversities of ideal, the results in a material form will give rise to vague uncertainties, and endless discussions, such as those by which we find ourselves now surrounded.

It will be seen, therefore, that from my point of view I could offer you no more important or comprehensive question than that I have chosen as the title of my paper.

I had no sooner plotted out what I thought should be said on an occasion like the present, the facts it would be necessary to put forward, the deductions it would be proper to draw, and the general line of treatment it would be desirable to pursue, than I became overwhelmed with the magnitude of the task before me. For just observe for a moment what a paper on "the attack and defence of fleets" might be expected to deal with. Think in what aspects a professional audience might justly call upon me to place the subject before them.

There would first be the theory of the matter. You would expect me to set out the theoretical relative values of the gun, the ram, and the torpedo, as offensive or defensive weapons. Each must, therefore, be carefully and separately considered, and then considered afresh in their relation to each other.

It would next be proper to look at the state of naval opinion at home and abroad on this question of relative value, and to note how it might coincide or differ with the conclusions independently arrived at. The ultimate conclusions, whatever they were, ought then to be applied

to the combat between single ships of existing types, and from the whole discussion should be drawn the deduction as to how present ships fulfil the ideal requirements so far.

I do not think I exaggerate when I say that any discussion of the attack and defence of a fleet is absolutely valueless prior to the analysis I have sketched out, but it is apparent that analysis would fully occupy the limits of a single paper.

The next step in the enquiry would be the theoretical methods of making a fleet mobile and flexible under the control of an Admiral. The state of naval opinion at home and abroad should be applied here, as it was to the values of the weapons, and compared with the facts.

After this, you might fairly call upon me to consider the offensive and defensive features of the various formations proposed or possible, and of the movements by which they are obtained; and here it would be necessary again to glance at the state of naval opinion on this head. Then, and not till then, should we be in a condition to place ourselves in the position of a fleet attacking, or a fleet attacked, and so deduce the rules within which we must act to give the greatest vigour to our attack, and the greatest solidity to our defence.

In facing these conditions which seemed to me unavoidable, I had to consider how I should meet them. I might touch very lightly and inefficiently on each branch of the subject, and compress the whole of it so greatly as not to extend the limit of time allowed, but I felt it was not just to so great a subject, so very casually studied, to treat it in that cursory way. If I had had any further doubts about it, they were fully resolved when I found that I had written enough for an hour and half's reading, and had not so much as touched the fleet question at all!

Therefore, to my great regret, I come before you to-night under the false pretence of a misnomer in title, "The Attack and Defence of Fleets," has dwindled to the attack and defence of single ships, and if I receive your censure at the outset for my acknowledged short comings, I shall hope to modify it by showing at the conclusion that I was a helpless instrument in the hands of my facts.

Without further preface, then I shall proceed with the examination of guns, rams, and torpedoes, in the order and with the objects I have pointed out.

Guns.

In my paper on "Modern Naval Tactics" read here five years ago, seagoing turret-ships were not, and the discussion of the gun-power of a fleet was necessarily confined to broadside ships, whose fire covered an arc of three points before and abaft the beam.

In my "Lessons from Lissa," also read here in 1867, the "Bellerophon" was our representative ship, and the calculations used to illustrate gun-power were drawn from her capabilities.

The "Monarch" is now our representative sea-going ironclad, and she must do duty as our typical ship. In so using her, I am not prejudging the great cause of turret versus broadside, on the contrary, my

opening remarks show that I do not mean to take the "Monarch" as a perfect ship, and consider how a fleet of such ships can be best employed. I take the "Monarch" as my ideal, in order that I may not find myself dealing with an impossible type, and because the "Monarch" embodies in the highest degree the principle of construction and armament most opposed to that found efficient in former naval wars.

All round fire is unquestionably the object to which so much is sacrificed in the "Monarch," and if I were to take a ship like the "Hercules" as my representative, I should find the struggle after all-round fire just as prominent there, but carried out under a smaller departure from old methods of construction. The "Monarch" has the fewest and heaviest guns of any sea-going ship in the Navy, and she exercises her gun-power over a larger area than any other. She is the embodiment of the idea that the gun is the decisive weapon at sea, to which all others must give place, and that this weapon is most powerful when mounted in limited numbers, of the greatest size, and with the largest arc of training.

The question I propounded four years ago in my paper on the battle of Lissa was, "whether the gun was advancing or receding in power as a naval weapon?" The illustration was whether the guns of the "Bellerophon," as against a "Bellerophon," were more or less powerful than the guns of a 90-gun ship against another of her class before the advent of ironclads. The question to-night is, so far as guns are concerned, the same, but carried a stage further. "Has the 'gun-power of the 'Monarch,' as against a 'Monarch,' advanced or receded from the position held by the guns of the 'Bellerophon' 'against a sister ship?'"

In the discussion of the earlier stage, I endeavoured to show by an analysis of the forces at the battle of Lissa, how enormously the gun was falling back before the increasing work it was called upon to do. My comparison was in the first instance, that, under the old system of building and arming ships, each Italian gun would have had only fifty tons of material to destroy in completing the annihilation of the Austrian fleet; and each Austrian gun would have had only 93 tons of Italian shipping opposed to it. With the new methods of building and armament, however, under which the Fleets actually met, each Italian gun had 260 tons of material to destroy, and each Austrian gun 432 tons: that is to say, unless the guns at the battle of Lissa could give shot for shot of the light guns used in former times, and each shot were about five times as destructive, the gun had receded from its place as a naval weapon. I then proceeded to show, that so far from modern guns keeping up shot for shot with their prototypes, their speed of fire was very materially reduced, and that one round in two minutes was as rapid a fire as could be expected.

A Lissa ship opposed to another, gave an average of 346 tons of destructive work.

A "Bellerophon" opposed to a "Bellerophon" gives 600 tons of destructive work to be done by each gun. A "Monarch" opposed to a "Monarch" gives no less than 1,275 tons of work. If, therefore, I had reason in pointing to the recession of the gun from its place as a

weapon, by the results of the battle of Lissa, what am I to say when I find it has now receded three times as far as it had then?

I imagined that guns, then, supposing them to give shot for shot with the old ones, must be five times as powerful to retain their places. Now, on the same principle, I must imagine the "Monarch's" guns to be about twice as powerful as the "Bellerophon's," or about fifteen times as powerful as the old smooth bores, in order to keep their place in the race.

If the "Bellerophon's" plating be considered to have a resisting power of 36, the "Monarch" has a resisting power of 49, which again tells against the guns. But, on the other hand, the "Monarch's" guns exert a striking force of 5,000 foot-tons at 1,000 yards, in lieu of 2,400 foot-tons which the "Bellerophon's" guns exert at the same range. Making a proportion, we find that the power of resistance has increased in the ratio of 1 to 1·3, and of attack in the proportion of 1 to 2. The net result in favour of the guns is 0·7, and, consequently, the net recession of the gunpower since the "Bellerophon's" time, is in the proportion of 1 to 1·3.

Now, it seems that a shot from the 25-ton gun, fired at a range of 700 yards, having on impact an energy of 170 foot-tons per inch of shot's circumference, fails to penetrate the "Hercules" target.

The "Hercules" target is, in resisting force to the "Monarch," as 64 to 49, and the energy of the "Monarch's" shot, at 1,000 yards, is 137 foot-tons per inch of circumference. The proportion between the figures show that the resisting powers of the "Monarch's" side against her guns at 1,000 yards are as nearly as possible equal to those shown by the "Hercules" on the occasion referred to; that is to say, that a "Monarch" firing at another "Monarch," will fail to damage her at 1,000 yards when her shots strike fair.

But how little can we calculate on this result? The general idea concludes that a ship will rarely present her broadside to be fired at. To be fair to both sides, suppose the shot strike at an angle of 45°, and the resisting power of the "Monarch" rises from 49 to 98. In other words, it is doubled. What possible prospect has a "Monarch" of deciding an action with another "Monarch" by means of her artillery, under circumstances such as these?

But we are only on the borders of the "Monarch's" powerlessness as yet.

In my paper on Lissa, I endeavoured to show that at the utmost rapidity possible, the "Bellerophon" could not fire more than 4 rounds per gun in 6 minutes, or 28 rounds in all. I am informed that the "Monarch" does not calculate on a greater speed of fire in action than 1 round in 3 minutes per gun; that is to say, the rapidity has fallen from 28 rounds in the "Bellerophon," to 8 rounds in the "Monarch" in 6 minutes! We have no grounds for supposing that more than a trifling increase of accuracy has been gained, and, therefore, I must debit the guns with this further reduction, equal to 3·5 in their power. If my figures approach correctness, the recession of the power of the gun since the battle of Lissa, as exemplified in the "Monarch" and "Bellerophon," is in the proportion of 1 to 4·8. The guns are

now in point of fact, about five times as weak as they were five years ago.

This seems to me a very startling conclusion to arrive at, and one which lies at the root of all construction and armament. It is not as though it were certain the gun must meet the gun, and therefore the recession was common to both sides of the equation, but it is that some other weapon or weapons are making tremendous strides, and are beating the gun in competition. It may mean also that the manner of constructing the carriage—that is the ship—is at the bottom of the recession. In any case, I can conceive no more important subject for inquiry than whether my figures and deductions are correct. If they are, I can only express my belief that we are close upon a very extraordinary re-construction of our Navy.

Thus far, then, for the relative place of the gun now, compared with that formerly held by it. Let us look at its actual power in view of the future comparison we shall have to make between it and other weapons.

Unfortunately, precise figures are wanting here, and very little attempt has been made to obtain them, as they can alone be obtained by experiment. The inquiry takes the form of two questions: How many shot will strike the hull of a "Monarch" in a given time in the open sea, and what amount of damage will they do? and I must own it has struck me as alarmingly suggestive that I cannot get an answer off-hand to either query. Nobody seems to have made the calculation, even with such data as are obtainable, and no steps have been taken to improve the data. It is true, I believe, that the materials for determining the number of shot which will strike a given vertical target at a given range, when fired from a steady platform, are obtainable, but such a determination must be a very fallacious guide to the results of practice at sea; nor am I sure that even the materials obtained have been applied to determine the practical question.

My figures must be, for these reasons, very imperfect; but I am obliged to use what I can get.

