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An Attempt to Estimate the Probable Influence of the Introduction of Q.F. Guns on Naval Tactics and Construction

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ADMIRAL SIR R. VESEY HAMILTON, K.C.B., President, Royal
Naval College, Greenwich, in the Chair.

AN ATTEMPT TO ESTIMATE THE PROBABLE INFLUENCE
OF THE INTRODUCTION OF Q.F. GUNS ON NAVAL
TACTICS AND CONSTRUCTION.

By Rear-Admiral S. LONG.

THE subject which, by the wish of the Council of this Institution, I am to bring before you to-day is one of great importance to all navies, and especially to our own. The enterprise and skill of Lord Armstrong and Co., emulated by numerous other firms on the Continent, have resulted in the production on a large scale of powerful guns with a rapidity of fire at least five-fold as great as that obtainable from guns of such calibre only five years ago.

The 4·7-inch and 6-inch Q.F. guns, to which I allude more especially, are probably familiar to all who had the opportunity of visiting the magnificent Armstrong gallery of the Royal Naval Exhibition of 1891, but a comparative table is exhibited for convenience. Guns of this type will now form an important feature in the armament of even the heaviest battle-ship, while they will constitute probably the main armament of most cruisers.

Such a marked increase in the rapidity of fire is likely, in the opinion of many Officers, to have more influence on sea fights than the increased power of the guns which has been so marked a feature in all navies since the Crimean War, and which was described by Captain A. Noble, C.B., F.R.S., in his address to the British Association at Leeds in 1890, which may be found in "Engineering" of September 12 and 19, 1890, from which I quote the following:—

"A trial has also been recently made between two cruisers, the one armed with ordinary breech-loading, the other with quick-firing, artillery, from which it appears that, when firing at a target, the

latter in a given time was able to discharge about six times the quantity of ammunition fired by the former.

"I need not impress upon you the significance of these facts, or the importance of quick-firing armaments, especially if firing shell, possibly charged with high explosives, against the unarmoured portions of cruisers or other vessels."

Naval Officers will readily acknowledge the truth of this statement when the large area of unarmoured structure to be found even in armour-clad vessels is considered.

While on the subject of Elswick, I will quote a very interesting statement contained in the work "Modern Naval Artillery," published as a guide to the Armstrong exhibit at the Royal Naval Exhibition, showing the advantages of Q.F. guns against torpedo-boats:—

"One of the principal reasons which has led to so large an employment of Q.F. guns in the naval services is, no doubt, the necessity of being able to cope instantly and effectually with the attack of torpedo-boats. The very high speed possessed by the modern torpedo-boat, while increasing its powers of offence, has, at the same time, diminished the risk of its being hit. It not only remains a much shorter time exposed to fire when making its attack, but its rapid motion necessitates a great alteration of aim between each round fired at it, and a corresponding likelihood of error. Suppose a torpedo-boat to be sighted at a distance of 1,700 yards by a war-vessel having a broadside armament of three Service 5-inch B.L. guns, each capable of firing two rounds a minute; the torpedo-boat could not hope to discharge a torpedo with much certainty at a longer range than 400 yards, and would therefore have to traverse a distance of 1,300 yards under fire before she could begin the attack. Assuming the speed of the first class torpedo-boat to be 20 knots an hour, the time occupied in traversing 1,300 yards would be, roughly speaking, two minutes. The war-vessel, therefore, armed with a broadside of three 5-inch guns, each firing two rounds per minute, would be able to discharge twelve shots at the torpedo-boat before there was a chance of her being torpedoed. If, however, in lieu of the three Service 5-inch guns, she were armed with three of the improved Armstrong 4.7-inch 45-prs., she could in the same time fire no less than seventy-two shots, each gun being capable of firing twelve shots a minute. Besides the obvious advantage of being able to fire six times as often, and have six times as good a chance of hitting, there is the collateral one of a very slight alteration of aim being required in the one case, and a very considerable one in the other. Between each round of the 5-inch breech-loading gun the torpedo-boat would move 340 yards, and the aim would have to be correspondingly altered, while between the rounds of the Q.F. 45-pr. gun she would only move 50 yards, and a very slight alteration would be required, and a successful shot would be instantly repeated." "Rapidity of fire must under most circumstances be considered as a very important element in war, but it is recognized by most artillerymen that a rate of about ten rounds a minute is sufficient for all guns larger than the 6-pr.

Any quicker rate is liable to be obtained at the cost of impaired efficiency in other directions, and carelessness on the part of the crew in loading and aiming will probably be developed." "Smaller Q.F. guns than the 4.7-inch have been introduced recently, firing shots of 25, 20, 12, and 10 lbs. respectively, and the 25-pr. with a calibre of 3.75 inches is specially suited for the armament of torpedo-boat catchers. A good many of these guns have been made, and they possess a muzzle velocity of 2,200 feet with ordinary powder, and can fire from twelve to fifteen rounds per minute." "It is found that three times the weight of the cordite charge is necessary when powder is used."

It may be remarked that rapidity of fire is more important at sea, where moving bodies are concerned, than on land, the power to repeat a shot instantly before the vessels have much changed their position being likely to produce much more effective firing.

From the same volume the record of Series D of the Silloth experiments with the 6-inch Q.F. gun, which took place on October 8, 1890, is extracted. It is remarked that smoke of a reddish-brown colour was given off by the cordite, but this was so transparent that it would never have interfered with laying the gun; moreover, it rapidly disappeared in spite of the absence of wind.

Series D.—Five rounds with 15 lbs. cordite, and common shell, weight 100 lbs., for rapidity at 900 yards target.

One trial round was fired to obtain elevation, and the firing was then carried on, with the following results, the total time being only fifty-five seconds:—The first four rounds hit the target, the fifth being 5 yards short; the casks supporting the target flag were entirely destroyed and the flag perforated.

The opinion expressed by Major G. S. Clarke, R.E., in his work on "Fortification," is interesting. After stating that armour was originally introduced as a protection against shell, and reviewing the various types of vessels found in our own and foreign navies, with respect to their powers of attack against guns posted on shore, he remarks:—

"To attempt to pierce the armour of the 'Dandolo' and 'Duilio,' or of our 'Inflexible' class, would be a pure waste of ammunition, considering that any of these vessels might be put out of action in half an hour by well-handled medium guns."

The present Director of Naval Construction, Mr. W. H. White, C.B., F.R.S., has also expressed the opinion at the Institute of Naval Architects that it is possible an action between armoured ships might be decided without the armour being pierced, and more to the same effect will be found in "Modern Naval Artillery."

There is no finality in invention, but naval Officers are bound to endeavour to forecast correctly the effect on tactics of each change in naval weapons, of which the present generation have seen so many.

It appears certain that the increased rapidity of fire will render tactics afloat more important, for the subjection of an inferior force to the fire of a superior one, even for a short period, will have at least five-fold significance.

In looking back for guidance as to the changes of opinion on naval tactics which have taken place during the last twenty years, I must acknowledge my indebtedness to the numerous members of this Institution who have written and spoken on this subject, as well as to those Officers who have published books and pamphlets upon it. In these studies we can only follow up trains of thought suggested by others, and no claim is here made for originality.

On comparing the views set forth in 1880 with those indicated in 1886, we are at once struck with the influence the torpedo has exercised in modifying the conception of a sea fight therein exhibited. At the former period the ram held a paramount place as the arm whose effective use constituted the tactical object even during the first phase of an engagement.

At the latter date the torpedo is admitted to be some counterpoise to the ram, and the possibility of an artillery duel constituting the first phase of an engagement between fleets is contemplated.

The progress of gunnery and torpedo equipment during the last five years has certainly strengthened the arguments in favour of the latter view, and the anticipated introduction of smokeless powder will greatly lessen, if not altogether remove, the impediments to manœuvring resulting from the smoke of guns. It, therefore, appears probable that we may look for a more unrestrained use of artillery in future naval actions, and that the intimate connection, to use the words of the late General Sir Howard Douglas, between the Service practice of gunnery and naval tactics will be universally acknowledged.

When the powerful gun armament, and the large amount of displacement devoted to armoured protection in modern battle-ships is considered, as well as the fact that the displacement devoted to armour is of no avail against the explosion of a torpedo, it would appear that full advantage should be taken of these features in her equipment before staking everything on the hazard of a torpedo at close range.

While, therefore, the ram, which at one time appeared undisputed arbiter of naval tactics, from the first appearance of impending battle, continues to hold its place as perhaps the most important weapon, seeing that it utilizes a larger portion of the displacement than any other, and retains its efficiency, so long as the ship floats with motive and directive power intact, it does not appear probable that the efforts of antagonists will, during the first phase of a naval engagement, be devoted to its use, though doubtless it will become an important factor in the ultimate decision of the contest.

On this point Vice-Admiral Bourgois, of the French Navy, writing some thirteen years ago, said: "The return to the ancient methods of fighting with artillery from a distance and on the broadside can only be conceived in the case of two hostile squadrons equally disinclined to risk being struck by the torpedoes of their respective adversaries."

"But the more and more pronounced superiority of artillery over armour plates, in close actions, the only ones of a decisive character, would expose the fighting ships to serious dangers, almost as formid-

FIG. 1.

FIG. 3.

POSITION OF SUPPORT.

FIG. 2. TWO PIEMONTE.

SPEED 20.5 KNOTS.

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FIG. 4.

FLEET ON VOYAGE.

FIG. 5.

