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Captain P. H. Colomb R.N.

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THE ATTACK AND DEFENCE OF FLEETS.

Part II.

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

Much of the neglect under which my subject undoubtedly lies, may proceed from an idea which impressed me very strongly at one time, namely, that the attack or defence of a modern fleet cannot be profitably studied prior to the experience of many actual combats. It seems at first sight probable that no such thing as rule or law can be evolved except from the facts of experiment in war. It is therefore readily assumed that naval strategy is not yet in a condition to be made a subject of study. This line of thought would be excusable after many failures to discover the hidden law or laws which may exist, but it does not excuse the neglect to seek for them. We have no business to make the assumption in the first place, for it is founded on no data; and, moreover, I trust to have shewn in former papers that so far from being the vague conglomerate of conflicting opinion generally supposed, a very superficial analysis recovers many points of absolute certainty round which theories may safely revolve, or, at the very least, gives encouragement to persevere.

There are, however, two ways of approaching the study. The first is very easy, very common, and very misleading. The second is slow, troublesome, rare, but may lead us to the very centre of the maze. The first is the empirical or ratiocinative method—the second, the inductive. The first assumes some theory of attack and defence, some pet formation, or favourite weapon, and argues to the particulars of a combat founded on these assumptions. The latter assumes nothing at the outset. It establishes particulars by observation and experiment, and then collates, or colligates, as it has been called, these particulars, until it weaves them into general harmony. The former method *may* turn out a truth in the same way as you may throw sixes with dice. The latter method may be less brilliant, but what it establishes is reliable, and in any case such errors as occur, are capable of detection before the general result comes to be applied in war, for they must be caused either by some mistaken particular, or by some wrong application of particulars which are in themselves true.

I need not say which of the two methods has my approval, or on which of them I intend to base my present enquiry. My former paper* sufficiently shewed that I was content to make any sacrifice rather than proceed to generalise hastily. But in applying such particulars as I assumed to be established when I last addressed you, I must ask you to bear in mind that they are assumptions still, in a greater or less degree. There is not one of the points then adverted to which will not bear—nay, which does not imperatively demand—rectification by observation and experiment. I deny absolutely that we can form any

* See Journal, vol. xv, page 405, *et seq.*—Ed.

correct notion of what a future naval action will be from the colligation of circumstances which we do not know absolutely to be facts. At the same time I hold in good faith to the theory that if we knew accurately all the facts which can be established by experiment and observation in peace time, we should have materials amply sufficient to guide us to complete success on the first occasion of putting our theory into practice against an enemy.

These remarks are not unnecessary at the outset of my paper. There is not one of us naval Officers who has not either heard or expressed the most decided opinions on the efficiency of certain formations and the inefficiency of others; yet I venture to say not 10 per cent. of us have ever heard any good reasons as to why one formation is better than another, and not 2 per cent. have ever thought out the matter even superficially for themselves. The danger we run of committing ourselves to some definite theory of attack and defence without any inductive steps leading up to it, is real and tangible; and if, instead of advocating a particular view, it should come to pass that I show the end farther off than ever, and leave your minds open on the questions, I shall not consider I have done bad service.

I must now advert to an opposite opinion on this matter which is held by men of greater practical experience than my own, and of deservedly greater weight. It is very strongly held by these that it is far more important to have a plan than to have a good plan of attack or defence. It is insisted that the Admiralty would be wise now, with our present information, in deciding on a particular formation and mode of attack, and in enforcing its use on our Admirals, so far as excluding all other plans from the Signal Book goes. The issue raised is very distinct, but it is not one I am called on to argue here. For, if I be wrong in supposing a bad compulsory plan to be worse than no plan, still, as no plan is yet adopted, such investigations as mine go to establish not only a plan, but, if properly conducted, a good plan, even though, as I before remarked, the attainment of one were so far off.

It is now incumbent on me to state what the aim of my arguments will be.

I understand the success of a fleet action will depend jointly or severally on four things, namely, material superiority, moral superiority, superior mobility, and superior position.

Material superiority we have nothing to do with. If we have it, and an equality in the other three things, we shall win without a discussion. Moral superiority is often confounded with strategy, and often spoken of as though it were a possession not only exclusively English, but incompatible with strategic skill or even strategic plans. I hope I should be the last to despise that fire, dash, and stolid determination which hurled a Nelson on the van of the French at the Nile, and on the head of the Mole at Santa Cruz. I trust no English naval Officer will ever forget that, guns or no guns, rams or no rams, torpedoes or no torpedoes, he who places himself most completely in the spirit of Nelson's orders to his Captains is doing the best service to the State, and runs most chance of winning. If nerve gained naval

victories for us a century ago, surely those who have it in superiority possess an increased power now! But the instances I quoted of Nelson at the Nile and Nelson at Santa Cruz are sufficient to indicate that bravery and strategy combined are very much more powerful than bravery alone. The brave man had better be intelligently brave while he is about it. It may raise his reputation for pluck to win with great loss, but it will benefit the State more that he should win with small loss. Besides, a man cannot be argued into bravery, and he can be taught strategy.