The 12-pounder rifled gun, at an elevation of 2° , is stated to be capable of placing fourteen shot out of every twenty in a target 9 feet square. Speaking roughly, this amounts to saying that two-thirds of the shot fired from a rifled gun are capable of striking a target 9 feet square at a distance of 1,000 yards. Actual practice at Shoeburyness seems to bear out this statement fully; for on firing twenty rounds from the 12-ton gun, the extreme error of elevation at 1,000 yards was only 13.5 feet, and the mean was only 4.7 feet. In direction, the extreme error was 9.75 feet, and the mean error only 4.4 feet. Out of the whole twenty shot, four only would have missed the "Monarch;" two would have fallen short, and two would have gone over. It appears safe to conclude from these figures that the "Monarch" is not liable to receive more than four-fifths of the shot fired at her at 1,000 yards; and if the chances of being hit vary directly as the distance, at 2,000 yards the "Monarch" is only liable to receive two-fifths of the shot fired at her. This is an admission in favour of the guns; for the chances of being hit diminish in a still greater degree; but as the error

given is entirely due to elevation, and the "Monarch," as a target, is very much longer than she is high, the admission may pass.

Under impossible circumstances, therefore, if a "Monarch" opened fire on another "Monarch" at 2,000 yards, she might hit her eight times in ten minutes, but none of these shot would damage the ship in a vital part, and probably would pass through no part of her plating. I use the expression "impossible circumstances," because to get that result, a steady platform, a fixed object, and perfect coolness and deliberation are required, not one of which conditions can be secured at sea in action.

I have tried to obtain some idea of the deductions necessary for each of these conditions; an unsteady platform, a moving object, and extreme rapidity of fire. But it is not easy.

Taking the experiments carried out at Vigo between the "Monarch," "Captain," and "Hercules" for what they are worth, it appears that the three ships fired for five minutes each at a rock distant about 1,000 yards, which was estimated to be 600 feet long and 60 feet high, or twice as long, and four times as high, as a ship. "Hercules" fired seventeen shot, of which ten hit; "Captain" fired eleven shot, and made four hits; "Monarch" fired twelve shot, and made nine hits. Speaking roughly, as I am bound to do with rough figures, it would appear that a ship such as the "Monarch" would, under those circumstances, have been hit three times by the "Hercules," once by the "Captain," and say three times by the "Monarch."

We have seen that .8 of the shot fired would have hit a "Monarch" at 1,000 yards, the platform being steady; we now find from the foregoing experiment that .147 of the "Hercules" shot, .09 of the "Captain's" shot, and .187 of the "Monarch's" shot might be expected to hit her at sea in smooth water, when the distance did not materially vary.

The question for us is whether these figures may be relied on as a guide—whether they fairly represent practice at sea, or either under or over estimate its accuracy. The only other figures at my disposal in order to check the calculation are the following. In some recent carefully conducted prize firing by one of the ships in the Channel Squadron, it was estimated that at from 800 to 1,200 yards there were only 25 lost shot out of 208 fired. A "lost shot" appears, according to the Admiralty circular, to be one which would miss the "Monarch," passing over her either *en ricochet* or directly. The firing on this occasion appears to have been exceptionally good, for a triangular target with 9 feet sides is represented to have been hit no less than four times.

If therefore we are to accept these shot not counted as "lost shot" to be a fair representation of the percentage of hits in a "Monarch" at sea, we shall find it to be .88 of the shots fired. But we have quoted accurate figures showing that at 1,000 yards—a mean of the distances at which the practice under review was carried on—no more than .8 of the shot fired will strike a "Monarch" when the distance is accurately measured from a fixed and steady platform, and the gun is laid with a nicely impossible afloat. This .88 of hits cannot be therefore a true

representation of the practice; and I think naval men generally will admit that observations of the fall of shot taken from the mast-head and extremes of the ship, are, at their very best, of an extremely rough character. The tendency of observers in such circumstances is almost always to exaggerate the accuracy of fire, as I am bound to confess appears to be the case in the details of firing under consideration.

But we have seen that the probable number of hits on a target 9 feet square, at about 1,000 yards, is 14 out of 20. A 9-foot square target gives an area of 81 square feet, while an equilateral triangle with 9-foot sides gives an area of 35 square feet in round numbers. Accepting the assumption that the fall of shot on a given surface varies as its area—which I think will be true enough for our present purpose—we should find that '3 of the shot should strike the floating target in the case referred to. But as 4 only out of 208 struck it, the actual hits were '019 of the shot fired.

Now compare the results of these two investigations. According to the record of "lost shot," this ironclad's practice was really better and closer than that obtained from a steady platform at Shoeburyness; while, measured by the percentage of hits on the target, it was very much worse.

Looking again at the Vigo practice, the average hits of the three ships upon a "Monarch," at 1,000 yards, was '141 of the shot fired, in lieu of the '8 of the shot which would have struck had the practice reached its maximum accuracy. If the prize firing practice had been as good as this, '053 of the shot ought to have struck the floating target in lieu of the '019 of the shot which actually did strike it; in other words, ten hits ought to have been made instead of four.

Artillerists may very likely smile at the rudeness of these calculations and surmises. No doubt they are very rude, but I am not conscious of the endeavour to establish a foregone conclusion of their means, and, dealing with them as rudely as they require to be dealt with, they appear to me to establish the probability that a very much smaller proportion of hits by shot will be made in action at sea than any of us have hitherto imagined.

Is it really then the case that at the moderate range of 1,000 yards, under the most favourable circumstances, a "Monarch" can only expect to hit a sister vessel from twice to fifteen times out of every 100 shot? And if she carries so many as 1,000 rounds of shot, will only from 20 to 150 take effect? This is a question we should not have left so long unanswered, and it ought to be ascertained with certainty without any delay.

I, however, cannot stop to ascertain how the fact may be; I must make a reasonable assumption on the facts I am possessed of, and I take a mean position between the result deduced from the Vigo experiments and those taken from prize firing, and I lay it down that 10 per cent. of the "Monarch's" shot will strike a "Monarch" in action at 1,000 yards.

We have seen that the "Monarch" is, in her vital parts, impenetrable to shot from the 25-ton gun at 1,000 yards when struck fair. Practically, I believe she will be so seldom struck fair, that no part of her

plating is vulnerable until within 1,000 yards, and in anything approaching the end-on position I feel bound to extend this invulnerability to within 500 yards of her adversary. However the question may be argued, it is certain that only a portion of the shot striking the "Monarch" will penetrate, and we cannot suppose this proportion greater than one-half with any certainty. The amount of damage done by the penetration of 5 shot out of 100 fired must be small in any case.

I have now tried to answer the question as to the proportion of shot which might hit a "Monarch" at a mean range, and the other as to the damage likely to be done.

The next question arises from a combination of the two facts evolved from the argument, and it enquires "How much damage will be effected upon a 'Monarch' by another in a given time, say six minutes?"

And here I must endeavour to correct the assumed speed of fire by the same data taken to arrive at the percentage of hits.

At the rock off Vigo the speed of the "Hercules," was 17 shot in five minutes from four guns, being 3·4 shot per minute, or ·85 shot per gun per minute. The speed of the "Captain's" fire was 11 shot in five minutes from four guns, being 2·2 shot per minute, or ·55 shot per gun per minute. The speed of the "Monarch's" fire was 12 shot in five minutes, or 2·4 shot per minute, or ·6 shot per gun per minute; the average of the three ships giving ·66 shot per minute per gun. The average speed of the prize firing I have used was ·7 shot per gun per minute. We must take it therefore that this is the maximum speed attainable under the most favourable circumstances. It amounts to one round from each gun in a minute and forty-two seconds, so that I do not think there need be any fear of adopting the one round per gun in three minutes, which is assumed afloat to be the probable speed of "Monarch's" fire in action, as representing the truth. But for my purposes I would rather assume something above the average, and if I allow one round in two minutes, and 10 per cent. of hits, I do not think I place the gun at the range of 1,000 yards in action at all in arrear of its actual place.

Our summary of the actual gun-power of the "Monarch," therefore, amounts to this.

In six minutes from the opening of her fire on the sister ship at 1,000 yards, she will have fired 12 shot, of which one will have hit and another may have glanced, and it remains an even chance whether the single hit will have penetrated the enemy's armour.

With this extremely curious conclusion to our investigation I shall leave it, and proceed to the newer weapon—the Ram.

Rams.

If we are to consider the question of the attack by rams with any hope of a good result, we must begin at the beginning. We must endeavour to treat the question from a purely abstract point of view. We must take two ideal ships of equal speed and turning powers, and

condemn them to abstain from many methods of defending themselves which both would use in actual warfare. No disturbing causes must enter into our first analysis, but after we have seen how the case stands, when both ships are limited to strict rules in their behaviour, we can ascertain the relative values of those methods which would be used in practice, and we can determine which of them deserve the foremost place.

While, however, we select two abstract ships for our purpose, we must take care they are not impossible types. The relations of the length to the turning powers must be such as existing types fulfil; and the speed over arcs must be such as can be realised: and, as it has been ascertained with regard to existing ships, that at their highest speeds they turn in a circle whose diameter is from four to six times their length, we may take a circle whose diameter is five times the length of our ships as a safe piece of data whereon to found our investigation. The two ships in diagram 1, therefore, are supposed to travel when their helms are hard over, on the arc of a circle whose radius is two and-a-half times their length. We must suppose them for the present unable to reduce their speed, and consequently unable to travel on a curve with a smaller radius; but we allow them to do anything they wish with their helms; and we are to suppose each equally anxious to ram his neighbour and to avoid being himself rammed. For convenience we shall assume the speed of each ship to be 9 knots, and their length to be 100 yards, or 300 feet. The length of each ship in time, that is, the time it will take each ship to pass over her own length with helm amidships, will be 20 seconds; 10 seconds will, therefore represent half each ship's length in time.

It must be now borne in mind that the fact of putting the helm over reduces the speed over the arc in a degree proportional to the amount of helm given. The "Bellerophon," for example, when going 12 knots with helm amidships, reduces her speed to 7·8 knots over her arc; and when going five knots with helm amidships, she reduces her speed to 3·6 knots over her arc. This peculiarity in the action of the helm deserves more consideration than there is now time to give. It is, however, enough for my purposes to state that the fact is so, and that it will affect the question of ramming in the manner to be presently seen. Closer scrutiny of the phenomenon will be found in my former paper on "Modern Naval Tactics."

If now we take two ideal ships under these conditions, represented in diagram 1 as x and y , we shall observe that so far as x is concerned, her object is to obtain the position given in Fig. 1 as regards y , and to avoid that given in Fig. 2. y , on the other hand, wishes the opposite. She desires to obtain the position given to her in Fig. 2, and to avoid that given in Fig. 1.