FLEET IN ORDER OF BATTLE.

able as those presented by torpedoes, if they should not present their plated sides obliquely to the impact of projectiles.

"Against this oblique fire the armoured side still offers a protection it would be rash to disdain. The skill of the manœuvrer, when the ram blow shall be denied to him by torpedoes, should be directed to avoid presenting his broadside to the direct or normal impact of his adversary's projectiles, while at the same delivering his own with direct impact on the enemy's side.

"This double object is too different from that formerly held in view by wooden steam vessels to permit of any reversion to the manœuvres suited to squadrons of such vessels."

Admiral Bourgois's prescience will probably be acknowledged, and I shall assume in what follows that an artillery duel will form the first phase of a naval engagement, the object being to engage beyond effective torpedo range, until the enemy's battery is much reduced in power, and his exposed torpedo discharges rendered useless.

It is necessary then to assume some distance as a limit to the effective range of the gun and torpedo, as well as to define approximately the limit within which the approach of a ram must influence movements. In view of the serious effect of high-angle fire-practice against decks, distant shots may under special circumstances be resorted to, but the decisive events of an action will probably take place at ranges under 2,000 yards, at which distance the remaining velocities of the 6-inch and 4.7-inch projectiles are about 1,630 f.s. and 1,440 f.s. respectively.

While recognizing the great influence the state of the sea would exert in any particular case, and the advantage conferred upon the combatant possessing the larger and steadier vessels, I shall in the present paper consider gun-fire efficient at sea up to 2,000 and torpedo-fire up to 600 yards.

As regards the ram, if we assume that one ship will in most cases be able to turn herself parallel with another in two minutes, and that two minutes turned into space traversed at 16 knots speed per hour is 1,080 yards, we see that the ram may become an influential factor in a ship's movements when vessels are yet beyond what has been described as effective torpedo range.

The other feature governing the use of artillery is the effect of the projectiles on impact. From this point of view the presentation of the armoured broadside parallel to that of an enemy abeam is to be avoided, as his shot or shell striking normally would have a maximum penetration.

The large arcs of fire now given to broadside guns will frequently enable an enemy suitably placed to be struck normally to his armour, while the vessel firing occupies an oblique position.

It may be assumed that projectiles of ordinary form whose path makes a less angle with the surface of an armour plate than 45° will not penetrate.

Thus an enemy occupying a position in the sectors extending four points each side of a vessel's bow and stern would be unable to penetrate her side if armoured along the broadside portion.

In a battle between armour-plated ships of the same date of construction, it would on this ground be useless to discharge the heavy armour-piercing guns until the target aimed at presented a suitable angle.

If a vessel armoured sufficiently to keep out shell were engaged with another destitute of such defence, the latter would be at a great disadvantage, as while one would be vulnerable from all points of the compass the other would have, with respect to her armoured parts only, an arc of impunity of no less than 16 points.

It will be observed (Diagram 1) that if two vessels on opposite courses are so situated as to pass each other abeam at a distance of 800 yards, they would be within 2,000 yards of each other for more than 1,000 yards distance before presenting a direct target to each other. In many cases of actions between single ships and of ships engaging forts, there would probably be an advantage open to one opponent by maintaining the position as much as possible in which he presented an oblique target to his enemy, and this especially at the beginning of an action, when all guns are intact and fire a maximum.

In a single-ship action superior speed would be an important factor in enabling its possessor to select his own position, but in elaborating any system of tactics based on speed, it must not be forgotten that in any but the smoothest waters speed means spray, which on the weather side may very easily amount to a serious impediment to effective gun-practice, and it may be predicted that the weather gauge if two ships were steering the same course at a high speed would constitute an important advantage, as the lee guns could be fought with much greater rapidity and precision than the weather ones.

Such illustrations of practical naval warfare as are afforded by the history of the last thirty years were brought before us last year by Mr. Laird Clowes, so that nothing is to be gained by repeating them; but, while concurring in most of his deductions, I think he has underestimated the importance of the ram.

Possibly the fact that the "Shah" was not fitted for ramming may have escaped his notice; had she been so, it is scarcely likely that with her superior speed the "Huascar" could have escaped either her ram or a torpedo fired at close quarters.

The naval warfare consequent on the late civil war in Chili has afforded an example of the power of the torpedo in the sinking of the "Blanco Encalada," on April 23rd, 1891, in Caldera Bay. In this case the "Almirante Lynch" and "Almirante Condell" were torpedo gunboats of the latest type, built in 1890, by Messrs. Laird, of Birkenhead, while the "Blanco Encalada" was built in 1875, and presumably not subdivided into as numerous compartments as vessels of more recent construction, though her scantlings are probably quite as heavy.

The utter abandonment of all precaution on the side of the "Blanco Encalada" appears to deprive the incident of much interest from a tactical point of view.

Assuming, therefore, that single-ship actions between cruisers of

current types would generally be fought on the principle indicated in this paper, it appears only necessary to examine the case where one combatant, whom we may call "Aries," either specially constructed for right-ahead attack, or conscious of markedly inferior gun armament, should determine to keep his opponent right ahead continuously.

If the other, who may be called "Sagittarius," decide to keep "Aries" as far abaft the beam as is consistent with his guns bearing, and has arcs of training to his broadside guns extending to 60° before and abaft the beam, he will subject "Aries" to a superiority of fire, for a period whose duration will depend upon the relative speeds of the ships. Moreover, when "Aries" approaches within torpedo range, he will offer a favourable mark for the torpedo of "Sagittarius," unless he has succeeded in destroying the latter's torpedo equipment. On the other hand, should "Sagittarius" suffer damage to motive or steering power, he will incur great risk of being rammed, though, if his torpedo gear is intact, he will be able to torpedo his approaching adversary.

In order to estimate the probable extent of the superiority of fire alluded to, the case of two "Piemonte's" is taken, supposed to be steaming at equal speeds of 20.5 knots, being the maximum natural draught speed credited to the vessel. "Piemonte's" armament, as stated by Mr. Watts, in his paper read at the Institute of Naval Architects, April 11th, 1889, is four 6-inch guns, three $4\frac{1}{2}$ -inch guns, five 6-pr. Hotchkiss guns, five 1-pr. ditto, and four 10-mm. Maxim guns, can be fired on either broadside, while three 6-inch, four 6-pr. Hotchkiss guns, two 1-pr. Hotchkiss guns, and two 10-mm. Maxim guns can be fired either right ahead or right astern.

The diagram (2) shows the vessels during a period of five minutes, and at distances apart varying from 2,400 to 590 yards.

Should they be credited with continuous firing from right-ahead and broadside armaments respectively, the case will stand as follows:—"Aries," firing right ahead, will have expended 75 6-inch shell, 500 6-pr., 300 1-pr., and 7,000 Maxim bullets; while "Sagittarius," from his broadside, will have expended 100 6-inch shells, 105 $4\frac{1}{2}$ -inch shells, 625 6-pr., 750 1-pr., and 1,400 Maxim bullets. Thus "Sagittarius" may claim a superiority of 25 6-inch shell, 105 $4\frac{1}{2}$ -inch shell, 125 6-pr., 450 1-pr., and 7,000 Maxim bullets.¹

As regards impact, the guns of "Sagittarius" would be more enfiladed by the fire of "Aries" than the latter's by the fire of his opponent. The crews of disengaged guns on both sides would probably be kept as much as possible under cover from small projectiles and Maxim bullets.

The guns of "Aries," on the other hand, bearing on his adversary, and exposed to such a torrent of projectiles, could scarcely fail to be disabled, which might induce him to alter his tactics.

According to the table given in Admiral Colomb's War Game, the shots of "Sagittarius" would be of more value, shot for shot, than

¹ Mr. T. Van Roosevelt, in his "History of the Naval War of 1812," states that in the action between the "Shannon" and "Chesapeake" only fifty-six round shot struck the "Chesapeake," which was carried by boarding.

those of "Aries." It appears probable that such a superiority of fire would be too great to be voluntarily encountered, except under very exceptional circumstances, so that the attempt to approach end-on appears disadvantageous, and there appears no other alternative to gun tactics, at least in the first phase of an engagement.

It may be remarked that a similar study, made some eleven years ago, before the installation of machine and Q.F. guns, showed a superiority of fire in ships of similar size of only twenty-four to eight, and this example may serve to show what a torrent of projectiles will be fired from a vessel while her weapons are undamaged.

Turning now to the case of ships acting in concert, Captain Noel pointed out some years ago the necessity for defining the meaning of support. Directly two or more ships act in company, the necessity for organized movements becomes evident, and it may be remarked that in the action off Angamos, between the Chilean ships "Almirante Cochrane" and "Blanco Encalada" and the Peruvian "Huascar," the absence of concert appears to have very nearly led to disaster, as we are told that a shot from the "Cochrane" struck the "Blanco Encalada," and that the consorts nearly rammed each other.

Thus it seems evident that when two or more ships are in company, action on a preconceived plan will be essential, both for their own safety and to unite their forces successfully against an enemy.

Should a battle between fleets become, as is sometimes said, a *mêlée*, in which every ship acted independently, it seems probable that many cases of involuntary damage to friends would occur, but it is difficult to contemplate such a scene of confusion as the result to disciplined forces of the effect of battle, unless the destruction of all leaders had reduced a fleet to a mere mob of ships, so that while doubtless damaged communications would introduce occasional disorder, the fleet of any great nation would preserve its cohesion more or less, until reduced by the fortune of war to such a disadvantage as to be compelled to fly, or able to compel the surrender of its opponents.