Again, mobility in a fleet must be attained before the latter can be strategically employed. I pre-suppose we have it in equality with the other side. Of the four qualities set out there remains now only the last—superiority of position. What constitutes it and how to gain it, is the subject I intend to discuss.

To those, therefore, and they are many, who pin their faith on the moral superiority given by audacity and nerve, and propose without any plan to rush upon an enemy's fleet and frighten him into submission, I have nothing to say of a controversial character. I am not about to argue whether audacity be a greater or a less powerful weapon than skill. But I am about to argue, and do maintain, that audacity supplemented by skill is irresistible, and my object is to arrive at some conclusion as to how your own Fleet can be best disposed so as to allow your audacity to produce the greatest possible effect on your enemy with the least harm to yourself.

I must now set out in order those points which, discussed in my last paper, or generally admitted, have, for the purposes of my present argument, all the force of facts, and must be acknowledged as such until they are controverted.

First comes the possible speed of a fleet in action: we know that this ranges between, say, eight and thirteen knots, and if I take a mean of ten knots, I shall place myself in such a position that half my hearers will say I put it too high, and the other half too low, a sufficient guarantee for being somewhere near the truth. Assuming such a speed, enables me to deal with the all-important relations of time and space; will permit me to show what can and what cannot be done by a fleet in the time allowed; and how the skilful commander may avail himself of the limit which time imposes on his enemy's movements.

Next comes the turning power of ships, which I showed in my last and former papers cannot be taken as to space, at a smaller arc than one with a radius of two and a-half times the ship's length; and as to time, a reduction in speed over the arc of one-third. It is perhaps necessary to repeat here that this statement does represent in the rough an absolute fact; and that the figures do give the smallest space combined with the least time in which average ships can turn. If the space be diminished the time will be increased, and if the space be increased, so also will the time.

If we now take 300 feet as the length of an ordinary ironclad, we get an arc of turning for the ships of our fleet of 250 yards, and a time of turning through (say) eight points at ten knots, of two minutes.

I must draw your particular attention to the foregoing figures, because I base my whole view of naval strategy upon them, not indeed on the exact numbers, but upon their relations to each other. These relations are, in my view, the bounds within which the strategist must work, and beyond which he will only fail in attempting to pass. It is no use to call them matters of detail or assumptions, they are vital principles; and the only assumption about them is the exactness of the figures. Ships may not be 300 feet in length, but the shortest turning ironclad which has ever been built, going at her highest speed, takes about a minute to turn through eight points on an arc whose diameter was 5·2 times her length, reducing her speed over the arc by more than one-tenth.

The next point to be considered is the gun-power of ships. I laid it down last year from the best data obtainable, that only about 10 per cent. of the shot fired from a sea-going ship would take effect upon another broadside-on, and at a fixed distance of 1,000 yards; and that the highest speed of fire which could be calculated on, was about one round in three minutes. The damage done by hits at that range was of course not easy to estimate, but except at close quarters, when the shot strike fair on the broadside, all allow it to be small: the effect of hits received when end-on is generally considered to be *nil*.

I held the ram to be the effective weapon in a single-ship action, the gun being subordinate, unless the Harvey torpedo should supersede the former; and while on this subject, I must say two words. I have usually in my papers stated that the idea of the ram originated in our Service, with the gallant Admiral of the Fleet, Sir George Sartorius. He will be pleased to know that another Officer, Sir James Sulivan, was, contemporaneously with him, pressing the weapon on the notice of the Government, and assisting in that development which we are yet so far from seeing complete.

Again, I have seen, since I last addressed you, the Harvey torpedo in action, and I have modified my views of it. It is not, in my opinion, so powerful a weapon as I formerly believed it to be. To use it effectually, special ships of high speed must be employed, and even then, much more skill is required than I imagined necessary. It seems to me also, that the mitrailleuse or volley-gun will be a very effective defence against this torpedo. It would be used both to sweep the manipulators off the decks, and also to destroy the torpedo itself. In any case, it must here be said that even when I read my last paper, I could not view the Harvey torpedo as an effective weapon in fleets. It is true that one or two special ships towing torpedoes, might, as an *avant garde*, throw a hostile fleet into some confusion; but, as the enemy might equally well employ the same weapon, we should have a combat of torpedo vessels between the fleets before they met, which could not lead to decisive results. If this torpedo is ever rendered powerless against friends, fleets might employ it with greater reliance on its power, against enemies.