What is the difference in these two positions? What constitutes the badness of y 's position in Fig. 1, and of x 's position in Fig. 2? In both cases these ships are 50 yards too far ahead in space; and ten seconds too far ahead in time. What on the other hand constitutes the goodness of x 's position in Fig. 1, and of y 's position in Fig. 2? The ships are in both cases 50 yards behind in space, and 10 seconds

behind in point of time. It is clear also that if x were anything between her whole length and half her length *in space*; and between 20 and 10 seconds *in time* behind the position given to her in Fig. 1, she would still strike y a fair ramming blow, for y would not in that time or space be so far ahead as to let x pass astern of her. Again, by as much as x is less than ten seconds in time, or half her length in space, before her position in Fig. 1, by just so much does she run the risk of finding herself in the position given to her in Fig. 2. x 's object is therefore to be between 50 and 100 yards behind in point of space, and between 10 and 20 seconds behind in point of time. Her blow will be just as good if delivered abaft her adversary's beam, as it would be when delivered before it, and if she runs the risk of being too late, she only becomes liable to miss her blow, and does not leave herself open to attack; whereas, if she runs the risk of being too early, she not only misses her blow, but lays herself open to destruction. Even at this early stage of the enquiry, therefore, it is not unimportant to note that if "excess of speed" be capable of substitution for "being too early," and "lack of speed" for "being too late," a ram is not advantaged by the former in the supposed case.

The ship x in Fig. 1, and the ship y in Fig. 2, has gained her object and her complete victory. But before she could have got to that stage, there must have been a time when neither had any advantage over the other. They must have once been outside ramming distance, and free from attack, and therefore on an equality. And they may have entered upon the ramming distance on an equality, which had been converted into an inequality by the superior skill of x in Fig. 1, and of y in Fig. 2. But they may have come into ramming distance on an inequality, and the conqueror may have had it all his own way from the first. Let us, therefore, examine what constitutes ramming distance first, and then what constitutes the inequality.

Every ship when advancing at speed, carries on each side of her two circles of considerable size, within the circumference of which no power on earth can place her. These circles will vary according to the speed at which the ship travels, and according to the power she possesses of stopping herself quickly. Another ship which is anywhere inside this circle, cannot be rammed so long as she remains there. It is clear from this, that it must be from some point within this circle that a ship will find herself able to deliver a blow safe to herself and damaging to her adversary. Outside this circle neither ship can ever get an advantage over the other, both must always be equally free to move. I therefore assume that a ship is within ramming distance of another whenever she is on, or inside, the arc on which the other turns. And, extending this definition to meet cases where neither ship is within the circle of the other, though in close proximity, we may say their ramming distance is twice the radius of the arc described. In diagram 1, Fig. 3, I have represented the ramming distances due to y under the hypothesis we have assumed, and large as these spaces seem, you must remember they are only the average spaces which existing ships carry about with them when steaming. The mere fact of being within

ramming distance of another ship gives no advantage beyond the safety from your opponent's ram. The ship x at p , the centre of y 's port circle has no advantage over y , because y is also at the centre of x 's circle. Nor has x at q any advantage; x is in precisely the same position as regards y , as y is with respect to x . But suppose x to have come into y 's circle as in Fig. 4, and we shall see she has a great advantage. In this case x is *inside* y 's circle, and, therefore, safe herself, while y is *outside* x 's circle, and is therefore open to attack. It seems to me that the whole art and mystery of ramming will be found to consist in this endeavour to get your adversary outside your own circle while you remain inside his.

x has a manifest advantage on the face of matters in this figure. She is excluded from receiving a blow, and is not prevented from giving one. Let us therefore enquire more closely as to the exact chances she has of ramming y under the circumstances postulated.

In the positions given, x is 40 seconds from the collision point o , while y is only 25. If therefore both ships pursue their present courses, x will ram y 75 feet from her stern; y cannot therefore continue her course with safety. Let us suppose she puts her helm hard-a-port, to turn from x along the curve $y s$. The average time of turning of four ships of the Channel squadron at 12 knots is given as 6 minutes 2 seconds, and at 5 knots, as 10 minutes 45 seconds. We may therefore assume that our ideal ship y will complete her circle in 8 minutes; it will consequently take her 1 minute to turn through four points, which will bring her to a . But x is just 55 seconds from the point a ; and she will, if she goes straight on, be herself rammed by y , 75 feet before her starboard beam. She avoids this mishap by porting her own helm, which has the double effect of delaying her progress, and enabling her to strike y a fair ramming blow before she reaches the point a ; y in short cannot escape either under steady or port helm.

If y puts her helm hard-a-starboard, she has a better chance, for x is only 25 seconds from the point p , while y is a minute from it, and consequently y may get inside x 's circle and be safe, before x is aware of it. But x can only lose his chance from want of skill. It is his sole business to keep inside y 's circle, whatever happens, and he should put his helm hard-a-port immediately, and turn along the arc $x q$. If y now persists in keeping his helm over, x has only to reverse his own at the right moment, and give y a fair ramming blow amidships.

In the case before us, therefore, y does not appear to be able to avoid the stroke of x 's ram by any employment of her helm. If 9 knots is her utmost speed, she cannot now increase it, so escape by that means is cut off. If she had it in her power to reduce her speed *instantaneously* to 5.6 knots, she would only reach the point o at the same time, and therefore on an equality with x . It may be assumed that a ship of any size could not reduce her speed by so much in so short a time; but let me remark, parenthetically, of the difficulty I am placed in for want of data on this subject. It will be clear to you all, that next to a knowledge of the turning powers of ships, and the theory which may be found to lie at the bottom of it, there is no more important consideration for any one proposing to attack by rams, than the time and space

within which the ram can stop herself, or reduce her speed to a given figure. Yet I am not aware that the experiment has been tried with any ship, or that it has been so much as noticed as a requirement.

However the actual case may be, we may reasonably assume that y cannot reduce her speed so as to be 20 seconds later than x in arriving at the point o . But she may hope to escape by reducing her speed, and putting her helm hard-a-port. Let us suppose that she can and does reduce her speed instantaneously to 5 knots. What is the result?

The difference in the diameters of the circles of four ships of the Channel squadron at 12 knots and at 5 knots, was only 53 yards. The radius of y 's arc at 5 knots cannot therefore be assumed to differ from that at 9 knots, by more than a quarter of a ship's length. Hence the arc y now describes will not cross x 's path more than 10 or 12 yards to the right of the point a . This is not enough to save her, in fact it brings x 's blow still nearer the midship point. But besides making this trifling alteration in the matter of space, y 's reduction of speed has made a more considerable one in the matter of time; y will take 20 seconds longer to cross x 's path under port helm at the reduced speed than she did under the full speed of 9 knots. We deduce this fact from the knowledge we have that the average time of four ships of Channel squadron in completing their circles at 5 knots, was 10 minutes 45 seconds, in lieu of the 8 minutes calculated as the time of turning at 9 knots.

Supposing x , therefore, to allow herself to fall into the trap, and to proceed along the line xa at speed, she would cross y 's path entirely, just before the latter reached the point a . But before she got so far as this, she would have surrendered her advantage over y , in having got outside her circle, and allowed y to get inside hers. Admitting she was unskilful enough to do this, y can only deliver a 5-knot blow upon x , and has surrendered so much of her power by reducing her speed to that figure. But we cannot suppose x would lightly surrender her advantage when she can keep it by the use of a little port helm. In this case it is evident that y 's delay along the curve ya , leaves it open to x to give her a perfectly fair ramming blow almost at her leisure.

There is still one last course open to y , namely, to reduce speed with the helm hard-a-starboard; and this seems to me the most judicious thing she can do. She will now take 1 minute and 20 seconds to reach a point ahead of x , somewhat nearer to her than the point b , which latter is, by our hypothesis, 25 seconds only from x . If x therefore delays an instant in putting her helm hard-a-port, her circle will pass ahead of y , and she may find herself open to the blow of y 's ram at the reduced speed, or, if she saves herself from the danger, there may not be room for her to give y a stem blow. The two ships will, in short, most probably rub broadside to broadside in passing, without material damage to either.

But it must not be supposed because y does the best thing possible under the circumstances that she gains any advantage over x ; she may recover the position of equality she originally lost, if x is unskilful enough to permit it, but that is all which is left open to her, and in any case her

reduction of speed is a surrender of her manœuvring power directly in favour of x 's proceedings. It is open to x to reduce her speed at the same time y reduces hers, in which case she retains all her former advantages, except that her blow, if delivered, will not be so heavy.

I have not time on the present occasion to pursue the enquiry as to whether the position I have assigned to my two ships in Fig. 4, is really the worst for y and the best for x ; it is sufficient for my purpose to show that it is a position extremely desirable for x to seek and for y to avoid, and that if y unhappily allows herself to get into it her fate is very nearly sealed. I think, however, the general principle may be assumed that the grand object of an attack and defence by rams must be to keep your adversary outside your circle, and at the same time to keep within his.

The next point we have to consider is how should x approach y so as to get into the desirable position?

There is a very prevalent idea afloat that the end-on position is the one proper to be assumed. It was one held by myself also, I may say, until I undertook the preparation of this paper, and I can, therefore, the more freely deal with it, and, if necessary, condemn it.

Let us suppose, then, that x and y , meeting in the open sea, and being each imbued with the necessity of keeping the end-on position, steer for each other. They must either give up their end-on theory, or they will at length reach the position given in Fig. 5. They are now within ramming distance, on an equality certainly, but each precluded from using the weapon that each is endeavouring to use, unless they are willing to try which is the hardest at the point o , an extremely improbable conjecture. But observe the position they have placed themselves in. They must either stop where they are, and give up all hopes of ramming, or they must dash at each other on an equality, or one of them must try some other plan. What plan is open to her, let us say, to y ? She may turn along the curve yp , or along the curve yq , or along any curve between those.

Let us suppose she puts her helm hard-a-port; in 30 seconds the ships will be in the position given at Fig. 6. In this position y has turned through two points, and is just about surrendering her equality, and allowing x to come within her circle, while she herself is outside x 's circle. The danger of her manœuvre is not so great as it at first appears, but there is no doubt that she has surrendered all hopes of using her ram upon x .

That she is not actually in danger may be noted from considering that she is 30 seconds from the point d , while x is one minute from it; y , therefore, has a good chance of dragging her whole length across x 's arc before she reaches the point d . But y has a still better chance of escape if she now rights her helm, for she is only 20 seconds from the point b , while x is 53 seconds from it. But, whatever her chances of escape may be, she has no chance of attack, and, as it may be assumed that any movement either ship might make from the position given in Fig. 5, would result in a position similar to that in Fig. 6, we must take it that there is a fundamental error in the end-on approach of two ships intending to ram.

It may be true that the end-on position is proper to avoid being rammed when there is no intention of ramming, but this is not the case we are now called on to investigate, and is assuredly not the case supposed by those who have abrogated the flank method of evolution in favour of the oblique.