By support, then, I understand the maintenance of such a position relatively to the other vessel or vessels in company that the fire of the ships could be united efficiently against an enemy.

Further, that the position of the vessels be such that an enemy attempting to ram one would himself incur serious risk of being rammed by the other.

The distance apart at which ships of a squadron are to keep station affects the question of artillery support. Two cables appears to be accepted generally as most suitable, and considering the result of damage to communications or steering gear in action, no less distance is likely to be accepted on the open sea.

This being so, it follows that the number of ships which can unite their fire efficiently against an enemy approaching from ahead is limited, and may probably be estimated as not more than four ships in single line ahead, such a line extending over a length of 1,000 yards.

The formation in line ahead is that ordinarily used for navigation,

especially in circumstances of difficulty, and when it is considered that the maintenance of any other formation involves the use of the compass, which is likely to be shot away in action, it seems probable that its advantages as regards facility of maintenance will outweigh any disadvantages it may have from other points of view.

When two ships are in line ahead the arcs of fire interfered with by each other's hulls are a minimum. It is true that the right-ahead fire of a squadron is reduced to that of one ship, but the assumption of a very slight échelon or quarter line will set free the bow fire, if required, and this on either side of the leader.

The more the échelon approaches to a line abreast, the nearer will the vessels composing it approach equi-distance to an enemy approaching from ahead.

A distance of one cable, or 200 yards, on either side of the wake of a ship would suffice to enable a following ship turning across it to assume an efficient ramming angle at the point of intersection. If two ships are 2 cables apart, the bearing of five points abaft the beam of leader would cause the follower to assume such a position. (Diagram 3.)

The speed at which a fleet would engage must depend on the condition of the ships composing it. Admiral Bourgois tells us that in one squadron employed during the Franco-Prussian war a speed of 8 knots was laid down in orders.

In the present discussion I shall assume 12 knots as the speed maintained. It allows a margin for increase with all recent ships, and a considerable margin of superiority to the high-speed cruisers accompanying a modern fleet, which is essential. It has one subordinate advantage for purposes of discussion, that the interval between ships of 2 cables is, at that speed, passed over almost exactly in one minute, so that, if four battle-ships are proceeding in line ahead at 12 knots, the sternmost one will in three and a-half minutes occupy the place of the leader.

Admiral Bourgois pointed out that superiority of numbers is nowhere so important as in the ramming attack; two ships well handled must succeed in ramming any single opponent bold enough to encounter them, and, in view of this, an organization of the fleet in pairs, as ordered in one of the fighting memoranda mentioned by Admiral Bourgois and approved by Vice-Admiral Sir Ed. Fremantle, K.C.B., in his paper read here in 1886, seems to possess great advantages, not the least of which is the power it gives to Officers detached in pairs to handle their ships in concert, and satisfy themselves as to the best means of utilizing their powers. In this connection, Captain, now Admiral, R. D. King's, R.N., "Remarks on Naval Battle Training," published in 1883, merits notice.

It now appears improbable that a fleet on the open sea will be accompanied by torpedo-boats, though if it has to fight in the vicinity of their headquarters they may be expected to intervene.¹

¹ It would be the province of the strategist controlling events to screen his fleet from any unexpected attack by such vessels.

On the other hand, every fleet will be accompanied by cruisers, of which one for each battle-ship would be a minimum.

If, then, we suppose a fleet to consist of twelve battle-ships accompanied by twelve cruisers, the cruisers would require a separate organization to enable them to move in company when not dispersed on scouting duties.

I shall confine myself to pointing out probable positions for these cruisers and the fleet.

1st, when navigating on a voyage.

2nd, when advancing to attack a willing foe of equal numbers.

Diagram 4 shows a fleet steaming in three columns, which may be called the van, centre, and rear squadrons respectively. Their cruisers, which are likewise organized in three separate squadrons, attached respectively to the squadrons of battle-ships, are shown extended in scouting order. The distance to which scouts would be spread would depend on the state of the weather. At night the fleet might probably assume the formation shown in Diagram 5, the cruisers remaining extended but drawn in nearer the fleet.

Diagram 5 shows the fleet in order of battle, the rear squadron being posted a mile astern, to act as a reserve.

An enemy's fleet, supposed to have assumed a similar formation, is shown advancing, the distance apart of leaders being 6 miles, or fifteen minutes at combined speed of 24 knots.

The cruisers on both sides, which may be supposed to have extended across the front of each fleet to obscure its formation and movements, are shown, formed in squadrons a mile to the right of their respective fleets.

The great desideratum in naval tactics, that of doubling on your enemy, as was done in such a brilliant manner by Lord Nelson at the Battle of the Nile, would appear very difficult to achieve simultaneously when fleets are in motion on the open sea, while, on the other hand, Vice-Admiral Sir Edmund Fremantle pointed out here, in 1886, how it might be done successively in the case of a fleet on a wide front attacking one on a narrow front.

The line I have shown, if opposed to eight ships in line abreast, would receive the fire of their right-ahead guns, or eight against two, while passing over the 2,000 yards, which, if both are going 12 knots,¹ would occupy 2 minutes 28 seconds, and if fleet A concentrated his fire on the leader of B he would suffer severely.

The plan of battle on both sides will no doubt have been matured beforehand, and I shall only offer the following remarks:—

If the range at which fire becomes effective be taken at 2,000 yards, which is passed over by vessels nearing each other at a combined speed of 24 knots in little over two minutes, there would not be time, after approaching to that distance apart, for either side to assume a different formation before being intersected by the other fleet, should its leader elect to continue his course.

Is it then possible for one leader electing to begin the engagement

¹ Knot at Greenwich 6082·5 feet.

with an artillery duel beyond torpedo range, to prescribe the *mancœuvre* by initiating a movement involving a corresponding action on the opponent's part?

If both fleets continue their course there would be no advantage to either side, but the leaders encountering the fire of a line in succession would probably be crippled or reduced to a sinking condition.

If both fleets turned sixteen points in succession, leaders first, they would each deliver their fire against their opposite numbers, and no advantage to either side is apparent.

If fleet A turns four points to the right in succession, and fleet B does the same, they would exchange their fires on an equality.

If fleet A turns four points to the right while fleet B keeps straight on, B's van would pass through between the van and centre of A, receiving the fire of A's van and torpedoes from the Nos. 3 and 4 of A's van, while, if they attempted to ram any ship of A's van, they would almost certainly be rammed themselves immediately afterwards by the centre of A's fleet, and, supposing them to pass through without collision, they would, whatever they did, be subject to a superior fire.

If B's leader ordered a course at right angles to A's directly he saw him alter course, their fleets would intersect each other's lines in about four minutes, supposing them 2,500 yards apart to begin with. In such a case, the leader of B would receive a very heavy fire from A's van, but if he escaped damage to his steering gear, he might ram one or more of A's van.

This would not be in accordance with gun tactics, but may be considered. No advantage to either side is apparent.

The possible case of one antagonist assuming line abreast was shown here by Vice-Admiral Sir E. Fremantle in 1886, when the line ahead was shown to have an advantage if passing through between two ships, and has been already alluded to.

The effect of damage likely to be incurred from an enemy's fire while approaching to ram is very difficult to estimate, and should exercise much influence on the decision of the question.

If B's leader took the course of attempting to ram A's van, he would in any case, as both fleets are going at a high speed, be undertaking a task requiring great skill and no accident to gain success, while if accident to his steering gear occurs at a critical moment, his attack would be disadvantageous to him.

Altogether it appears most probable that if one combatant turned off to bring his broadsides to bear, the other would follow his example at the outset of an engagement, unless some peculiarity in the vessels of one fleet pointed to the greater advantage of the other form of attack.

Some event of importance to one side or the other would sooner or later occur, determining the course of an engagement, by rendering it imperative to succour some disabled ship, and it would be futile to attempt to carry the movements further.

It seems clear, however, that if both fleets be supposed equal as regards skill in gunnery and numbers, advantage would remain with that side whose organization and experience of combined action

should enable it to preserve its coherence to a greater degree than its opponents, thus asserting a superiority of fire at various phases of the engagement.

A superiority of number would be a great advantage, especially if rams held in reserve until the torpedo and gun armaments of the hostile fleet had suffered material damage.

Concerning the part to be played by the cruisers in a battle between fleets, a greater variety of opinions may be held than as regards the movement of battle-ships. Having fulfilled their duty as scouts, it would probably be the object of both sides to keep them intact during the first onset.

One of their duties, no doubt, would be, as was suggested here by Admiral Sir W. Dowell, in 1881, that of saving life from sinking vessels.

An interesting question arises as to the possibility of a number of cruisers coping successfully with a battle-ship.

In sailing days, the smaller ship was endowed with such a large sail spread in proportion to her displacement that she always had the heels of the line of battle-ship. This, however, is no longer the case: the smaller ship has to carry engines and coals, and, when a sea gets up, is less capable of maintaining her speed than the heavier battle-ship. Thus the cruiser is simply a vessel in which speed in smooth waters and Q.F. guns are the prominent features, while protection even to vitals is reduced to a minimum to avoid the necessity of heavy displacement, and enable the number of vessels capable of going at a high speed for a moderate expenditure of coal to be augmented.

It is not difficult to conceive circumstances in which high free-board battle-ships would be faster than cruisers; but, on the other hand, in smooth waters the cruisers would have the advantage in that respect.