I now arrive at a point on which there is not, and cannot be any data, but which universal assent has established as a fact. I allude to the general understanding that whatever formations may be in future

assumed by two hostile fleets in action, the ships composing them will always be end-on, and never broadside-on to the enemy. Some explanation is required to shew how I look on it.

In my last paper I endeavoured to shew that, prevalent as the notion was that the end-on position was that which a ram would assume towards another ship in action, it was in reality a false one. I showed that this was quite a right position for a ship *not* herself a ram, and desirous to avoid being rammed, but that if a ram were so to range herself she could never strike at an advantage. I find now very many Officers hold that I am wrong, not in upholding the advantage of making your stem take your enemy's broadside, but wrong in believing that two ships will seldom, or never, meet stem to stem. It is difficult to argue either side of the question, but I may note that the Russian gunboats never met stem to stem in their experiments; and I may express my firm belief that one or other ship will in such a case swerve at the last moment, and pass broadside to broadside without any result from either ram. Those who think otherwise must remember that there is no analogy between the old principle of getting broadside-on to your enemy at pistol range, and pounding him till either one or the other struck, and the stem-to-stem encounter between two rams. The superiority of the English seaman in our old wars lay in his muscle and his steadiness. The weakness of our enemies was never in material, but they failed in nerve and stolidity. It was the height of strategy to bring our strong points against his weak ones, and broadside to broadside did this in perfection. But for one ship to run against another, stem-to-stem, is no strategy, but rather a reckless blind trusting to chance.

The victory depends upon which ship turns out to be hardest, and the spinning of a tectotum will represent the chances on either side. The strong probability is that if two ships met at speed, stem-to-stem, the shock would be so terrific that both combatants would instantly disappear.

I am saying nothing here of the policy of charging straight down upon your enemy in the belief that he will flinch from his end-on position before the last moment, and give you the opportunity you seek. Such a course may be the most excellent strategy, as you are opposing your presumed strength of nerve to your enemy's weakness. I have before said, however, that I have nothing to do with strategy of this kind, and if a stem-to-stem encounter is contemplated in any other view, it will, I think, be a very foolish proceeding.

If there is anything to be said on the other side, I am not now aware of it, and I therefore base all my ideas on what I have here stated.

Those, therefore, 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, and is itself the chief weapon; I, on the contrary, conclude that the ram dominates and prescribes the formation

DIAGRAM IV

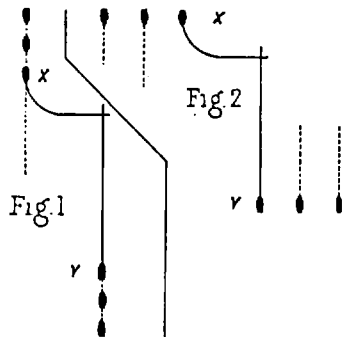

DIAGRAM VI

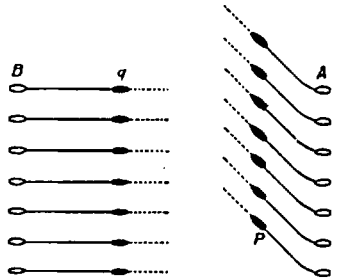

Fig. 8.

DIAGRAM VII

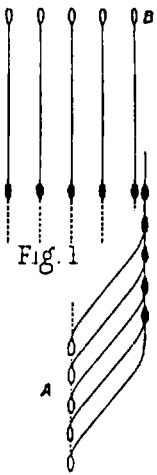

Fig. 1

Fig. 2

DIAGRAM V.

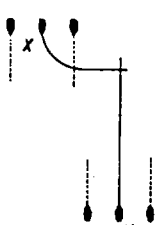

Fig. 1

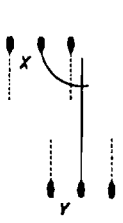

Fig. 2.

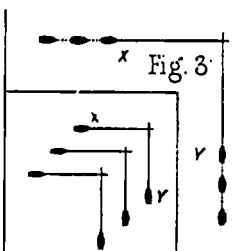

Fig. 3

Fig 4

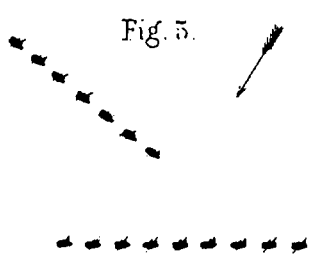

Fig. 5.