Let it be noted here that though from a consideration of Figs. 5 and 6, there is great objection to the end-on position when *within ramming distance*; there is no objection to it beyond ramming distance; but then, on the other hand, neither is there any objection to the broadside position, or, in short, to any other position. The question of the nature of an evolution does not seem, therefore, to be affected at all by the proposal to attack by rams, although the nature of a formation may be. The only movement undertaken when within ramming distance would be the final sweep to ram, or avoid being rammed. Any preparation for this final sweep must be made beyond ramming distance, where the ships are free to use what means they please.

As this end-on approach is not to be sought for in a ramming attack, because of its liability to result in a position given at Fig. 5, the question is how should two ships approach each other who are equally ready for the combat?

The answer is to be found by considering that the only difference between x and y in Fig. 4, is that x is half a ship's length further from the collision point o than y is. We must expect the struggle to be to keep the courses at right angles to each other, but to be rather behind in reaching the point where they cross. The two ships may, therefore, steer for each other in the first instance, but before they close they will each mutually assist to place their courses at right angles, and to keep them so, or one of them by superior skill will approach on something near the end-on position until he can by a sudden and unexpected movement bring himself within ramming distance, at right angles to the other's course, and inside his circle at the same time.

In the first case, each ship would immediately bring the other, four points on the bow, and so gradually approach each other, and the most skilful of the two would by such means as were open to him take care to be a little behind at the last moment, ultimately taking the place of x in Fig. 4.

In the other case the ships would steer directly for each other at first, and might be expected to assume parallel courses, at such distance as would be determined by the most skilful of the two, and we should thus ultimately find them in a position similar to that given in Fig. 7. Here x has determined to get into the position p , by a turn of eight points to port, at the same time as y , by pursuing his course, arrives at the point q . x is 2 minutes from the point p , consequently his turn must be made when y is 2 minutes, or 600 yards, from q . The distance between the paths of x and y must be equal to the diameter of the circles, or else x cannot come into position at p . x will consequently commence proceedings when y is at the great distance of 1,200 yards from him, and nearly $2\frac{1}{2}$ points on her bow.

If all goes well, and y permits herself to fall into the trap, x will certainly gain her wishes and destroy or damage y , being herself in

perfect safety; and there is certainly this to be said for such a method of attack, namely, that *y* will only observe the bearing of *x* to alter a couple of points, will have little guide as to her intentions, and only two minutes in which to make up her mind. Yet, of course, any movement of *y*'s helm either way, before she reaches the point *q*, will overthrow *x*'s calculations, and make it necessary to try some other plan. *y*, however, may divine *x*'s idea, and may, by slight alterations of course to port, bring herself within *x*'s circle when she gets abreast of the point *q*. She will thus turn the tables upon *x*, which is just the risk she runs, and which may arise from a miscalculation of the distance or speed of *y*. The point to notice is, that this method of approach on parallel courses, a diameter apart, is one which may be adopted by two ships equally anxious to try their skill against each other in ramming.

We should notice that *x*, in adopting the foregoing method of approach, proposes to obtain her object by a double movement: one into the safety position inside *y*'s circle, and the other the delivery from thence of her final blow, and she leaves it in her power to abandon her intention at any moment prior to reaching the point *p*. Having once reached it, she places herself in the power of *y* if she turns out to be a certain distance to the left of *q*.

But *x* may also decide to deliver her attack from the outside of *y*'s circle, and only to come within it at the moment of collision. In this case, she will approach on a course parallel to that of *y*, but only one radius distant from it, as shown in Fig. 8. Here *x* must put her helm over when *y* is $1\frac{1}{4}$ points on the bow, and about 850 yards off, and she will arrive at the point *q* a little after *y* reaches it, supposing the latter to steer a straight course. But it is most unlikely that *y* will put herself into the wished-for position. The change of helm by *x*, will be very apparent to *y*, and her design almost equally so, and the smallest possible movement of helm may not only baulk it, but place *x* in a very difficult position, for it is possible that *y* might meet *x* within ramming distance, while the latter had her helm hard over, and the former had her's amidships. In this case, *x* would clearly have only half the manœuvring power of *y*, and might suffer for it. *x* in short cannot make a re-calculation of her position and prospects when within ramming distance, should she attack in the method given in Fig. 8, while she can well do so should she attack as in Fig. 7, and should she choose the first method of approach, bringing her enemy rather less than four points on her bow, and forcing her to keep so, she is perpetually re-calculating her chances and position.

We have now discussed roughly the principles of an attack by rams from ahead, when the ships have equal speed and turning powers, and I think it is apparent that the 4-point method of approach is the one we should choose under the circumstances.

We may now look into the advantage, if any, which *x* would gain from the possession of superior speed. We may in doing so, leave out of the question those advantages which speed gives in bringing the enemy to action against his will, for we are supposing both ships equally anxious to meet. We need not, therefore, trouble ourselves

except with the changes which greater speed for x would introduce in her position in Figs. 4, 7, and 8. In Fig. 4, if x had a speed of 12 knots in lieu of 9, she would, by pursuing a straight course, strike y nearly amidships at the point o , instead of well abaft her beam, she might therefore begin her attack from a position farther astern, and therefore safer from a miscalculation of the size of y 's circle. This would be her advantage also in case y put his helm a-port. But on the other hand, if she found herself at the position given, with this extra speed upon her, she may be obliged to forego her attempted attack in order to save herself, for if y puts his helm hard-a-starboard, x is advancing so rapidly that she can hardly avoid allowing y to get inside her circle, and the moment that happens, she is either at y 's mercy, or she must escape under starboard helm and her superior speed.

In Figs. 7 and 8, the advantage of superior speed is that x may allow y to approach more closely, and therefore under a better estimate of her distance before she turns: there is no other advantage known to me.

Reverting then to Fig. 4, if x with greater speed than y means to attack her with the same advantages as x is now seen to possess in the diagram, she must either be further from the point o herself, or y must be nearer to it; but the skill required at the low speed and at the high speed is equal, and the dangers of being rammed instead of ramming, are possibly a little increased. I do not look upon great speed consequently as very important for a ram.

But if the question is not one of permanent speed, but of the power of increasing or reducing the speed of the ships rapidly, then there can be no question of the advantage. The increased speed will save the ship from being herself rammed, and the power of reducing it will enable her to ram effectively, and hence we may assume that a very heavy ship is an inefficient ram, for she cannot have the same powers of varying her speed as a much lighter one would have.

But now, suppose x with no advantage in speed, is half the length of y with the same proportionate turning powers, and observe the conditions under which she will meet y in Fig. 9. It may be seen at a glance that she has y absolutely in her power, for she has all the advantages she before possessed, besides the infinite advantage of manœuvring freely within y 's circle, and being able to frustrate in the most perfect manner any attempt of y 's to escape under starboard helm, which we before saw was really her only chance.

Then again, look at Figs. 7 and 8 as to her facilities for attack under the new conditions. In Fig. 7, if x had miscalculated her distance and found y would be too far ahead to be rammed from the point p , her stroke was altogether lost, but under the new conditions she may commence on the curve $x p$, but end on the curve $x t$, thereby having it in her power to move the point p to suit the movements of y . While under the old conditions, the boundary of her possible movement under starboard and port helm was $x p q$, it is now enlarged to $x t s$. So in Fig. 8, x may commence on the curve $x q$, but has a reserve of manœuvring power as far as $x r$.

If it be said that y by increased speed can make up for x 's increased turning powers, I think we must deny it, unless y surrenders all idea of ramming, or even of allowing her adversary to come within ramming distance. If she allows x to close her, and to get into the position given at Fig. 9—which she is very likely to do—her speed will hardly save her; for allow her 12 knots to x 's 9 in Fig. 9, and she cannot escape under starboard helm, she has not a foot to spare under port helm, and she has not a ship's length to spare under steady helm; and it is not to be supposed that x in the confidence of her manœuvring power, will not provide against this chance, by keeping much closer to the point o .

There is, however, a method of attack for which superior speed is necessary to success, and that is the attack from the rear, either directly or by an advance past the adversary, and a turn upon her. Of the direct attack I need not speak much; it would doubtless be possible for a ship with superior speed to chase and to ram a ship of inferior speed, which declined to face her. But the blow so given would be a light one, as its velocity would only be the difference between the two speeds, and it would undoubtedly be long in coming. The indirect attack is made by the ship with superior speed coming up from the rear on a course parallel to her adversary's, and one radius distant, then drawing sufficiently ahead to strike her at right angles by a turn of 8 points. This case is ably treated by Admiral Boutakov, and I agree with the conclusion he draws, that the adversary need never allow herself to be so rammed; she can see the opponent gaining on her, and must know what the result will be; she can then either turn from her or towards her in perfect safety, and the result will ultimately be the direct attack I have noticed.

Long as we have dwelt upon this question of the ram as a weapon, it must be apparent to all that I have only touched the outskirts of the question, and until Naval Officers will turn their intelligence fully upon it, on the outskirts of the question we shall remain.

We have, however, I think, shown a probability that the following conclusions approach the truth:—

1. The end-on position must never be taken up by a ram until the moment her spur strikes the object.
2. Extreme speed is not so necessary for a ram as extreme powers of turning.
3. Great length and weight are an inconvenience to a ram. It may be added that they are not necessary for an effective blow. The work done upon a ship by the 400 lb. shot from the 18-ton gun is under 5,000 foot tons. The work done by the stem of a vessel weighing 1,000 tons, propelled at 10 knots, is equal on impact to 4,270 foot tons, and the work is done below the armour.

4. So far from ramming being a difficult or impossible task, it is a thing which can be accomplished by superior skill with vessels otherwise equal. But a ram whose turning powers are much greater than her adversary's, may attack her with every confidence of success.

This seems the place to advert to the ordnance proper to be carried by a ram.

I must confess myself doubtful about the end-on fire—a result I did not at all expect to arrive at when I planned the paper. I had in my previous papers laid it down that I would in no case use my guns on approaching to ram, but that I should be glad to see my adversary use his, because my movements would be disguised thereby, and I observe a great French authority, Admiral Jurien de la Gravière, has recently advocated the same view. If this is so, when *is* a ram to use her artillery? The answer seems to be, when she has missed her blow, and is passing her adversary broadside to broadside. Except at that moment, “The poor advantage,” as Admiral de la Gravière says, “to be gained by a discharge rendered uncertain by the rapidity with which the distance varies, cannot compensate for the cloud of smoke which would envelope the ship at the all-important moment, when her safety depends on the precision with which she is handled.”

It may be argued that this is true enough of the case when within ramming distance, but that ships should be armed for end-on fire before coming within it. The answer to this is, that we have seen how a ship may really commence her ramming manœuvre at the distance of 1,200 yards if she approaches the end-on position, and that if she approaches on a 4-point bearing, a very slight alteration of course, will bring her broadside guns to her.