If we suppose four vessels of the tonnage of the "Latona,"¹ armed with Q.F. guns, and engaging in smooth water, when they would have a superiority of speed, and there would not be much difference in the steadiness of their gun platforms, engaging, say, one on each quarter and one on each bow of a battle-ship from a distance of 3,000 yards, their superiority in light guns would be such that all the unarmoured parts of the battle-ship would suffer severely.

It would, however, be impossible for the cruisers to sink the battle-ship, except with a torpedo, while the battle-ship's heavy guns might destroy the motive power of a cruiser, supposing them uninjured by the lighter projectiles. Should the battle-ship's heavy guns be disabled, she would be at a great disadvantage. On the other hand, if one cruiser's engines were disabled, she would be at the mercy of the battle-ship. If the cruiser succeeded in disabling the battle-ship's armament, they could torpedo her in all probability.

It may be remarked that four "Latonas" represent less displace-

¹ "Latona's" tonnage, 3,000; armament 2 6" B.L., 6 4.7" Q.F., 9 smaller Q.F. guns; cost about 173,000*l*.

ment and cost than our "Royal Sovereign," though the cost of maintaining the four vessels would probably be greater.

Whatever view may be taken of this, it is possible that a squadron of cruisers might be employed to act the part of torpedo-boats rushing past battle-ships at night, or after they were to some extent disabled by an enemy's fire.

To guard their fleet against such attempts or to make them against an enemy would be the lot of cruisers, and would probably lead to cruiser actions. The Commanders of cruiser squadrons would have most onerous and exacting duties, as they would have in many cases to divine the intentions of the Commander-in-Chief, and act on their own judgment for the general welfare.

Should a hostile squadron of torpedo-boats appear, the cruisers would have to deal with it, and, doubtless, much might be done in peace manœuvres to afford young Officers an insight into probable tactical dispositions in war with the movements likely to result therefrom.

The Q.F. gun is likely to produce many vacancies, and while great care and discrimination may have been exercised in the selection of the Officers who are to conduct a fleet into action, it is very possible that those who survive to bring it out may not be gifted with the same ability and experience, and therefore it appears most desirable to extend a knowledge of tactical requirements as widely as possible among the Officers. If midshipmen are acquainted with the tactics in favour when they are under tutelage they are more likely to keep pace with the age they live in, and note the various changes incidental to novel or improved weapons.

From this point of view, the annual manœuvres now carried out by our fleets are most useful and instructive.

Having endeavoured to indicate the possible course of a naval engagement between single ships and fleets, taking the gun as a paramount weapon of offence, but allowing the torpedo a most decisive influence on the tactics observable in the first phase of the conflict, it would appear that the following consequences may be expected to result from the greatly-increased rapidity of fire due to the introduction of the Q.F. guns.

If the zone of effective fire be limited at sea to 2,000 yards, it is clear that the possibility of traversing that zone without receiving a large number of projectiles has disappeared, and as it appears that one nation, at all events, has adopted smokeless powder for service afloat, this deduction becomes doubly justified. The prospect, therefore, of a fast torpedo vessel passing through the zone of fire of a battle-ship during daylight and clear weather is quite a forlorn hope.

Success in naval battles will, more than ever, depend on the effective working of the guns, which is, in turn, largely dependent on the tactics employed.

The first effort will, no doubt, be to disable the offensive power of the enemy by striking his guns and torpedo tubes; and, in the progress of such an artillery duel, a very large number of the guns' crews may

be expected to be disabled, so that the practice of filling up vacant places becomes more than ever important.

In the rapidity with which guns can be fired, we have a means of ascertaining the range approximately, likely to be more practically useful than any range-finders.

It will be expedient not to lose a chance of using the heavy guns, as their shell will exercise a most destructive effect on the unarmoured parts of ships even when fired from positions whence the armoured portions are not penetrable, and it is by no means clear they may not be disabled by light shot striking on the chase.

The fire of Maxim guns and rifles from tops is likely, as pointed out here by Commander Lowry, to be of great efficacy in subduing the fire of all upper-deck guns.

In an action between fleets, the control of gun fire will be very important, both to avoid waste of ammunition and also firing at friends; but it will not be expedient to exercise that control by any other means than through the Officers of quarters, as all mechanical and electrical means of conveying orders or firing guns from a central position are exceedingly likely to be rendered useless by the first hostile projectile striking a ship, unless they are entirely under armoured protection.

For the same reason it appears very desirable that the power of firing torpedoes by sight from the tubes themselves should be arranged for where possible, and it may be remarked that submerged torpedo tubes, such as are fitted in some ships, gain in importance, as the installation cannot be attacked by hostile projectiles. The means of firing them, however, if not conducted under armour protection, should be so arranged as to be independent, if necessary, of broken wires.

As regards construction, the first point that occurs is that the introduction of the 6-inch Q.F. guns as the probable limit to the size of that type of weapon will give stimulus to the endeavours to armour ships sufficiently to keep out the shells from that nature of gun, and the accounts of some recent experiments seem to promise that the last word of armour has not yet been heard.

The much-discussed question of belted *versus* internal protection for armoured cruisers must be alluded to. If a ship will not float or stand upright, and her machinery and steering gear cannot be kept intact, she is obviously unfitted to play the part of a war-ship, but I think the question of the relative merits of the competitive kinds of protection as regards the stability and buoyancy of the ships may best be settled by naval architects.

Mr. Bile's paper on the subject, read at the Institute of Naval Architects in 1887, and the discussion thereon, is most instructive. It seems worth considering whether the belt, if it extends up to the level of the battery deck, is not likely to protect the gun platforms, and hence the offensive power of the ship, better than the internal protection, which will allow shells, striking at any angle, to pass through the side, and, bursting, may probably dislocate the gun racers and pivots.

Most Officers I have spoken to prefer the belt, but where adequate thickness can be given to the internal protection, there is much to be said in its favour except as stated above. The risks incurred by war-ships in action are so numerous and various that it is easy to exaggerate one, at the expense of others.

Coal may be advantageously utilized for protection, but can never be a wholly satisfactory substitute for armour. It is required most above water, and when the supply below is used, it may be necessary, for the maintenance of stability, to empty upper bunkers. A ship dependent on coal protection with her upper bunkers empty would be at a great disadvantage in meeting an enemy, at the end of a voyage, just come out of a port.

The Q.F. gun then seems to afford another reason for increasing the displacement of war-ships to enable them to carry an amount of armour sufficient to afford protection to their vitals and gun platforms against 6-inch shells. When the cruiser of the present day is contrasted with the offensive powers installed on board her, the contrast from the position in the days of wooden ships is very marked. Except in the single risk of fire, the guns of the day are far more powerful to destroy the structure which carries them than they were forty years ago. So long as ships are pitted against ships, the conditions on both sides are equal, and mutual destruction probable, but if ships are pitted against guns on shore, unarmoured ships do not appear to be so favourably situated as in the days of wooden ships.

The thin steel deck-houses which occupy the centre of the deck in cruisers would furnish a large number of fragments when struck by shot or shell, and guns placed on the poop or forecastle appear to occupy a more favourable position in that respect than those in the waist. The space taken up by air-shafts and funnels is, necessarily, large, but it may be well to restrict structures in wake of gun batteries within the narrowest limits, and to use mechanical ventilation where possible to reduce such structures to a minimum so as to free the batteries as far as possible from such sources of langridge.¹

Next in importance to the buoyancy, stability, motive and steering power of the ship, comes the means of exercising control over the two latter powers. These are usually concentrated in a conning tower, a somewhat conspicuous object, by no means in unarmoured ships impenetrable to quick-firing projectiles. It was once remarked by an Officer of great experience that the conning tower should form an integral part of the armoured structure of a battle-ship. When it does so and is capable of resisting 6-inch Q.F. projectiles, its weight is justified and its conspicuousness less important. When, however, as in an unarmoured cruiser, it is merely an excrescence showing in a pointed way whence the ship is controlled, but incapable of protecting the communications even within it against 4.7-inch or 6-inch projectiles, which communications are necessarily exposed to risk over a considerable distance, for the purpose of bringing them to this con-

¹ I saw fragments of brass rubbing pieces on main bitts of "Agamemnon" go through three parts of funnel casing on quarter-deck on October 17, 1851.

spicuous point, it certainly does not seem likely that the conning tower in unarmoured cruisers will survive the early impressions of the Q.F. gun.

If you cannot protect a thing, do not point out where it is, but place the communications as much as possible out of danger, and afford the Officers controlling the ship such shelter in an inconspicuous manner as may be feasible.

The effect of shells on unarmoured structures is well known, and to carry up steering rods and telegraphs through unarmoured structure into a small thinly-armoured apartment in a conspicuous position appears to me a mistake.

The fate of the "Huascar's" conning tower was such as to cause much reflection as to the expediency of devoting weight to such structures. All the communications being there, it must perforce be occupied unless the still more vulnerable position of ordinary navigation be occupied, and both of these positions have the disadvantage of affording conspicuous marks to an enemy's gunners. I am speaking more especially of the rods and telegraphs, damage to which at once renders the conning tower useless. The men may be replaced, but one shell among the communicating rods will probably render them useless for that action.

The object sought would rather, it appears, be attained by the principle of concealment, or avoidance, as Admiral Colomb has called it, and on shore we hear much more of pits for guns than of towers.