Fig. 3.

Fig. 4

which is so good a defence against it, that the ram is not the chief weapon in fleet actions. 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.

If we examine the ramming tactics for single ships laid out in my last paper, and endeavour to apply them to fleets, we shall soon see, I think, their inapplicability. Take Diagram I, figs. 7 and 8, and Diagram III, fig. 1, of my former paper, and you will at once note that the

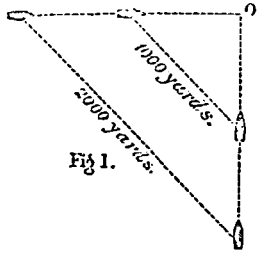

Fig 1.

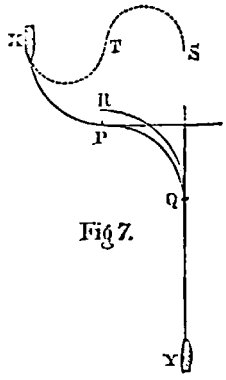

Fig 7.

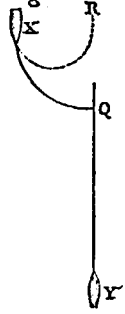

Fig 8.

mode of approach is of small value. If x and y, Figs. 7 and 8, were leaders of single columns in line ahead, as in Diagram IV, fig. 1, it is apparent either that the leaders alone would encounter, or that the turn of x to ram, throwing her broadside open to the next astern of y, would be taken advantage of by that ship, and even if x succeeded in ramming y, she would herself be rammed in turn. So if x and y were the port wing ships of single lines abreast, as in Diagram IV, fig. 2, their manœuvres would have no reference to the remainder of the fleet. If x and y were not wing ships, but some other ships in the lines abreast, as in Diagram V, fig. 1, then x must make his turn astern of his left hand neighbour; he lays himself open to attack by y's left hand neighbour, and breaks the order of his own line, cutting himself off from support at the same time. Should he, however, use the short turn, as in Diagram V, fig. 2, his manœuvre will be baulked by his own left hand neighbour, to avoid whom he must exercise caution, and who more or less hides the object of his attack, just at the moment when all depends on his getting a clear view. He again lays himself open to the attack of y's left hand neighbour, or, if he misses y, of his right hand neighbour.

If x and y, however, being leaders of lines ahead, choose the 4-point method of approach given in Diagram III, fig. 1, the rest of the fleet does not partake in any of the advantages of the mode of advance, as may be seen from Diagram V, fig. 3. If, however, they were the leaders of columns in quarter-line, as in Fig. 4, their tactics would equally apply to the ships astern of them. But the difference is, that

x is no longer solely occupied with his attack. If his own next astern by any accident lets y's next astern slip past him, x has two ships upon him, and fights at a disadvantage. We see running through all these positions a principle by which, in formation, one ship covers or guards another from a ramming attack, and renders useless the methods which are available between single ships. The fleet which rigidly maintains its end-on position, and whose ships only swerve from that to deliver their blow upon the enemy, who presents his broadside while attempting to ram the ships to whom they are guards, goes into action with an advantage, for it runs no such risks of being rammed as its opponents who seek to attack in that manner, and while it never drops its own guard, it is ready to take advantage of any slip its enemy may make.

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 me to advise that policy in a fleet attack. You must beat your enemy in some other way.

Before leaving this part of my subject, it is necessary to point out that some ships in every formation have no guards, and are open to the same attack as single ships. The rear ships in line ahead are open to the ramming attack on both sides; and the wing ships in lines abreast and quarter lines were open to attack on their outer sides. Hence, although you cannot, as it seems to me, make your general effort a ramming attack, you will be foolish to avoid any opportunity which offers of attacking particular parts of your enemy in that manner.

We are now in a condition to apply the principles we have brought out to the actual business of my paper, the Attack and Defence of Fleets.

In all sea-fights of former ages, we see either of two conditions; both fleets equally ready for the combat, or one assuming from the outset the attack, and the other the defence; the former condition is rare. Hitherto, I believe, no case has occurred where—as in so many battles on land—a skilful movement has converted the defence into an attack. The most that could be done in former times was practised by the French, before the revolutionary war, in taking advantage of the weakness of the British attack to damage them seriously while keeping themselves out of harm's way. Clerk of Eldin shews that in the attack from to windward, generally practised by us before Lord Rodney's victory changed our views, we really offered a portion of our fleets to the whole fire of the enemy, as shewn in Diagram V, fig. 5, and the van becoming disabled from this cause, the French were in a position to bear away to leeward to re-form, and to repeat the manœuvre, which they usually did.