I thus conclude the rough examination of the ram question as applied to single ships, and as separated from artillery fire and the torpedo. I must now pass to the latter and newer weapon.

Torpedoes.

In the very admirable paper given to us by Captain Dawson, on Offensive Torpedo Warfare, he expressed his conviction that we were neglecting a very powerful and valuable weapon in the outrigger torpedo, which he believed applicable to fleets. Unfortunately experiments on the question are wanting, and it would not be possible, in the absence of them, to make the outrigger torpedo a basis of attack and defence. This much may be said for them, however, that if they succeed at all, they will certainly succeed in an attack from the rear. I have shown that a vessel with superior speed may strike another about the stern with an inefficient blow, equal to the difference between their speeds. These are the conditions under which the outrigger torpedo would supply the deficiency. The vessel using it, consequently wants speed, but need not be a ram. Captain Dawson thinks they might be employed in outriggers at right angles to the keel, and be so used by a ram which had missed her blow and was passing broadside to broadside of her object. Under such circumstances the torpedo would compete with the broadside gun, and I am rather inclined to think the latter to be the more effective weapon.

The Harvey torpedo seems to me a weapon by itself, and not an auxiliary, like the outrigger torpedo. I understand that Captain Harvey deprecates its use in ordinary ships, and proposes special ships, to employ no other weapons. To me, however, it seems a weapon well adapted as a defence against rams in large and long ships. If the ship

y in Fig. 9 was known to be towing a torpedo on her port quarter, as in Fig. 10, it enormously increases the hazard of *x*'s attack, although it need not deter her altogether. Her tactics would be, in the event of missing her blow, to pass close under the stern of *y*, trusting to run over the torpedo line. The danger, however, would be great, for the line might easily be fouled, and then *y*'s progress might draw it under *x*'s bottom and explode it there.

The Harvey torpedo vessel does not require anything but great speed, but this she must have to be efficient. The tactics she pursues are very much simpler than those of the ram, for she does not want to be in a particular place at a particular time; all she requires is to pass her adversary within about 200 yards on any course, and her mission is fulfilled if she succeeds in doing so. In the attack by such a vessel on another of her class, skill appears useless as against speed, and it would seem the slowest ship must be destroyed. The object would probably be an endeavour to cross each other's bows, and the fastest ships must ultimately do this.

These few remarks are all which seem to me necessary on the question of torpedoes as applied to the attack and defence of single ships. They are weapons destined to play an enormous part in the operations of future naval war, and if hereafter I continue this subject, their immediate part in fleets must be examined, but as regards the chief of them, the Harvey torpedo, I don't see how it can be discussed by itself. A Harvey torpedo ship meeting another in the open sea, and knowing her to be one, cannot run down upon her and trust to chance as to which torpedo takes effect first. She may certainly approach as a ram (*x*) would in Figs. 7 and 8, with the intention of crossing *y*'s bows at some distance; yet *y* can never be supposed foolish enough to run such a risk. If she thinks she has superior speed, she will carefully abstain from all close quarters except with her head the same way as her enemy, and with helm amidships. It is not as in ramming, where a distance of 50 yards or so makes all the difference between victory and defeat. It is more a question of superior speed, and a knowledge that the superior speed, properly used, *must* destroy the adversary by torpedo, just as superior turning powers must destroy her by ramming.

The effort of two torpedo ships, it seems to me, will be confined to ascertaining which has superior speed, and the strong probability is that in the ascertainment of that fact one of the two will perish.

The Attack and Defence of Single Ships.

Only now, after this separate treatment of the gun, the ram, and the torpedo, are we in a condition to combine them, and to observe the effect under such circumstances. But before proceeding to such combination, it appears to be the proper moment to advert to foreign naval opinion on the status of the weapons. I must leave the torpedo out of this account, for I know not the opinion entertained about it abroad.

The rise of the ram in foreign estimation is one of the most re-

markable features of the age. Dating from the first utterances of our gallant Admiral of the Fleet, Sir George Sartorius, the ram has carried all navies by storm, and, so far as I can gather, except in Russia, without enquiry. When I read my paper on Modern Naval Tactics here, in the year 1865, and acknowledged myself a complete convert to Sir George Sartorius's views, English naval opinion was incredulous. Admiral Boutakov had written ably on naval tactics, but had nowhere expressed a conviction that the ram governed the tactics of the future, although an enquirer so acute and unprejudiced could not avoid allusion to its growing importance. In France, a system of tactics based wholly on the supposed unrivalled empire of the gun existed, and there was only the faintest glimmer of an idea that the old line of battle was about to fall from its high estate.

Now look at the change. Admiral Boutakov has worked at the ram question to an extent unattempted by us; and Russia has drawn up her scheme of naval evolutions on the avowed principle that the ram is the only weapon of value against a fleet. France has pushed her old system of evolutions into the back ground, in the firm belief that the ram, and the ram only, need be feared at sea.

The ramming experiments tried by the Russians under Admiral Boutakov, are altogether too interesting to be left without a passing notice. He took two gunboats of 200 tons each, and fitted them up as harmless rams. A sort of gabion or extra large fascine was fitted to the stems of these craft, and a belt of fascine work ran all round their gunwales. Captains of two of the ships present were placed in respective command of the rams; they were turned broadside to broadside, head and stern, and started to damage each other as much as they could. Cross-bearings of the two rams were constantly taken during the continuance of the struggle, and the corresponding tracks mapped out. Two of these encounters have been reproduced in diagram II, where the dotted line represents the track of the ram "Priliv," commanded first by Captain Kolong, and secondly by Captain Vogak. It was a rule in these encounters that a Captain lost his command when he was rammed, and consequently some Captains of greater skill slew several foes before they lost their own command. The struggle represented in the upper figure lasted 16 minutes, and the track of the victorious ram, the "Goul," commanded by Captain Ivanov, is shown in black. Ivanov was again victorious in the struggle shown below, but not till 30 minutes had elapsed. Twenty-one of these encounters are given in the pages of the "*Revue Maritime*," and the shortest time in which the ramming was effected was 5 minutes; the longest being 50 minutes; the average being just 20 minutes.

No doubt the battle of Lissa has had much to say to the advance of the ram question, but in England we did not lay that lesson to heart as Russia and France have done. The confirmation of my belief in the ram which Lissa gave, and which I very strongly put forward, carried only a small section of the service with me. I was still met as before, by the remark that it was very difficult to ram another ship, and I believe that even now only a section of the English Navy is disposed to forsake the trust in our guns and to put it in our stems.

I am not completely in error on the question, I hope that what I have already said to-night will lead my brother Officers to look into the matter more closely than they have yet done, and with minds so much more capable than mine, to ascertain what the truth may be, and not to be satisfied with mere vague phrases and vaguer thoughts.

Let me now briefly endeavour to picture what the nature of a duel in the open sea would be between two "Monarchs," each equally ready for the fray, but one of them determining to use her guns and depending upon them, and the other looking at her guns as a secondary weapon. To keep up our terminology, I shall call x the ramming ship and y the one depending on her guns. x would, on first sighting her adversary, bring her about 4 points on the bow and manœuvre so as to keep her there, while she advanced at speed. y might be expected to steer direct for her enemy, trying perhaps an occasional long shot and swerving slightly to do it. At about 2,000 yards distance, x would find it convenient, if not forced to do it before, to bring about 4 points on her bow so as to keep a steady fire upon her, which we must suppose from that moment to commence. They are now, in Fig. 1, diagram III, 1,400 yards from the point at which their courses cross; and if they were going 10 knots,—which x at least will be certainly doing, as she knows her greatest safety from shot lies in the rapid alteration of elevation of y 's guns,—if they were each going 10 knots, they are only 4 minutes 12 seconds from collision. What damage can y do with his shot in that time? She may fire two shots on each gun, or eight in all, of which we have seen none would hit the ship was steady at 1,000 yards; and the distances at which these shot are fired varies from 2,000 yards to nothing. The gauntlet which x runs is a bagatelle, no ship need fear it, and if y has laid herself open, and permits x to get into ramming distance, as in Fig. 4, diagram I, it is all over with her, unless she has reserved her fire for the supreme moment. But we may be quite certain that no fire will be served. She will have exhausted all her efforts in combined accuracy and rapidity, and x will only run the chance at close quarters of receiving a stray shot badly aimed, as it is sure to be at such a time. If x has passed through 4 shots, a minute before collision, she is safe from y further fire.

But suppose that y is wise enough to perceive his danger, and to turn towards x , along the curve $y r$, Fig. 2; x cannot now ram conveniently, he therefore takes the step he had previously prepared for, and brings his guns into play. His method is to sweep round upon a large circle $x q$, with his guns trained right abeam on the starboard side. In 30 seconds he discharges them full into the plates of y at point range, and passes away unharmed to prepare a renewed encounter.

I cannot pass a very probable feature of this kind in a naval duel, without remarking on the advantage y would have were she armed as broadside ship. If y discharges her port broadside at x , two minutes at least elapse before she does it again; more than two minutes must elapse before she can transfer her fire to the opposite broadside; consequently x has it all her own way in passing starboard side to star-

board side. If y , however, had a second set of guns ready on her starboard side, x might take less from her manœuvre.

Time does not permit me to dwell longer on a part of my subject which will bear any amount of the closest study. I have indicated what seemed to me the absolute values of the gun and the ram, and I have endeavoured, by bringing them into opposition in a fight between two ships, which I imagine to be a representative combat of its kind, to get at their relative values. I might infinitely vary the circumstances of approach and subsequent conduct, but so long as x acts on the assumed superiority of his ram, and y on the assumed superiority of his guns, their combat must partake of the nature of that I have sketched out. x will again and again make his effort to ram, and will only take to his guns after each failure; y will persist in believing he is damaging his opponent, which in my view he will not do, and x 's failures to ram will not prevent him damaging his opponent effectually by his broadside guns.

There are some points to be noticed in the details of such a combat, as I have sketched. x cannot be put to a disadvantage by the direction of the wind, whereas, if y is unhappy enough to engage to windward, the smoke from his own guns will hide x from him, and will, while it interferes with his own fire, effectually shield the operations of x from view. y , however, is not at all hidden from x , who observes her every movement at his leisure.

The temptation to go at slow speed so as to make better shooting, is very great; yet nothing could be more dangerous than to be caught at slow speed within ramming distance by a ram.

It may be thought that it is improbable that all combats should take the form I have sketched out, but I think it is possible, that if one ship determines to keep her opponent on a 4-point bearing, she compels her to do the same, as being the only way of approaching, so that the ram is still the master, even in directing the method of his enemy's approach.