The wires for lighting a cruiser internally are likely to be cut frequently in action, so that no reliance should be placed on electric lights for any places required in action.

Loth as we may be to place armour on a ship, in view of its intility against torpedoes, yet Q.F. guns, smokeless powder, and high explosives renew the old cry of "Keep out the shells," and would appear to make its application to a limited extent most desirable in all ships designed for war purposes.

The great difficulty caused by the high freeboard necessary for the maintenance of speed in a seaway is that the area to be armoured becomes so large as to make it impossible to cover it all, but it seems a question whether the central portion of cruisers should not have a belt sufficient to keep out shells in combination with the internal arrangements generally made use of for other parts of the vessels.

With the object of defeating torpedo-boats, a number of torpedo-boat catchers are now built to which speed is essential, while a very light armament will suffice, more especially as rapidity of fire is much more important in their case than anything else. Such vessels are very useful for the purposes for which they are designed, but it should not be forgotten that, no armour being possible on their displacements, they are unfit to engage protected vessels, and so long as they possess superior speed in smooth waters to torpedo-boats, they are sure to be yet more swift in proportion when a sea gets up.

As regards protection to the guns' crews, everything that appears feasible as regards shields may be seen in progress in our workshops.

It is a great thing to place guns so as to reduce the risk to the crews as much as possible to the direct hit, and avoid the inevitable shower of fragments which must be caused by a shot striking neighbouring structure.

From the foregoing imperfect review of the salient points of the results of introducing Q.F. guns, it would appear that in naval actions it will be most important to develop as heavy a fire as possible for a short time, with a view to which as many guns of adequate power should be mounted as possible. Coals will have to be replenished so often that other stores can be filled up at the same time, and all available weight devoted to offensive power.

It is impossible not to sympathize with the naval architect of the present day whose ships are a mark for such destructive weapons, both above and below water, that it is most difficult to see in what direction progress lies.

Where a theatre of war will admit of small vessels maintaining their speed, and the base of supply is near at hand, economy may result from the employment of moderate sized vessels, but where high seas prevail and base of supply is distant, we may be sure large displacements will be essential to efficiency, and must be prepared to pay the cost. No doubt the practical rule to make our ships somewhat superior to those of our possible enemy may suffice, if we are certain that his requirements in war and our own are similar, but this is a matter of practical statesmanship.

The only satisfactory point about the vast expenditure now incurred in all countries for the manufacture of war material appears to be that hitherto it has resulted in the maintenance of a far larger population than it has ever destroyed, with which reflection, not perhaps a wholly satisfactory one to the objects of destruction, yet a decidedly good feature to dwell upon, I must conclude my lecture.

Comparative Table of Guns.

Ship.	Description of gun.	How worked.	Weight of projectile.	Results.
"Benbow"	16·25-in. 110-ton B.L.	Hydraulic	lbs. 1,800	3 rounds in 6 minutes, starting from gun loaded.
"Trufolgar"	13·5-in. 67-ton B.L.	"	1,250	4 rounds in 9 mins. 7 secs.
"Colossus"	12-in. 45-ton B.L.	"	714	4 rounds in 6 mins.; target struck 3 times.
"Thunderer"	10-in. 30-ton B.L.	Hand	500	1 round in 2 mins. 10 secs.
"Impériceuse"	9·2-in. 22-ton B.L.	"	390	5 rounds in 6 mins.
Cruisers	6-in. 5-ton B.L.	"	100	1 round a minute.
Cruisers and battle-ships	6-in. 5-ton Q.F.	"	100	5 rounds in 55 seconds.
Cruisers	4·7-in. 2-ton 1 cwt. Q.F.	"	45	12 rounds a minute.
Torpedo-boat catchers	3·75-in. ? 25-pr. Q.F.	"	25	12 to 15 rounds a minute.
Battle-ships and cruisers	6-pr. Q.F. Hotchkiss.	"	6	25 rounds a minute.
"	3-pr. Q.F. "	"	3	30 rounds a minute.
"	1-pr. Q.F. "	"	1	About 30 rounds a minute.

Figures derived from "Modern Naval Artillery" and Major Clarke's "Fortification."

The CHAIRMAN: We have listened with great pleasure to this lecture, and a very instructive one it has been, particularly as it deals with a subject which none of us know anything about practically, whatever we may know theoretically. I am not sure that it is not one of those subjects where "When ignorance is bliss it is folly to be wise." I hope, as there are some naval architects present, they will take part in the discussion. We shall be happy to hear them.

Admiral Sir GEORGE WILLES, K.C.B.: I do not wish to take any part in the discussion, and will leave it to younger men. The lecturer tells us, at page 3, that the "Shah" was not fitted for ramming. I do not believe that the "Shah" has a cutwater. I do not think any ships had cutwaters since the "Black Prince" and the "Warrior." In my opinion, every modern ship is capable of ramming, and, like Admiral Long, I have never been able to understand why the "Shah" did not try to ram the "Huascar"; and after the statement of the lecturer as to the number of shots fired from the "Shannon" and "Chesapeake" which were effective, I do not think the "Shah" would have been much damaged by the "Huascar's" fire. The lecturer quotes the opinion of Admiral Bourgois. I knew him very well. He had the reputation in the French Navy of being a purely scientific Officer, and most unpractical. I do not think we ought, therefore, to attach too much importance to his opinions.

Lieutenant STURDEE: I did not expect to open the discussion, but I appear here as a torpedo-boat Officer, and I do not think that torpedo-boat Officers often have a hearing in this Institution. Sir William Armstrong's firm have made rather a large statement, which is quoted by Admiral Long; it may have done for exhibition purposes, but I do not think it can be ever borne out in a practical way by actual results. I have taken part in several torpedo attacks, and no doubt there are others here who have done the same; I know that Admiral Long has taken part in many himself. What I would like to point out is that there are several points in that statement that are not borne out in practice. The first one is the statement mentioned that a torpedo-boat can be seen at 1,700 yards. That I am sure is not practically true; of course I am referring to a night attack. The second statement is, that the use of smokeless powder is assumed; that is a condition we have not yet reached. The next thing is, it does not take any notice of the accuracy of the fire, which is a very important thing; neither does it take any notice of firing into a friendly ship. It is stated that if, instead of three Service 5-inch guns, the ship were armed with three of the quick-firing guns, she could fire seventy-two shots in two minutes, but none of them probably, excepting the first few, would be aimed shots at all. It would take a very good gunner to make good practice under the circumstances, with his ship rolling and the boats continually altering their bearing and distance, and probably steering different courses. To take these points in more detail: as to the first point about *invisibility*, I think if you look through the number of torpedo attacks that have occurred, you will find, in the majority of cases, the boats have not been seen at distances over 1,000 yards, and in many cases they got nearly alongside before anyone knew they were there. I have seen cases of that, and have known cases where the boat, in a single ship attack, has not been seen, and it has actually come alongside, and made fast, and the men come inboard without being discovered. The Umpires in the manœuvres, I know, have a very difficult task to decide on different points, but if I may venture to offer a suggestion, there is a time limit now which tells very hardly against torpedo-boats. I fancy the reason is that everyone in the ship, from the Captain downwards, feels it an indignity to be put out of action by a little "mosquito," probably barely one-hundredth the tonnage of the ship, and as the time is taken from the first gun, which there is no rule should be aimed at the boat, and probably in many cases to the "cease fire" bugle, it is probably stretched in favour of the ship. This, I am sure, is felt by every torpedo-boat Officer, and I humbly suggest that the conclusions arrived at are not those that will probably be obtained in actual war. Might I suggest that the claims be kept by the Umpires until after the manœuvres, when both sides would have had a chance of a hearing, and then certain points be allowed for each case? I think some arrangement of this sort would enable a more correct result to be arrived at, which, I feel sure, is one of the main objects of the annual manœuvres. When you are discovered the cry is "Torpedo-boat!" What is the

first thing that happens? A gun is fired off to take the time by. The first gun is never pointing at the boat. The torpedo-boat Officers can see better than the men and Officers of the ship, and it is a proverbial fact that the gun is generally fired on the wrong broadside, and quite irrespective of the position of any friendly ships, and as the friendly ships occupy a very much larger arc of training for the gun than a little torpedo-boat, the friendly ships, I believe, will suffer more than the boat. There is one case in point at Plymouth. The first attack, in 1890, came in through the eastern entrance, and the second through the western one. The firing for the second attack was started from the eastern end of the Breakwater, which could have been of little or no effect.

Admiral COLOMB: I rise to order with regret, but I am always afraid, in this Institution, of seeing discussions turn off in the wrong direction. It is very easy just now to get on the torpedo-boat, and the lecture is not on the torpedo-boat attack.