Sir John Jarvis at St. Vincent, and Lord Nelson at the Nile, are brilliant examples of an opposite mode of proceeding, and though the approach of Lord Nelson at Trafalgar might seem a recurrence to old methods, it was not really so, as the enemy's fire was divided between two vans, and the approach was direct, and as rapid as it could be, instead of the slow and "lasking" approach, as it was called, shewn in Fig. 5, Diagram V.

In the changed condition of things now, we must be very careful to guard against following history too blindly as our guide; but, at the same time, we must by no means neglect to avail ourselves of the lessons she really teaches; though, therefore, the *manner* has passed away, the *matter* remains as worthy of adoption as ever it was.

I think now that steam has done much to alter the former state of affairs, and that an inferior fleet may, when direct attack is not at first attempted, convert a defence into an attack, and perhaps even gain a victory.

The principles of a skilful attack or defence must ever remain the same; they must always be the offering a superior force to an inferior; and if a part of the enemy's fleet is made to bear the brunt of the whole of your own, the greatest strategist can do no more.

I am sorry, however, to believe that we are at present drawing more inspiration from the manner of our forefathers in naval tactics than from the matter. I do not think we have shaken ourselves sufficiently clear of the traditions of naval sea fights to perceive the laws which underlie them, and become applicable to our own times. In days of yore we had a broadside position; small sail; and low speed. Now we have the end-on position, and great speed. I do not think, from all I have seen and heard, that naval minds habitually dwell on the speed at which future actions must be fought. It is known and acknowledged that a ship without speed, if met by a ship with speed, is doomed to certain destruction by ramming, but in spite of this, the picture of a fleet action naval men have before their eyes, is always a confused assemblage of ships more or less stationary. It is quite common to hear it said that "the best tactics are for every captain to put himself alongside an enemy's ship," as if such a thing were now possible, unless the enemy's ship were a consenting party. The French system of tactics did much, and Lissa did more, to confuse the picture of a future sea fight, and to paint it as a *melée* of independent attacks. The *melée* at Lissa was entirely due to the broadside position of the Italian fleet, and its want of speed; two concomitant blunders which no commander will ever be mad enough to bring together again. Had it been otherwise, Tegethoff might have had his *melée* to himself, but the Italians would have been out of it from their own impetus. If two fleets charge one another at ten knots in the end-on position, three minutes will elapse between their being a mile apart and their meeting, and in another three minutes they will again be a mile apart. If the very instant after one fleet had passed through the other, they put their helms hard over, still the other fleet would be three-quarters of a mile away before the first was in pursuit. Under such circumstances the only *melée* will be amongst the wounded birds, and the type of the battle would be a rush, a contact, a separation, a re-formation, again facing each other, another rush, and the same thing repeated.

The other type of action—still due to speed and the end-on position, would be where one fleet retires before the other until, by happy skill, or by happy accident, it is able to face its pursuer with advantage.

How to face your enemy with this advantage, how to bring your

whole fleet on a portion of his when facing him, seems to me the problem before us.

We shall all be agreed, I think, that anything like elaborate manœuvring is out of the question, except in the process of retiring. The mere moment of time which elapses between the coming into range of two approaching fleets and their shock, renders either manœuvring or signalling absolutely out of the question. Nay, even after sighting an enemy's fleet—say ten miles off, he will be a hardy admiral who attempts to do more than throw his fleet into the formation he intends to fight in. In such circumstances, the fewer signals the better, as a mistake might be fatal, and the chances of mistake are trebled when the nerves are tightly strung, as they would be at such a moment of excitement.

The very numerous, and sometimes eccentric, fighting formations which are proposed for adoption by our own and other Navies, may be classified under four heads; which, on still closer examination, may for the purposes of argument, be resolved into two. These are—

(1). An extended front, with small depth.
(2). A narrow front with great depth.
(3). The mass or square, where depth and front became equalised.
(4). The system of groups, however, disposed. The principle being that the attack or defence is not concentrated, each group making itself felt as occasion offers.

The mass, or square, must possess in a less degree the advantages and disadvantages of the extended and narrow front, and of the small and great depth.

The groups must be disposed either along an extended front or along an extended depth, and, therefore, must, so long as they remain in formation at all, possess the weakness or the strength of those formations.

If, however, we reflect a moment, we shall see that when an enemy's fleet is approaching in an order of battle, all that can be detected in the few minutes of time allowed, will be either its extended front, or its extended depth. Therefore, although if time permitted, I might go into greater detail, I think that I shall best argue out the principles I have in view by imagining all formations classed under the two first heads, and considering the relations between an extended front, as opposed to an extended front; a narrow front and great depth as opposed to an extended front and small depth, and a narrow front and extended depth as opposed to the same formation. A few words will then suffice to treat of the mass or square, and of the system of groups.