Wherever the Harvey torpedo makes its appearance, whether in company with guns and rams, or by itself, it is still speed which must carry the day. Whatever one ship may think of his guns or his ram, he must try his speed and his torpedo, if the other chooses to adopt that mode of attack. y could not, as in Fig. 2, diagram III, if x was towing a torpedo, turn towards him and allow him to cross his bows: he must turn away from him, and trust to his own torpedo to keep x 's ram clear of him. Hence they come to parallel courses, and artillery fire, broadside to broadside. The struggle will immediately be, which is to head the other, and whichever can succeed, must be victorious. The tendency of the Harvey torpedo seems thus to be, to bring the gun forward again, as the tendency of the ram has been to push it back. While this struggle for precedence continues between two torpedo vessels at short range, much damage must be done by artillery; and if the speed of the ships is nearly equal, the combat might be decided by a broadside action of the old type, except, that it is carried on at high speed.

Here then, I close, my examination of the bases on which the attack,

and defence of modern fleets must rest, and no one can be more conscious than I of its vagueness and imperfection; but I hope it will be admitted, that I could not proceed to carry out the examination set forth in my title, until I had come to some conclusions, such as I have put forward: and, in any case, I trust to have shown, that with proper experiments and deductions therefrom, the relative importance of the weapons we are dealing with, and their judicious employment, first, in single ships, and finally, in fleets, may be fairly estimated.

I must not quit the subject without adverting to those principles of construction and armament, which the matters we have been discussing, appear to recommend.

End-on fire appears less a desideratum than I at first supposed it would turn out. For a ram it seems quite unnecessary, as the latter seems to combine much more satisfactorily with the old-fashioned broadside gun.

The ram, pure and simple, is strongly advocated as a weapon, by Sir George Sartorius; and I must own that, it seems to me, a gunless ram of equal speed with the "Monarch," but about one-fifth her size, would meet her on equal terms in the open sea.

If such a ram were to attack, a larger ship could best defend herself by a large number of light shell guns. Such might be easily employed on a broadside ship, in addition to her plate-piercing armament, but could not be employed in the "Monarch." If, however, it is found that a ram of 1,000 tons can be so plated as to resist all but the heaviest shot when striking at an angle of 45° , then it appears to me, here is no help for the larger and more unwieldy mass such as the "Monarch," except the towing torpedo.

If light swift torpedo vessels are designed, a heavier and slower ship must meet their attacks by multiplying the numbers of lighter guns carried.

On the whole, it does appear to me a matter for very serious consideration, whether this struggle after guns which will pierce the heaviest plates at long range, has not overshot itself—whether the point has not already been passed at which the reduction in the number of shot, which can be fired per minute, is compensated by the increased power of the gun.

But while it is impossible to dogmatise on these various points, am I wrong in thinking that the service and the country, should seriously undertake to determine the relative values of the gun, the ram, and the torpedo, and not to rest content for one moment longer in an atmosphere of misty ideas on the question?

The CHAIRMAN: If any gentleman has any question to ask, or any remark to make, I am sure Captain Colomb will be glad to reply to him.

Captain DAWSON, R.N.: When Captain Colomb read a very interesting paper, a year or two years ago, on a similar subject, I went away very painfully struck with the fact, that there were so few experienced Officers present who attempted to grapple with the subject brought before them, and to give us the benefit of their experience. I hope that we shall not have the same complaint to make this evening. I did not quite agree in all respects with what fell the other evening on the subject of "naval education" from a brother Officer, that Naval Officers

are altogether deficient in the logical or reasoning faculty. If that idea be still held by my friend, I think that to-night he must have been disabused of it very much indeed, for Captain Colomb has shown that he has not lost his reasoning powers during his recent service afloat. Confining myself to the general subject, I will not enter into the details of this paper, which we cannot do off-hand. There has been no real fighting in earnest at sea since the days of our grandfathers. There has been none in connection with our own Navy; and there has been very little in connection with foreign navies. There has been no real out-and-out fighting like that of the old sea-days, except, perhaps, a little the Americans had in their recent civil war. So that the conduct of a modern sea-fight is entirely a hypothetical subject, which one can only speculate upon as an interesting problem, full of unknown quantities. As an old gunnery Officer, I long ago came to the conclusion that steam was against the gunners, fatal to the guns, fatal to accuracy of fire, because of the fatal facility with which the helm can be used simply to manœuvre, without reference to the guns and gunners. I have often felt, as a gunnery Officer, that the days of guns as a truly offensive weapon were numbered. If we went into action now with other navies, that are equally skilful and equally courageous as our own, and equally ready to join in action, the first attempt, I think, on both sides would necessarily be to use the guns. But when we are told, as I understand from the paper, that the "Monarch," can only make one hit every four minutes, so that in the course of forty minutes she would only make ten hits at various angles, with hardly any penetrations, patience on both sides would soon be exhausted under that process, and both would necessarily be driven to ram. If that is the case, then, every ship, large and small, ought to be fortified and strengthened in the bows for the purpose of ramming, should the opportunity arise. I have always thought that there would be very great difficulty in ramming at a vital angle; but, as the lecturer went on, he shook my ideas of the difficulty of a ram striking another vessel, though I still think experience and skill and nerve would alone accomplish it. What shook me most was the account of the experiments so practically conducted by the Russians, under the guidance of the first seaman of the day, Admiral Boutakov, in which it appeared that striking with the ram was a certainty. It appears, then, to be an established fact that one of the vessels can ram the other at the end of a certain number of minutes. That fact has shaken my scepticism as to ramming. But if those Russian vessels had not only acted as rams, but had been provided with guns, and also with torpedoes, they would not have passed one another so frequently in the effort to ram without inflicting injury with their guns, or without bringing their torpedoes into destructive contact with one another. That brings me to another point. If the torpedo were to come into use in conjunction in the same ship with the ram and with the guns, it would restrain the indiscriminate use of the ram; for just as the ram supplants the gun, so the torpedo will supplant the ram, as it would be difficult and dangerous to approach a vessel for the purpose of ramming, which was bristling with torpedoes all round. The gun would then come into requisition to protect both the ram and the torpedo. The conclusion I come to is, not to build special vessels for any one arm, but that every ship should be armed with all three weapons, to be used as opportunity offers. These are the changes which are coming in future combats, and they must be met by corresponding changes in our ships. I understand that Sir George Sartorius, whose opinion we should all defer to, thinks he can avoid the torpedo when he is ramming; but I should not like to come into close quarters with a vessel that was bristling all round with torpedoes. That is a point upon which I should be glad to hear the opinion of the Officers present, who are better qualified than myself to give an opinion.

Commander A. H. GILMORE, R.N.: I came here prepared to hear a lecture on manœuvring fleets, and Captain Colomb has given us a lecture on a trial of skill between two rival Captains in command of rams instead. I suppose they are to be either broadside ships or turret ships. I think in the case of ramming, the turret ship has a great advantage over the broadside ship. She has merely to be kept end-on, and she has the use of her end-on fire, to which the other vessel must expose her broadside before she can reply. I was with Captain Dawson some years ago, at the first trial of Captain Harvey's torpedo. No vessel would attempt to ram another that had the use of these torpedoes, unless she was fitted up on the cellular system.

No doubt those Russian officers, when trying to ram one another with gunboats, were under no idea of coming to any great grief. Their nerves were quite steady; they had merely to get their stem on one another's vessel if they could, and, protected as these experimental gunboats were, without danger. But, as Captain Colomb says, a few seconds here, a few seconds there, in calculating the time, a turn ahead of the screw more or less, must make it almost impossible for vessels to meet at an effective ramming angle. Then I think the power of the gun must have a great influence upon the vessel being attacked. For instance, x means to ram y . x being unarmed, merely a ram, y , bringing the whole force of her artillery to work, must do a great deal of damage to x . I think also the present system of guns will bear no comparison with Captain Harvey's torpedoes. I know no Officer in command of a ship that dare approach a torpedo vessel. All you want is a small vessel of high speed, belted round the water line, and decked over, as the Irish dispatch vessels are, with a rise in her deck, and the shot would glance off. She is perfectly impregnable to the heaviest shot of any gun, and would herself destroy an enemy with perfect ease.

Captain GOODENOUGH, R.N.: I think Captain Colomb, in his very suggestive paper, has given the very best plea that could be given for the intense study of these subjects. For, as it has been said that boldness, and nothing but boldness, will carry the day in war, so I think you can say that nothing but intelligent study of our profession in time of peace will prepare us for the development of that boldness at the proper time. In no case is that more strongly shown than in this system of attacks by ram, where boldness will be the necessary accompaniment of intelligence. Because, after all, you may conceive a number of imaginary positions of ships, and imaginary forces and speeds of ships, and you may draw a number of combinations of those ships' movements upon paper, and yet at last the ramming blow will be struck by the boldness and stomach of the Commander of one of them. I was very much struck with what was said by Captain Vansittart when he was in the Channel Squadron. Being asked his opinion on ramming, he said, the first thing necessary in an Officer who was going to ram was that he should have a good stomach and a good digestion. There cannot be any doubt about it; because in every case in which the ships are brought together, if they are ships of equal speed and equal turning powers, an excess of correctness of eye, of judgment, and boldness on the part of one man will in an instant decide the engagement. There are one or two points in the lecture to which I should like to advert. The first is on the general remarks which preceded Captain Colomb's lecture. He draws attention to the necessity of opinions being formed on this subject, in order that our ships might hereafter be properly designed. There can be no question as to the very great necessity of this. There was one thing said with regard to guns which I think Captain Colomb might correct a little. It is the experiment in Vigo Bay. His deduction from that experiment has been most careful, and he has rather overstated than understated the power of the gun; but in one place he stated that the number of the rounds fired from the 25-ton gun was one in two minutes; in another place, that it was one in three minutes. The Vigo experiment was this—that with the guns of each ship all loaded, a signal was made to commence firing at a large rock. Therefore, the guns were fired at the very instant the signal was given to "commence." The result was that the "Hercules" fired about four rounds per gun in five minutes; the "Monarch" and the "Captain" fired about three rounds per gun. Therefore, in estimating the number of rounds, you should subtract one round, or once the number of guns, in making the calculation. It would, therefore, appear that the guns were not fired so rapidly as Captain Colomb has said. That would make a difference in favour of his argument. Then, we come to the comparison of the "Monarch" and the "Hercules," a comparison which has been followed out still further in the general observations as to the turret and the broadside ship. I am not sure whether Captain Colomb wished to state the question in this way, and I would ask him in his reply to put it more clearly, whether he would consider the "Monarch" as a broadside ship carrying her guns in turrets, or whether he considers the "Monarch" as a vessel apart from the "Hercules," as a true turret ship. Because that is what the "Monarch" seems to me to be. There is no reason, for instance, why, under the fore-castle of the "Monarch," we should not put guns (sup-