Lieutenant STURDGE: I beg pardon. I was trying to point out the rôle of quick-firing guns *versus* the torpedo-boat. As to the quick-firing guns, it seems to me that, after the first boat is seen, the electric light is probably put on that boat, and the other boats coming in are not seen, and therefore a large number of unaimed shots are fired in any direction. To take the case referred to by the lecturer, the attack on the "Blanco Encalada" by the "Almirante Lynch" and the "Almirante Condell." The facts, as taken by one of the Officers of the flag-ship, and also the Captain of the "Almirante Lynch," seem to be these:—Fire was opened after the "Almirante Condell" fired the second torpedo; the "Almirante Condell" then cleared out, and the "Almirante Lynch" was 600 yards off, and came in and fired her first torpedo within 150 yards. They went full speed astern, to save ramming the "Blanco Encalada." The "Almirante Lynch" put her helm hard-a-port. Before firing the second torpedo four minutes had elapsed within 150 yards of the "Blanco Encalada," that ship being armed with two quick-firing guns and one or two Nordenfelts. The actual effect on the "Almirante Lynch" was this: there were four hits—two under the poop and two forward—and one man was wounded. These four hits were of practically no importance. Then they went out and met the "Aconcagua." There was an engagement of forty minutes at ranges between 3,500 and 500 yards. The number of shots fired were—the "Aconcagua," 160 shots; the "Almirante Lynch," 407; and the "Almirante Condell," 200. The "Almirante Condell" was not hit at all; the "Almirante Lynch" was hit three times. One Nordenfelt bullet struck her close to the water-line opposite the boilers, and one 3-pr. struck the water-line aft and one forward, so that they were practically uninjured. The "Aconcagua" was hit seven or eight times, all in deck-houses and awnings, not one actual hit in the hull. Then there have been experiments as regards firing at sections of torpedo-boats, and you will find that, in each case, there have been but very few hits in proportion to the number of rounds fired. Judging by the hits on the target at night-firing, I do not think the superiority of quick-firing guns is borne out by the facts. They act very detrimentally in the way of intensifying every false alarm, which are in the proportion of three to every real attack, and a large amount of ammunition is often expended on those occasions. The result is, the ships may possibly run short of ammunition before a real attack takes place. Admiral Long referred to the torpedo-catchers. Whether they are the best way of catching the torpedo-boats depends of course purely upon the quick-firing guns, and if the effect of quick-firing guns is so great that they can sink the torpedo-boat, of course the torpedo-catcher is the best way of catching the torpedo-boat. If the torpedo-boat has a very large superiority of speed over the torpedo-catcher, I doubt whether it is the best way of catching the torpedo-boat. I was glad to hear Admiral Long speak very highly of the submerged tube. Of course we have been driven down to submerged tubes by quick-firing guns, and that is one great effect of the introduction of quick-firing guns. In the case of the "Royal Sovereign" class, a beginning was made to protect her above-water tubes, but for Admiral Long's suggestion for second-class cruisers to run the gauntlet, the above-water tubes require a little more protection than they have at present.

Vice-Admiral Sir EDMUND FREMANTLE: As my name has been alluded to two or three times in a friendly and complimentary way by the lecturer, I should like to

say a few words. The first thing that strikes me in his lecture is that it is very complete. There is a great deal of thought in it, and I am quite sure, though we may not entirely agree with him as regards what ought to be attempted in meeting an enemy, that there is a great deal of study and thought in it, and we shall learn a great deal from it. The next thing that strikes me is that we do not see, in this Institution, a large number of young Officers. I am sorry to say this Institution does, to a great extent, lack young Officers, especially of the Navy, who naturally are not very much in London. I make these remarks because the lecturer observes very properly that a question of tactics and a question of quick-firing guns, or of torpedoes, or of any other question connected with warfare, is one which should be studied quite early and young, and I think that those who do begin that study earlier and younger than most of us did, will have a very great advantage. It is, perhaps, unnecessary for me to allude to it, but Captain Mahan's recent work¹ touches very closely upon the question of naval Officers thoroughly studying questions connected with war. He has stated very truly, as it seems to me—it is well thought out like everything in the book—that English naval Officers were very frequently very fine seamen and very good Officers, or thought so in peace time, but that they occasionally failed and failed curiously in action from want of study of naval war. He mentions this more especially with regard to Matthews' action of 1746. The next subject with which I think we shall all agree is the question of conning towers. I entirely agree with the lecturer that it seems a very strange thing that it should be so, that the naval architects should have insisted upon gathering together all the necessities for the management and fighting of the ship in a conning tower which is not defended properly from the projectiles which will be showered upon it. There is the excuse, of course, that quick-firing guns did not exist when most of our ships were laid down, and that has made a very great change, but we see, even in the case of the "Hunscar," the extreme danger of having everything brought together in one spot which was not protected. It would seem to me that, after all, anything would be better than that. I recollect the story of a Yankee who was giving his experience of what had happened in the American Civil War. He had been in command of a turret-ship. A lady said to him, "Oh, no doubt you always were inside the turret." "No, ma'am," he said, "I was not inside the turret." "Oh, really," she said "then where did you get to?" "Well, we were generally attacking forts," he said, "and I got on the lee side of the turret so as to have two thicknesses of armour to protect me instead of one." Then there is the question of the armament of cruisers. I think, when people talk of having a very large number of cruisers instead of our large battle-ships, they do not sufficiently think of the question of their respective armaments and the protection afforded. It has been brought to our notice very properly by the lecturer, and still more clearly in the work on fortifications by Colonel Clarke, that the cruisers built now, though they carry unquestionably a good armament, but having necessarily great speed, they have very little protection and are very vulnerable. It is a satisfaction to us to think we need not consequently arm our coaling stations quite so much as was thought to be necessary a few years ago. At all events, I perfectly agree with the lecturer and Colonel Clarke, that the armament of our cruisers is such that the strength of a cruiser is only sufficient to fight its own equal, and that she is not of much value against a fort. There is another question of detail, certainly, but I think we have all been trusting very much to the electric light, and as the lecturer has shown us, it is an extremely dangerous thing to trust to implicitly in action. I think we should always have some alternative means of lighting ready instead of trusting entirely to the electric light. This refers more particularly of course to unarmoured cruisers than to vessels where the electric light is so entirely protected as in some of our first-class battle-ships. We have had recently in the papers a considerable discussion on the question of torpedo-boats, and torpedo cruisers. I do not propose to go into that now, but it does strike me that the remarks of the lecturer are as true and just in that case as they have been in most of the lectures which he has given us, and that is, that if our torpedo cruisers are to compete with

¹ "The Influence of Sea-Power upon History." By Captain Mahan, U.S. Navy.

torpedo-boats they should have certainly equal if not greater speed. I quite admit that as a rule torpedo-boats, after steaming a certain time, say six hours, can no longer go at the speed which we see on paper, and very often the cruiser of 19 knots may catch the boat of 22—in fact, I am under the impression she generally will, but still the time will come when the torpedo-boats will run out of harbours and be at their best, and they will run at 22 knots. It will be idle, under those circumstances, if the water is smooth and the weather fine, to send torpedo-boat catchers after them, which can only go, say, 19½ knots. It was not my intention to take much part in this discussion, but as my name was mentioned so many times I thought it right to do so. There is one other point to which I should like to allude, which I think the lecturer has brought clearly before us, that is, that we must in future, in the beginning of an action, as far as possible avoid presenting our broadside normally to the enemy, and that we must show more or less an angle, and engage partially bow on, and that the position of 45°, which I think he seems rather to lean to on four points, was one which was especially favourable as enabling you to use all your guns on one broadside, whilst at the same time not being placed in a position normal to that of the enemy.

Captain MAX, R.N.: Admiral Long has brought so many subjects before us that I shall try, as far as I can, to keep to the question of change. The quick-firing guns have come in: what change has been introduced? I think Admiral Long has shown forcibly that any change goes to the benefit of the gun. We have three weapons—the gun, the ram, the torpedo. The gun has now been greatly improved, that is to say, it is more important than it was five years ago, and therefore our change must be in the direction of considering that the power of the gun has increased and we must regard it more. First of all, as to tactics. The only fleet action under comparatively modern conditions that I know of is Lissa. There the ram came to the fore—Admiral Tegethoff found the ram his winning weapon; he charged down amongst the enemy's fleet and defeated them. That seems to me reasonable and rational. You think the ram is superior; so you charge down amongst the enemy to use it. As far as I understand Admiral Long, he thinks now that the gun has so much improved we cannot do that any longer. We must begin, I understand him to say, by keeping off from the enemy until our superior gun-fire has given us some advantage when we may go into close quarters. If that is so, the problem is how are we to do it? I must say, having tried to follow Admiral Long's diagrams, I have not succeeded in forming any opinion as to how, if I were disposed to remain at 1,000 yards, and use my guns, I am to keep off from another fleet who wanted to charge and use their rams. Questions of that kind appear to me to be constantly coming up, and as far as I can see they cannot be studied entirely on paper. We want to study them at sea. We tried in a small way, when I was in the Red Sea, to do something of the kind in boats, but it was not very satisfactory. Still I thought we learnt a little. It does seem to me that we do want some tactical school. It has been recognized that although gunnery can be learnt in a seagoing ship, and torpedo work also, still we want schools to study everything now, and to keep everybody up to the mark. And it does seem to me we want something of the kind in tactics, or seamanship, if you prefer to call it so, at our ports, where those problems could be worked out, and young Officers instructed as to what is right and what is wrong. That seems to me a necessity of this change. Then there is another thing which appears very necessary. We hear a great deal of the word "fire discipline." In the Army a rapid-firing weapon has been introduced on shore. The power of small arms is greatly increased, and it is found by all armies that the result is to throw more responsibility on the junior Officers, the company and battery Officers, corresponding with our Officers of quarters, and that what they call "fire discipline," that is, control and direction of fire, is therefore of increasing importance. And so it appears to me that that is another necessity of this change, that we should pay more attention to the control of fire. Lieutenant Sturdee told us how lightly a torpedo Officer regards our fire as it is at present, and I am sorry to say I agree with him to a great extent. Admiral Long has told us that the quick-firing gun is its own range-finder, and I believe if the Officer, having his men in perfect discipline, can keep control over the fire, though we may not be able to stop torpedo-boats, at any rate