It will also, I think, conduce to clearness, if I do not go beyond the two representative formations of the extended front and the extended depth, namely, the single column in line abreast, and the single column in line ahead.

The attack I define to be when the ships keep their heads towards the enemy, advancing, or trying to advance on him. The defence is when the fleet retires before the enemy.

In the attack there is always one enormous advantage on the side of that fleet which takes the initiative. Ships cannot move simultaneously, except by signal. One or two ships may turn so closely after each other, moved by a common impulse, as to be practically simultaneous in their action; but this cannot be carried throughout a fleet. It follows, then, if there is not time to make a signal after the nature of the attack is disclosed, neither will there be time to manœuvre so as to counteract it. The Admiral assuming the initiative, or advancing in such a way as enables him to assume it without a signal, may do so with some security against a counteracting movement. While he who waits till the attack is developed in the hope of counteracting it, runs the risk of not being allowed time to do so.

Taking, now, Diagram VI, we have two fleets 2,000 yards apart approaching at the rate of 20 miles an hour. The fleet A may pass straight on, bearing down upon B, without alteration of course. In the three minutes elapsing between getting into range and contact, one, or at most two rounds may be exchanged. Supposing both fleets had been stationary at 1,000 yards, and each ship in A fired two guns at B, between one and two shot might strike, with a chance of penetration or damage at its minimum. But the fleet target, so far from being stationary, is altering its range eleven yards in a second. Under such circumstances, to fire is to waste powder A had better proceed without firing and with his guns concentrated right abeam and horizontal, ready to discharge point-blank into the enemy in passing, should his ships maintain their end-on position and so elude the ram. B, under present circumstances, ought to reserve his fire, and hence, when the two fleets have passed through one another, they will have fought on an absolute equality, and any less damage done to one or the other must be due to stronger plating, bad practice on the other side, or the chapter of accidents.

But, consider how very dangerous this method of engaging will be to the friends on both sides. In the confusion, excitement, and smoke, how more than likely is it that a friend will receive the broadside intended for an enemy? True, each fleet runs an equal risk of this, just as each runs an equal risk of being rammed. But to run these risks is not strategy, and it is, I think, plain on these grounds that an attack made direct, by an extended front, ought not to be met by a counter attack of the same nature.

It will be open to A, if there is time to make the signal before getting into range, to put in force the application of ramming tactics formerly mentioned, and by altering course together four points either way, to endeavour to force a similar movement on the enemy, and thus to convert an artillery combat into a trial of skill in ramming. If this movement were made at the moment of coming into range, the new positions of the fleets would be at p and q. It is pretty clear that A's manœuvre has no forcing effect whatever on B, who, on the contrary, appears to have certain advantages placed in his hands which he had not before. It is true that, for a moment, the artillery of A may be held superior to that of B, inasmuch as he can probably bring more guns to bear. But this advantage passes away as A moves to the right

along the front of B, and besides, A receives the shot of B more directly perpendicular to his broadside than does B those of A.

But while the port-wing ship of B is guarded from rams by her right-hand neighbour, the port-wing ship of A is not guarded at all, and should be the object of B's attack by ramming.

Except these alterations of course together, which must be ordered by signal before getting into range, there appears little that A can do so long as he remains in line abreast; and if it be as appears, that he gains no advantage either in a direct advance or a four-point advance, it seems to me he must give up the extended front if he wishes to attack an extended front with an advantage.

Let us therefore examine the extended and narrow fronts as opposed to each other. This we have in Diagram VII, fig. 1. We suppose two fleets, A and B, observing one another at sufficient distance to allow of consideration and to the coming to the conclusion to attack: but A determines to do so in a formation with a narrow front and B with an extended front. The headmost ship of A has approached to within 2,000 yards of B's ships. Let us see how matters stand between them. A's leader is open to the fire of the whole of B's bow guns, a fire which we have before shewn to be ineffective. That is her whole disadvantage. On the other hand she is within three minutes of contact with B's fleet, and yet has not disclosed the nature of her attack. Supposing the Admiral of A to be leading, his orders would be to the ships astern of him to follow his motions *together*, as nearly as possible, to concentrate their guns at point blank, right ahead, and to pour in their shot on the instant of passing an enemy's ship.