posing she had now a fore-castle big enough to carry them), of equal power with the guns under the fore-castle of the "Hercules." Therefore, it seems to me, it would be more distinct and more definite, and it would lead to more scientific argument, if the "Monarch" was to be defined as a broadside ship carrying her guns in turrets, leaving the appellation of "turret ship," or some other definition, to express clearly a vessel that has a fire from her heaviest guns all round, in line of keel, ahead, all round on either side, and very nearly in line of keel astern. In that case I am doubtful whether Captain Colomb would still stick to the broadside ship, pure and simple, or the broadside ship carrying her guns in turrets, when the former has so limited an arc of fire as 70° , viz., 35° before and 35° abaft the beam. Passing now from the guns to the diagrams, and to the part of the lecture which deals with ramming, and which Captain Colomb has so clearly set forth, I think he enters upon the argument with an admirable proposition, namely, that a ship advancing at speed has two circles on either side of her, within which she cannot possibly place herself. That is an expression which gives a very concise view of the state of affairs. Going now to Figs. 4, 5, and 6, the very arguments which he has used, and the diagram which he has drawn, lead me, contrary to his opinion, to have a very strong feeling in favour of end-on fire, which I would not limit to a fire simply in line of keel, but which I should describe as a fire uninterrupted in line of keel from some points on one side of the bow to some points on the other side of the bow. If the fire was simply end-on in line of keel, with very few degrees on either side, I think it would be very inoperative, and not worth the price which you must pay for it. But the fire round the bow is to me of the greatest value, because, looking at Fig. 4, it seems to me that the very great advantage which x has there—it has been well pointed out by Captain Colomb—is, that y is more nearly in the line of x 's keel than x is in the line of y 's keel; and that whenever x quits that position and turns away from y , she at once gives y the position of advantage which Captain Colomb has pointed out, and has so fully dwelt on. Now, supposing that the ships are not travelling towards each other at so wide an angle as a 4-point bearing, but travelling more nearly towards each other, the nearer y points towards x , the nearer must x point her bows towards y , if she wishes to avoid all danger of y getting within her circle. Take, again Fig. 5; there the very same thing, I think, is shown. Directly one vessel turns the least away from the other, she at once places herself in a position of disadvantage, unless she has something to make up for it, either speed, or turning power, or better stomach or eye in the body of the man who commands her. That is a point, that of meeting straight end-on, which I think requires to be very well looked into, and about which everybody who has to command a ship should thoroughly make up his mind; because that seems to me a position in which ships will again and again find themselves, pointing directly to their adversaries, and the first Commander who flinches, no matter from what cause, either from want of stomach or from want of eye, will put himself at a disadvantage. Other things being equal, he may recover himself, but once he has flinched, once he has slackened his speed, he has put himself into a position of disadvantage, that is to say unless he knows and allows for his opponent's state of mind and intentions. One can hardly follow out the arguments on Fig. 5, unless one imagines an advantage on one side or the other, but, supposing the ships to be equal in all other respects if they meet, the advantage will be to the ship that is most strongly built. In all the other points of bearing in which ships are supposed to approach each other, there is one thing which seems to be essential, and which, I think, it will be well for everybody to keep his mind upon, that is, the importance of improving our compasses. I do not see any prospect of a ship being able to manœuvre with success, to approach his adversary in such a manner as to give the decisive blow, unless the Commander is able very nicely to estimate both the line that he himself is proceeding on, and the line that his opponent is proceeding on. To do this, if you are in an open sea, you must have the assistance either of very accurate compasses, or you must be in a position near to land, where some objects on the horizon are distinctly marked out, and by the transit of your opponent past those objects you may estimate pretty well what he is doing, the rate at which he is moving, and how you may best hit him. I remember that when the Channel Squadron was entering Gibraltar there was rather an expectation on board one of the ships during

the evolution in which the lines were crossing each other, of two ships coming in collision. But I believe the fact was that the person who was conning the ship that was supposed to bring the other into danger had the opposite shore in view the whole time, with a perfect knowledge of all that was going to pass, and that he placed his ship exactly where he meant to place her. That was entirely due to the shore being in sight, and to the transit of the other ship past the points of the land being easily observable. To be able to do the same kind of thing in the open sea, you must have very accurately graduated, sensitively moving, and at the same time very steady compasses. These are very difficult things to get in one compass, but it is very desirable to have them, and it is very desirable that we should keep that very important object in view. There is one other point in which I entirely agree with Captain Colomb, that is the advisability of having high turning powers in our ships, to a certain extent that must be superior to the advantage of high speed. But there is an equation between the two to be arrived at. Anybody who can give us such an equation will confer the highest benefit on the service. It is to be arrived at by calculation and experiment, but I am afraid we are not in a position to arrive at it yet. I should not like to sit down without saying how much we ought to seek for opportunities to perform such experiments as the Russians have been making in the Baltic for some years. Those experiments are of incalculable value; if we cannot perform them in our big ships we must try by united representations to get them performed with gunboats, and, if we cannot have gunboats, then with models on the table. Whatever we can do towards ascertaining the powers of equal ships at equal speeds in combat I think we are bound to do for ourselves.

Captain HARVEY GILMORE: Captain Goodenough made a remark about the desirability of having good compasses in our ships. I do not know whether you have seen Lord Caithness's compass, which is the most perfect one that was ever made. The oscillation is reduced to a minimum, and the heaviest guns can be fired without making the compass spin round, as compasses do now when heavy guns are fired. At the same time it is very sensitive and good in every respect.

Captain ARTHUR: It is useless for four or five degrees of rolling, the friction is so very great.

Captain MONCRIEFF: In making one or two remarks upon this subject, I shall confine myself entirely to that part of it relating to guns. It may interest this meeting to hear a statement connected with the application of a new system of mounting artillery in ships which I have brought forward. Captain Colomb has alluded to the relative decrease in power of guns in vessels. The new system will have a tendency to restore that power. This drawing represents a vessel of the "Devastation" class, which I take for example, and we will suppose that this is a plan of the deck. The centre part, or breastwork, is placed somewhat in this manner. These vessels are intended to carry two turrets with four 35-ton guns. The statement which I wish to make is this, that in place of these turrets with four guns, six 35-ton guns can be mounted upon the new hydropneumatic carriages, with the following extraordinary results, that thereby you have increased the armament of these vessels, and yet leave a large margin of weight to be disposed of, or else the size of the vessel can be reduced for the same armament. With the Moncrieff arrangement in place of the turrets, five guns fire to the front in line of keel, and six on either broadside, the funnel, engine, ventilators, and boats being in the middle, as with the turrets. You will observe in this case that, taking the three bow guns, the centre one is only capable of firing on the same conditions as the turret, that is to say, with it you cannot fire with any great depression, on account of the bow. But if the vessel is a little cut away the other two guns can fire straight forward, and yet have a good many degrees depression; not only, however, can these guns fire to the front, but also two of the stern guns alternately, which makes five guns on line of keel; there is no turret in the way, you can, therefore, fire straight over the front guns. The horizontal port closes by the recoil, so that the heaviest charges can be fired over the heads of the men by another gun in rear of them, without either inconvenience or danger. Again, on the broadside you can fire four guns with maximum depression, and two with small depression on one side, or six guns on either broadside. If this arrangement is adopted for the "Devastation" two more guns are thereby obtained, but I maintain at the same time that much greater power than one-half more is got,

because I believe it is acknowledged both by naval men and artillerymen, that the twin guns in turrets (putting aside the inconvenience of muzzle-pivoting) have not the same power as guns acting individually; they are obliged both to be in the same line at all times, and, of course, if a turret is disabled two guns are disabled by one accident. Therefore, this arrangement of six guns, instead of four guns, gives an increase greater than at first appears, and, moreover, leaves a margin of a very large amount of tonnage to be disposed of either for carrying a larger quantity of fuel, or for increasing the armour. I hope that this statement, which you will find to be correct, will not be considered foreign to the subject before the meeting.

Captain SCOTT, R.N.: I think this is a very important subject, requiring much careful consideration. I followed with a great deal of pleasure the clear statement in which Captain Colomb described the ramming process. But it seems to me that he has given too great prominence to it. We have heard just now from other speakers of the importance of the torpedo, and of the probability that it will greatly interfere with successful ramming. If that should be the case, it must again bring the gun into its old place; but I am very far from admitting what Captain Colomb says as to the decreased value of the gun; I do not think it will be found at all to be what he imagines in actual practice. He says the gun has receded, and has drawn up a table to prove this. I think if you go more closely into the matter it will be found that the gun has not receded. We have placed very heavy plates on the sides of our ships, but these plates are borne upon light bottoms, and at present we do not know what will be the effect of hitting them. From what I have seen at Shoeburyness, and having afterwards considered the subject very carefully, it appears to me very doubtful whether under fire these plates will remain long on the side of a ship. If the plates come off, the ship will get a heel and be liable to attack on the weak parts which were previously under water. Even supposing you do not knock off portions of the armour, there will be a great deal of plunging and other fire, which will strike the ship very often in parts that are vulnerable. Ships do not always keep upright, but will be hit frequently when heeling over. As far as accuracy goes, I think steam has tended to very much increase it. At the present time we have very few relevant experiments, and our men are not well drilled, consequently are not on a par with the weapons they are called upon to use. But, hereafter, we may look for much greater accuracy of fire than we now obtain. The subject, however, has so many aspects that it is most difficult to draw the line between the relative value of the different weapons. It seems to me that to place the value of one weapon prominently before that of the other is a mistake, for all should be made as perfect as possible to meet the varying circumstances of warfare. Doubtless ramming will be the first mode of attack; that is, squadrons and vessels, if they are powerful enough to ram with advantage, will endeavour to do so. The gun will also hold just as important a position as it has ever done; and the torpedo will supplement the gun, and be a very effective weapon. With regard to the light vessels spoken of by Captain Colomb, if you have a vessel of 1,000 tons, how are you to iron-plate her, or even put an armoured belt round her, and give her speed? You cannot efficiently armour-plate a small vessel, and in merely giving her a belt round the water-line you expose her to be shot through sides and bottom from above the belt by a larger vessel. Again, with regard to the ramming, I think the proper way to use the ram is to advance end-on, and then the heavier vessel would catch and sink the lighter one, therefore I do not hold with the idea of building small vessels in lieu of large vessels. I think small vessels will be found not only unsuited for rams, but for the general services of our Navy. England is strong, but England's strength depends upon her long arm and her powers of offence. She must have vessels that can go to all parts of the globe, and can carry large quantities of coal, with heavy guns and large numbers of men. We cannot put large numbers of men, heavy guns, powerful engines, and large quantities of fuel into small vessels. Therefore large vessels are a necessity; large vessels will be the more powerful rams; large vessels will give a better means for firing the torpedo, and will also give the best platform, not only for the heavy guns, but also for the smaller guns, which must supplement them.