we shall be able to make it rather hot for them. With regard to stopping a boat, I may say I agree with Lieutenant Sturdee, because, if we look back to fighting in the old days, a 32-pr. loaded with grape ought to have stopped a pulling boat. It seldom did so, and the boat often pulled alongside a ship without very much damage, and I believe the same thing will happen again. Then one word about keeping your ships in an oblique direction. Now-a-days that we have so much curved armour, turrets, barbettes, redoubts, and the much-abused conning tower, I do not think the oblique direction is so important. If a shell comes in on the bow, 45° from the line of keel, and bursts, the splinters will diverge another 45° , and will rake the deck, going nearly fore and aft, whereas if the shell comes in directly abeam, you only get your angle 45° , and probably only one gun on the fighting side is injured. I think that is important, and we cannot afford to disregard it. As regards construction, may I say one thing? It appears to me that there has been some little confusion as to the number of hits a ship will get, because a quick-firing gun has been introduced. I take it the number of hits a ship will get in action depends upon her endurance. Admiral Long told us the "Chesapeake" received 56 shots, and then struck. Then I would say the endurance of the "Chesapeake" was 56 hits, and that it did not matter twopence to the "Chesapeake" whether those hits came from quick-firing or slow-firing guns; as soon as she received 56 hits, she must strike. If that is so, it seems to me that in considering the question as to whether a conning tower is sure to be hit it does not matter whether the enemy has quick-firing guns or not. The 56 hits will be distributed all over the ship in either case, and the conning tower will be hit either by slow or quick-firing guns. Of course the action will take longer with slow-firing guns, but the hits on the ship will only be one number. But if a ship with quick-firing guns meets a ship with slow-firing guns, then of course the 56 hits come in very much sooner than the slow-firing ship can get 56 hits on the enemy, and she will undoubtedly have to strike. As to armour, if the guns are so important, what we want, it appears to me, is more armour: that means more displacement. That I should gather would be the change which quick-firing guns have entailed on our shipbuilding. The gun has to be resisted, not the torpedo or the ram so much, and armour will resist the gun. Now if we take the cruiser whose conning tower Admiral Long talked about, she has no armour that will resist quick-firing guns of the present day. The conning tower which was abused was made to resist the quick-firing guns of that day; unfortunately it does so no longer, and therefore now you are in the same position that you were in the days of the unarmoured frigate—the whole of the cruiser, conning tower, and everything else is practically unarmed. The only thing we can do is to put armour; then she gets bigger and becomes an ironclad. We must steer the ship from somewhere, we must steer her from above water, and is it worth while to put gunproof armour on the conning tower alone? We cannot do it. The only alternative appears to me to be to have several stations from which you may steer the ship, and if one is knocked away you can go from one to the other.

Admiral COLMAN: This lecture is on "The Probable Influence of the Introduction of Quick-firing Guns on Naval Tactics and Construction." We are not discussing quick-firing guns *per se*; we are simply examining the position that quick-firing guns will give you so many more shots per minute—whatever it may be—above others, and what is the result of the rise in the speed of firing. That is the point, and we get it, I think, at once in the two "Piemontes." We see there the key of the position, which subsequent speakers quite agree with. We see it is perfectly evident that you cannot get a rapid fire from the bow position, but you can get a rapid fire with your guns from the broadside position. The result is that the effect of the greater amount of fire in a given time, which necessitates assuming the broadside position, is a matter of importance. But that really was always so, and we had always taken it in that point of view. I want to say about the paper itself, that, like everything else that comes from Admiral Long, it is clear, incisive, and lays down principles which, in his opinion, ought to be carried out. My experience on this question is, that, with a careful working from point to point, inductively, as it is called, you are bound to come to the truth, even though you do it only on paper. You cannot complete the truth on paper, but you can approach

it so as to show what your next step ought to be when you get beyond paper. I cannot help dwelling upon that, because I think Admiral Long has again laid down principles which have been laid down here before, and he has shown that those principles have become more widely acknowledged than they used to be. I take the influence of the ram on formations. We are told to-day, and it is important to note these things, because they help us to trace the causes which are to produce the results—we have been told, and as far as I can see most of us have agreed, that the ram does not influence formations in the first instance, but that it is at a later part of the battle that the ram comes in. But that again is twenty years old. I said in this Institution, in 1872, writing on "Attack and Defence of Fleets," "Those who think with me will observe the instinct of the naval world has led it to contemplate the end-on position for hostile fleets, not as the best means of attacking with rams, but as the best means of frustrating an attack of rams. Our opponents will take the opposite view. The latter party will maintain that the ram dominates and prescribes the formation, which is so good a defence against it, that the ram is not the chief weapon in fleet action. And the inefficiency of the ram as the chief fleet weapon, once the end-on position is firmly established, seems to me to be argued by other considerations, which I have not yet seen treated by any writer on tactics." Then again, "Naval strategy, therefore, while it dictates an attack by the ram by single ships as the most effective means of obtaining the victory for him who is most skilful, does not seem to advise that policy in a fleet attack. You must beat your enemy in some other way." That goes to show that it is not the advance of the torpedo which has thrown the ram back, but it is in the nature of things that the ram should be thrown back by the steps taken in defence. The battle of Lissa was mentioned. What made the ram powerful in the battle of Lissa was not the ram itself, but the unskilfulness of the people who met it. If the Italians had turned towards the Austrian fleet that threatened to ram, there would have been no such disaster as happened. Another point which I look upon as most important with regard to the ram, and which was noticed by Admiral Bourgois, although here again it was referred to twenty years ago in this Institution, is where it was shown that the *support* or *guard* was everything. In No. 3 Diagram, the rear ship threatens any ship attempting to ram the leader, and from my point of view prevents the attempt being made. Admiral Long rather spoke as if the *support* would act after the enemy had attempted to ram. From my point of view the work is done by way of threat, sufficiently complete to prevent the enemy from thinking of ramming. It was said, also twenty years ago, when there was only the Harrey torpedo, that the result of the action of the torpedo must be to bring the guns forward. Here we have it pretty well acknowledged that that is so. Then as to the question of doubling upon the enemy, that also I had the honour of bringing forward here, showing that in succession you can double, and that that was the way to do it—in succession, instead of simultaneously, as Nelson did. What I want to impress upon you is, if you will, as Admiral Long has done, follow out these things clearly and distinctly, even on paper, you are bound in the end to come to just results. You need not make mistakes, because if you take your subject from every point, and look at it from every point, you will find probably a mistake one way is corrected by a truth the other way. Twenty years ago I came to the conclusion, which remains unchanged, that to bring the enemy four points on your bow was an important position for you to take up, that you were safer thus than you could be in any other way. You force your enemy to disclose his intentions, which is everything to you, and in disclosing them he gives you, perhaps, the opportunity of taking advantage of them. But we must never forget that, in tactics, all we can really aim at is equality. You must always understand, whatever arrangement you may make in the way of getting an advantage of your enemy, he has an equal power of getting an advantage of you, and all you can do, if you are equally skilful, is to fight on an equality. In other words, your care must be to prevent the enemy taking an advantage of you, rather than to hope to take an advantage of him. Sir George Willes said a word with regard to Admiral Bourgois, which I do not quite agree with. It is perfectly true that Bourgois was a paper man. He was a great mathematician, and a most scientific man, but if you look into what he has

written, you will see most of the things with regard to this question that we now accept.

Admiral Sir EDMUND FREMANTLE: Will you explain the 4-point bearing?

Admiral COLOMB: You bring your enemy four points on the bow. It is too long a story to go into now, but it will be found in the journals of twenty years ago. I was very glad to hear Admiral Long speak out strongly against the *mêlée*. It is an abomination, a thing that no English Officer ought ever to dream about, or think about. It was an idea brought in by Admiral de la Gravière, as if it was a thing that could not be helped, but, as Admiral Long has pointed out to us to-day, the Admiral who has his fleet in proper command will not have a *mêlée*; he will take care to keep his ships together, *coute qui coute*, and to withdraw for a time from the battle to re-form, rather than allow them to get into a *mêlée*, where it is impossible to say who is to win. The value of the 4-point bearing is shown by "Sagittarius" on the diagram. She has taken the quarter 4-point bearing, which comes to very much the same thing, and you see by doing so she has put her enemy at a disadvantage, unless she also takes up the bow 4-point bearing. "Aries" is making the mistake because she does not see what her game is. After she has got pounded of course she does, but not at first. I think the "Shah" did not ram first of all, because she was not really a ram; she had no doubt a spur of some sort, but it was thin iron. Moreover, I do not quite agree with the lecturer in saying it would be very easy for her to have rammed the "Huscar." As far as I have gone into the matter, turning power more than speed has to do with effective ramming in a duel; not, perhaps, in other cases, but in a duel. It might have been a very good thing that the "Shah" did not try to ram, because she might have got it the other way. The value of the line-ahead remains, as far as I can see. I do not see anything to shake the belief I have held for twenty years. It need not be a long line, but, as far as I can see, the man who takes his fleet into action in a line-ahead, moving through the enemy, or passing the enemy, has an advantage.

Sir EDWARD FREMANTLE: Admiral Long does not go into action in line-ahead.

Admiral COLOMB: It is a narrow front.