A has three attacks open to him: the centre or either flank of his enemy, and leaving him in doubt up to within three minutes of commencing his attack, it is manifestly impossible for B to counteract him even if there were a movement capable of doing it. Suppose A chooses to pierce the centre, and therefore simply continues his course; as he passes between two enemy's ships he certainly receives their two broadsides; but if he be equal in power on both sides he gives them as good as he gets, with this advantage, that his shot which miss one enemy's ship may hit another; while the enemy's shot which miss him may damage their friends. But if A's leader has already been subjected to bow fire from those ships between which he passes, they will hardly be ready in the time to give him broadside fire as well from these guns. But in any case, the moment A's leader has exchanged broadsides with her enemies, and long before they are in a condition to fire again, a succession of fresh ships pass into her place at the rate of one every twenty seconds or thereabouts. The two ships between which A is effecting his passage will thus receive five broadsides apiece in about a minute and a half, without more than a single reply, and if this is not enough for them, I think it ought to be.

Here we have the process of "doubling on the enemy," as I conceive it must in future be practised. The principle remains the same as ever, only the detail has altered with the times. Instead of doubling simultaneously and so placing a ship betwixt two fires, we must now

double in succession, serving him with a continued succession of fresh ships.

The only objection I can see to this centre attack is, that you lay yourself open to the fire of both flanks on your near approach, whereas, by attacking on the flank, you can receive no more than half that amount.

In this attack, if the Admiral chooses to threaten the centre till close up with the enemy, which I think will be hardly necessary, his ships should turn together towards the intended flank and then turn again into line ahead, as shown in the diagram, pouring in successive broadsides into the enemy's wing-ship in passing. A's rear ship should, I think, be directed to attack the wing ships of the enemy with his ram, and for this purpose should steer further out than the ships ahead, so as to give himself room to turn. His orders should be not to embroil himself by making a second attempt if he misses the first,—indeed, he can hardly obtain a second opportunity,—but to follow the rest of the fleet, which should re-form with their heads again towards the enemy, ready to act again as may be necessary.

There are in this kind of combat a variety of circumstances to be noted which seem to me to tell in favour of A's attack. If there is no wind, A's ships after the leader, will observe B's wing ships emerging from the smoke of their own and A's guns, before they themselves have entered it. They will consequently be more masters of the situation than B's ships can possibly be. If B's whole line continues to fire from his bow guns, as no doubt he would, there is the greatest danger of his line getting into confusion, and also of some of the shot intended for an enemy reaching no further than a friend. It is, I believe, a fact that with modern heavy guns the compasses are thrown completely out of gear, so that no formation can be maintained by compass while firing.

In A's advance the compass is not appealed to at all, as each ship simply follows her next ahead in the closest possible order; and although the formation will probably be broken ultimately, this will not happen till its work has been done, and it is clear of smoke in rear of the enemy.

If the wind were blowing towards the attacked flank across the enemy's front, his view will be interrupted, and his fire will slack. But the smoke may also shroud A's ships from one another even before they fire, and their broadsides may be thrown away.

If the wind is from the attacked flank A will always be in the clear, while the ships of B's line will be shrouded, each one by the smoke of his neighbour.

I think, therefore, that A should choose the weather flank for his attack. If the wind be with B's fleet, so much the worse for him, while it will not affect A. While, if the wind be with A's fleet, the conditions will be those of a calm, except that A will be longer in his own smoke after he has passed the enemy.

But while showing the advantages of thus opposing a narrow to an extended front, we must not omit to ascertain what possibilities of

defence lie in the extended front. At first sight, many movements will suggest themselves as practicable, but when we apply the rigid standards of time and space, we shall think differently.

Remember, there are but three minutes in which B must form and execute his plan. On the face of it, therefore, there can be no combined manœuvre not previously arranged. No previous arrangement could embrace more than a single movement, yet there is no single movement preserving the line abreast, which can be executed in the time and space except by surrendering the attacking position.

Suppose B were to hope to swing his line round on his port wing-ship as the pivot? To do this, the port wing-ships, the very object of his solicitude, must reduce their speed, enabling A's rear-ship, already warned, to ram them with ease. But in no case can B's starboard wing-ship come upon A's rear-ship in time. Again, B surrenders his bow-fire in attempting any manœuvre, for it is admitted by all impossible to manœuvre in smoke. Besides, any one who has experience of fleet manœuvring, is aware of the difficulty of preserving the formation when swinging round, even for drill purposes.

Single ships, it has been said, may pierce A's line or ram him. This is so, but only by passing astern of their friends, and so separating from them and plunging into the midst of their enemies, can they effect their purpose. But then they pass at once into the heaviest of the smoke, and run at least as great a risk of destruction themselves as they bring upon their enemies.

On the whole, therefore, my view is, that an extended front is an exceedingly weak formation for attack, and ought to succumb to the narrow front in all cases where things are otherwise equal.