Commander H. W. BRENT, R.N.: I think Captain Colomb's data require examination, and to examine them they should be carefully read, and corrected if needs

be. The subject wants a great deal of study before we can discuss it. I must content myself with one or two remarks, having had the pleasure and benefit of discussing with Captain Colomb the battle of Lissa many years ago, when he held that guns were getting to a minimum of use. When I was serving afloat I took notice of firing when practising at a target, and found that we had the greatest difficulty in keeping the target in view, owing to the smoke of the gun; and I came to the conclusion that the smoke of the guns would be a nuisance to you in conning the ship, and that therefore you would fire but little. I found in the "Excellent" they were teaching ship's companies to fire very little in action. They were teaching them in this way, that the men should be so quiet at quarters that they would stand steady under all circumstances, and they were looking round for mechanical means to fire all the guns together. They had an electric system; and I see in the "Monarch" they have a mechanical system by which they fire the guns together. It appeared to me they were seeking for some means by which one person might fire all the guns together. With the men being taught to be quiet and the annoyance of the smoke of the guns, I arrived at the conclusion that you would fire them in action very little, only in passing your opponent, and that the ram would be your best weapon of offence. Expressing my opinion on the subject, I was told that the end-on fire was everything, that the end-on fire was the most useful of all. We had two bow guns in the ship I was in, and firing at a target, I found their smoke was more annoying than that from broadside guns when they were fired, and it was more difficult to keep the ship on the target. Therefore it appeared to me that the only time to fire bow guns would be when using your ram as you touch your opponent, and at no other time would you fire them, because they would be such a nuisance to you. Afterwards it was my fortune to see how Harvey's torpedoes were used. From the first, when I saw them, it seemed to me that we had got something that would frighten us from ramming. I quite agree with Captain Dawson that it would be a very dangerous thing to try to ram a ship if you found her bristling with torpedoes. Of course you might miss a ship, and to miss a ship with a torpedo astern would be certain death to yourself. At present it is very difficult to say where we are; we do not know; we are all abroad. Therefore I wish this discussion had been postponed, that people might have had the opportunity of studying this paper of Captain Colomb's. It is of such vital importance that it requires very careful looking into. As to the experiments that have been tried in the Baltic by the Russians, I think the same thing ought to be tried in the Solent by ourselves. Officers of all classes on half-pay would only be too glad to take part in them; it would teach them so much. I hope the mention of those experiments in Captain Colomb's paper will be the thin edge of the wedge that will cause us to have experimental ramming, and experimental attack and defence with our ships.

Captain WHEATLEY: Will you allow me to suggest that the experiments might be carried out with the steam launches of those ships that have steam launches.

Admiral of the Fleet Sir GEORGE SARTONIS: As Captain Colomb has been kind enough to allude to me in a complimentary manner on a subject in which I have taken a great deal of interest, I should wish to say a few words in reply; but as I am confined to ten minutes, I can touch only very slightly on the matter. I have long advocated the ram as the re-introduction of the ancient mode of fighting. It struck me that the use of steam as a motive power would enable us to use the ram with considerably greater efficiency and effect than the ancients could have arrived at. Since 1855 and 1856 my attention was more particularly drawn to this mode of attack. Without entering into detail, I would simply enumerate the conditions and circumstances under which the ram can be of the greatest service, and show its power and greatest effect over every other class of vessel. I will suppose a squadron of eighteen or twenty of the finest vessels that can be got, whether from Russia, France, or England; let there be one ram without a gun, without any armour-plating, but very rapid, and very handy, with much more speed, of course, than any of the vessels that she is going to attack; that this vessel has coal on board which will not emit smoke, when she accompanies this large fleet. By her superior speed she can always avoid an action when it is convenient to her, and she can make her attack when it pleases her. Granting me those two points, she accompanies this

squadron, take for instance, of twenty vessels. The night is dark; the ram carries a kind of jury mast, which she lowers down; she is low in the water; she sees every one of the larger vessels that she is accompanying by their high hulls, tall masts, and funnels; she runs down at the rate of ten or twelve knots upon any one of the vessels that she has fixed upon. I will now ask any sailor; here is a ram running down at night on the vessel that she is going to attack; she makes use of a fuel that emits no smoke; she has lowered down her masts; she is not seen until almost the very moment when the look-out man calls out, "The enemy is upon us," which can be but a very few seconds; how is it possible for any of these large vessels, particularly large broadside ships, by any action of the helm to avoid the ram in so short a time? Even if the vessel attacked is able to fire two or three guns, a vessel at night with a narrow bow presented to the broadside ship she is going to attack, how is she to be seen? She is more likely to be felt before she is seen. What is the chance of her being hit? To suppose in war that you are to be so perfectly protected that no shot can penetrate, that there is no life that can be lost—in something like the iron boxes we now make which are perfectly secure, but these can do very little mischief to the enemy—how can their guns be fired with any chance of hitting this ram before the latter gave the blow? It is impossible she can fail in doing that because there is nothing to disturb her; she fires no gun; there is no smoke to confuse her or bother her; she gives the blow, and the blow that is given with the force of *sixty or seventy* thousand tons, what vessel can resist that blow? Mr. Reed, who was one of my first opponents in 1855 and 1856, in his pamphlet admits that there has been nothing invented by human genius that has the power of the ram for naval purposes. I admit that the turret will be a more formidable enemy to the ram than broadside vessels. But at night the turret vessel has no time to fire with any chance of success. Then, again, suppose Spithead full of ships, as it was at the review, what is to prevent a ram coming in at night into Spithead or at daybreak, and running through the ships at anchor, hitting away right and left? What chance is there of a battery striking her when she is among the shipping? What battery can fire upon the ram without striking more friends than enemies? There are only two cases out of many where the ram has an enormous advantage over a very large number of the most powerful vessels that can be built by any nation. In a single action, of course, it is more difficult. The only point upon which I rather disagree from Captain Colomb is, that for the unarmed ram I think extreme speed and extreme handiness are indispensable. But these qualities are equally important for an armed ram. I advocate three classes of rams. But to show the special power of the ram as a ram, I shall content myself with quoting the case of the unarmed ram. These vessels can also carry much more fuel. Therefore, from the circumstance of being accompanied by a vessel of this kind which is able to carry a much larger quantity of fuel, and to make feints, the vessels of a squadron that are liable to be attacked by her, these vessels will be constantly keeping up full steam; and in the course of a very few days they will be lost from want of steam. When it is a stern chase, by the ram having speed, her tactics will be to get under the stern and to destroy the steering-gear of the ship she is going to attack, then she can deliver her blow with perfect safety. With regard to Captain Dawson's observations about the torpedo, I think the ram can be a torpedo vessel as well. Therefore, without entering into other details as to the expedients by which the attack of the torpedo might be very easily overcome or evaded—this is, however, not the time or occasion to enter into that question—I simply repeat it is undeniable that the ram can be a most effective torpedo vessel and a ram, also equally effective.

The CHAIRMAN: Perhaps Captain Colomb will now reply to the observations that have been made.

Captain COLOMB: There is not much for me to say, in reply. Captain Dawson expressed his opinion that the torpedo has now become the leading weapon, having taken, in point of fact, the ground that was occupied by the ram. I agree with that to a certain extent. Captain Scott spoke in the same strain. I had already met the opinion of both these Officers in this paragraph:—

"Wherever the Harvey torpedo makes its appearance, whether in company with guns and rams, or by itself, it is still speed which must carry the day. Whether one ship determines to use his guns or his ram, he must try his speed and his

"torpedo, if the other chooses to adopt that mode of attack. *y* could not, as in Fig. 2, diagram III, turn towards *x*, and allow him to cross his bows: he must turn away from him, and trust to his own torpedo to keep *x*'s ram clear of him. Hence they come to parallel courses, and artillery fire, broadside to broadside. The struggle will immediately be, which is to head the other, and whichever can succeed must be victorious. The tendency of the Harvey torpedo seems thus to be, to bring the gun forward again, as the tendency of the ram has been to push it back. While this struggle for precedence continues between two torpedo vessels at short range, much damage must be done by artillery; and if the speed of the ships is nearly equal, the combat might be decided by a broadside action of the old type, except that it is carried on at high speed."

Captain Goodenough required some explanation as to an early statement in my paper with regard to the firing of the "Monarch." In the first part of my paper I said one round in three minutes could be fired, whereas afterwards I quoted it as being one round in two minutes. The history of the anomaly is, that in the first instance I quoted the opinion afloat as to what the rapidity of fire would be in action. Afterwards I corrected that opinion by data, in order not to be too hard upon the guns; in point of fact, I gave them the full benefit of any doubt that might exist on the question, and cut an extra minute off, because it is possible to fire one round in two minutes—consequently, I allowed that it would be so. I do not quite understand Captain Goodenough's remark in reference to the "Monarch" and the "Hercules," and the method of considering the end-on fire. But I do not think I need go into it, because I only spoke of those two ships as *rams* combined with *guns*. My argument only goes so far as to say, that if you are to make the ram your superior weapon, then you do not care for a large arc of fire, and you do not care so much for end-on fire. If, on the contrary, you are determined not to use the ram as your weapon at all, then you come to a totally different state of affairs; then you require a large arc of fire; then you come to the position given to *y* in Fig. 5, diagram I, because she does not mean to use her ram, but her guns, and she means to use the latter in peace and quietness while the other uses her ram. She does that by bringing her adversary end-on. Captain Scott alluded to the use of light vessels and the possibility of destroying them. But you cannot destroy light vessels with a few heavy guns, the number of fired shot will be so small. To attack a light vessel, you must provide yourself with a large number of light guns, as well as heavy guns, in order to give rapidity of fire, in order to give a fair proportion of hits on your object.

The CHAIRMAN: I think we must all have arrived at one conclusion on this occasion, that of being very much obliged to the lecturer for the lucid manner in which he has brought the subject under our consideration, and for having brought out the discussion we have listened to. A subject of this magnitude must produce great differences of opinion. We have heard some expressed here to-night. The object is to set men's minds thinking, and in the interim between this and another lecture in continuation of the same subject, we shall be, perhaps, better prepared to enter into the merits of the subject in all its bearings. This, however, will not detract from the thanks that are due to Captain Colomb on the present occasion.