Admiral FREMANTLE: It is subdivisions—quarter line.

Admiral COLOMB: A narrow front of great depth, which is the general term for expressing "line-ahead," but then we must recollect, as it was very properly put by Captain May, you cannot guarantee that the enemy will meet you as you want him; you cannot guarantee that his fleet will stand towards you. Most likely he will not. If an enemy is determined to make you fight an artillery duel, I think he will turn his stern and fight it out that way. It is only in the cases where the advance is mutual that you get the order of battle that is shown *there*. There are, I consider, five distinct modes in which fleets may fight, and you cannot guarantee any one of those modes, but you can prepare for all of them. As to conning towers, I very much agree with the lecturer. Shortly before I retired from the Service, I had to go closely into it for the Admiralty, and I came quite to the conclusion that we should not have a conning tower in any of our ships. What we want is simply two or three good stout shields on each side of the deck that will keep out a 3-lb. or 6-lb. shell. Simple shelters for the Captain, or whoever is in command of the ship, and for the navigating Officer. Let them seek the position where they will have most shelter. Inside each shield there should be a tube of large diameter, and, below the water line, engine and steering telegraphs should be collected. The orders would then be given by word of mouth down the tubes.¹

Mr. BARNES: I may state that the "Shah" was not a ram; she had merely a stem with a wooden backing, sheathed over with copper. You could hardly say that she had a stem at all prepared for ramming.

¹ Note.—In trying to take a great many heads in a short time, I failed to put the general lesson of the lecture as I wished to do. Its points are:—(1.) The confirming of the theories of twenty years back. (2.) The maintenance of the gun in the first position. (3.) The effect of the torpedo in delaying action at close quarters. (4.) The bringing out by means of the quick-firing gun, into practical relief, twenty years old conclusions, namely, that naval power lies in a numerous artillery on the broadside, and not in small numbers of very heavy guns at the ends.

Captain CURTIS: Moreover, the "Huascar" was the more handy ship.

Admiral CLEVELAND: I concur in a great measure with the paper. I think, however, it has a narrow standpoint, and I regret that the lecturer has associated "Construction" with "Tactics." As I understand Tactics, the tactical problem is how best to apply *existing* matériel in such a manner as to develop the offensive as well as defensive powers of the ship or ships, viz.: the ram, guns, torpedoes, and armour protection. That is the tactical problem, and the "Construction" is thus so far settled for us. I need hardly say how necessary and how important this question of tactics is, and I quite agree with Captain May in thinking it desirable that some steps should be taken to form a "School of Tactics." I am very strongly of that opinion because, before we can satisfactorily discuss the best tactical formation, we must lay down certain broad principles as to the composition of the squadron—the number of battle-ships, the reserve, coal, ammunition, and torpedo dépôt ships; their speed and armament (primary and secondary), and also their torpedo armament (whether our battle-ships are to have torpedo tubes in them, or whether they should be relegated to torpedo gun-vessels in attendance). Then, again, the question of powder—is it to be black or smokeless? Also again, what ships are to be attached to battle-ships—are they to be cruisers? as our lecturer says—or, are they to be torpedo gun-vessels? These are matters which affect the movement of the ship, and therefore the tactical formation of the squadron. Are the steam-boats, especially the 2nd class torpedo-boats, to be hoisted out, or left in the crutches to be destroyed? And further, when these important factors in the problem have been authoritatively laid down, and the best tactical formations (varying with those of the enemy) based upon them, threshed out in "The School," they should be confidentially communicated to Officers in command for their guidance. I do not agree with Admiral Colomb as to the "line-ahead" being the best for attack. I do not profess to be a tactician, but I do think an échelon formation lends itself better to the development of the heavy fire of the battle-ship, and that is a most important thing. I agree with the lecturer with regard to the maximum distance at which we should open fire: 2,000 yards for guns and 600 yards for torpedoes. It of course gives very little time (one minute, both squadrons moving at, say, 10 knots) for reloading, and we should only get one round from our heavy guns before the two squadrons were abreast! The arguments of the lecturer are based upon that table of practice from quick-firing guns which I think will be found to be rather roscate. No doubt, these results have been obtained under favourable circumstances, but my experience leads me to infer that, under Service conditions, we should not get the same results from the quick-firing guns that are recorded there. The term "quick-firing gun" has, so far, lost its meaning. When it was first introduced into the Service, it was a gun which had "fixed" ammunition, and that was a very well-defined line. Now our 6-inch and 4.7-inch quick-firing guns do not have "fixed" ammunition. Relatively speaking, they are quicker firing than their corresponding calibres with the old ammunition, but I think the method in which their ammunition is made up will shortly be adopted for every gun in the Service, and the so-called "quick-firing" guns limited to those which use fixed ammunition. I beg to express my thanks to the author of the paper.

The CHAIRMAN: When I first went to sea, there were two classes of ships in the Navy, the Symonites and the anti-Symonites. Sir J. Graham, when First Lord of the Admiralty, said, "that with the exception of religious controversies, he did not know anything so bitter as the controversy which raged between the Symonites and the anti-Symonites." Now-a-days the controversy seems to be in much the same condition between the torpedoes and the anti-torpedoes, but we shall have to wait for the next war to settle the dispute practically. With regard to the "Shah," I think Mr. Barnes settled that matter. She is not properly a ram. There is one important point that we very much lose sight of in these days, and that is the mischief done by splinters. To show you how our forefathers were well aware of it, in 1708 two privateers, under Captain Woods Roger, went round Cape Horn, and I remember reading that part of the gunner's duty was to clear away certain portions of the woodwork, the reason given was that more people were killed by splinters than by shot. Sir Edward Codrington, writing of Lord Howe's victory on the 1st of June, 1794, mentions Lord Howe sleeping under the poop for

three nights before the action, not a single bulkhead up, and only a simple canvas screen. The reason he gave was, that the cabin was kept clear of anything that would make splinters. At the Battle of Navarino, 1827, the late Sir H. Codrington, then a mid. in the flag-ship, writes, "It was a lucky thing for us that the ships were undermanned in those days, and that we were not able to spare any crews for the guns in the cabin, as the Admiral's cabin, after the action, was a mass of splinters," and he mentions four fowling-pieces, lashed together in the cabin, being struck by a shot; in one, the barrels were separated, and pieces of the splinters were found out in the poop. That shows the extraordinary damage splinters may do. In my opinion, all boats should be lowered, if possible, before going into action, as we saw done in picture of engagement in the last great war, and all booms should be cleared away, and everything that might cause splinters, or burst a shell.

Admiral Long (in reply): I do not think I have very much to say. I must consider myself fortunate, considering how very little qualified I am to deal with these questions, that I have not been treated more severely. With regard to Sir George Wiles' reference to Admiral Bourgois, I may say that I read his book, and I was very much struck with the way in which he anticipated what has subsequently happened. I do not know what he did afloat; I only knew him by his book; I never met him. With regard to what Lieutenant Sturdee said, I am sure I hope we shall be able to persuade him to give us a lecture, but I quite agree that a very large deduction from the figures in this paper would have to be made if you wanted to arrive at how many shots are likely to hit anybody. That is a question which it is almost impossible to discuss. You can only say a quick-firing gun, if fired five times as fast, is at all events likely to make five times as many hits as other guns. Admiral Colomb said, some years ago, that about 2 per cent. might be expected to hit, and of course that 2 per cent. will now represent a much larger absolute number than it used to. Beyond that we cannot go. The attack of a torpedo-boat against quick-firing guns would, no doubt, take place at night, and I quite agree with Lieutenant Sturdee that at night it is not to be supposed the accurate practice will be made at sea, at all events, that is anticipated in that table, or probably anything like it. It can only be taken relatively as showing that whereas you could do certain things before, now you can do a great deal more. The flat trajectories of modern guns, however, are likely to produce much greater effects than the grape shot of old days. With regard to what Captain May said about study at sea being necessary, I must entirely agree with him there. I think these matters can be followed out on paper to a certain point, and then, if two ships are at sea together, they can, if they choose, work it out practically, and get absolutely accurate results as to those particular ships. I think that was a very important remark made by Captain May as to fragments. Of course he speaks with full knowledge of that point and should be attended to. With regard to what Admiral Colomb says about his lectures in times past, I entirely endorse all that. I may say, that his lectures were the first things that induced me to pay any attention to the subject at all, because, in the ordinary course of service afloat, such matters are not brought before us, and I think that is one of the great advantages in favour of this Institution, that these matters are brought before everybody, and young men, as they go on, get hold of things which stir them up to work out these questions. With regard to what Admiral Cleveland said, I think I said in my paper that I did not anticipate that the torpedo-boats would accompany fleets. Of course that was meant to cover hoisting boats out as well as first-class boats. That appears to be generally understood. The French appear to have come to the same conclusion, as the result of their manœuvres in the Mediterranean, that torpedo-boats were more trouble than they were worth directly they got away from land. But torpedo-boats will play their own part from their own bases. I am quite aware that the tactics I put forward must necessarily be imperfect; they are simply the result, in my mind, of what I have heard and seen done and read on the subject, and I hope it may be of some use to others beginning the thing to make a start with. I am very largely indebted certainly to Admiral Colomb and many Officers I see here—Sir William Dowell, Admiral Fremantle, Admiral Wiles, and others—for the knowledge that I possess on the subject. I thank you very much for the kind way in which you have received my lecture, and Admiral Sir Vesey Hamilton for taking the chair.