But the extended front may, when time permits, be changed for the narrow one. If B, surrendering his idea of the line abreast, were, on perceiving A's approach in line ahead, to meet him in the same formation, he would advance his port wing-ship and form astern of him.

This would give us the narrow front as opposed to the narrow front, shown in Diagram VII, fig. 2, and I think we see the balance is restored, and that if both fleets so advance, they will fight on an equality.

It is of course useless, and perhaps foolish, for the leaders to open fire till abreast of each other; they will then exchange their broadsides, and if they both pass on, will each receive the broadside of fresh ships before they can reply effectually. Here the same qualities might stand the British seaman gunner in as good stead as formerly, provided, that is, that machinery more perfect for working guns is not adopted by other nations, and a rapidity of fire obtained, which we cannot compete with.

But without this, or in spite of this, A may by proper orders to his ships, gain an advantage over B.

Suppose, for instance, that A's leader, and each ship astern of him, were ordered the moment they had fired their broadsides, to turn sharp off to starboard, B's fresh ships would never get the opportunity of firing at all, and his leader and her next astern, would have

received the fire of the whole of A's ships. When the smoke cleared away, A would find himself in quarter line with B in his rear, and might determine on the next stage of his attack.

I have now discussed as closely as time permits, the principles of Naval Strategy in the attack as they have presented themselves to me after such limited examination as I have been able to give to them.

It will be seen that I believe the extended front to be a weak formation, and that in no case should it be taken up in an attack. It has appeared also in the course of my enquiry that the bow-fire, on extreme training of guns, is not of great value, and that more is to be done by broadside fire in attacking fleets. These conditions appear reversed when one fleet retires before another. Then, unless the pursuer can enforce by his speed, or the pursued takes up for himself, the position of attack, the result must depend on the goodness of the gunnery practice. The pursued must spread out an extended rear, and the pursuer an extended front, in order to get the full value of their artillery. Here the distances will be fairly permanent, and the bow and stern fire becomes effective. I cannot conceive, however, a decisive victory gained on such principles; and for the defence, I would rather convert it into an audacious attack upon either flank of the pursuer in the manner before described.

I have already stated that if a formation, such as the hollow square proposed in Russia, possesses depth and extended front in combination, it possesses also the weaknesses and strengths of each quality, and therefore, if the better qualities of the line ahead be opposed to the less good ones of the shorter side of a square, there will still be an advantage, though not so great on the part of the former.

These compromises seem to me to be proper for adoption by such nations as, from their want of naval prestige, may be more solicitous to guard against defeat than to ensure victory. I must own my sympathies lie in the direction of audacity, and a determination to win all or to lose all; and hence I do not so much concern myself with half measures.

It will be seen that I lay great stress on compactness and concentration in attack, and I am in consequence opposed to systems of reserves of separate fleets acting conjointly, or lastly to the attack or defence by groups.

I cannot at present see how, when fleets are at speed, a group can act independently without running the great risk of finding itself surrounded by enemies and beyond the support of its friends. Suppose a group such as Figs. 3 and 4, diagram VII, opposed to even the same number of ships only, in close order in line ahead: The broadside fire of one ship in each formation is masked, and in Fig. 3 the attacking force of three ships would receive one broadside from the leader at double distance, and one from the wing-ship at close distance. But this wing-ship would get in return three broadsides at close distance. So with four ships in line ahead attacking the group of four. The leader might sustain one broadside at close distance, and two at double distance. But the wing-ship would sustain four broadsides at close quarters. Then observe the weakness of these groups in the

matter of ramming. Fig. 3 has two ships out of three, and Fig. 4 three ships out of four, unguarded. Such an opportunity for the ram-ships of a line ahead is all that can be desired, especially in Fig. 4, for the ram which misses the wing-ship, will almost to a certainty catch the rear.

Such, then, is my slight summary of the line I conceive our study of Naval Strategy should take. I should be very sorry, indeed, to dogmatise on a subject which is to all intents and purposes a new science, but I hope to have shown that there are sound principles to be got at even in peace time, if we will only take sufficient trouble to find them.

Commander DAWSON, R.N.: I hope that nothing may occur to this Institution to prevent for the future our having the pleasure of receiving information from the lectures that are occasionally given here upon the principles of "naval tactics;" for I do not know where else we should be able to gain any information upon that subject. It is true we have a Naval College at Portsmouth; but I am not aware that there is any Professor of "naval tactics" there. I understand that at the Military College there is a Professor of "military tactics." We have heard of a "Professor of military history" at that college; but I am not aware that there is any "Professor of naval history" at the Naval College. There is also a "Professor of artillery" at the Military College; but not one at the Naval College; even naval architecture is not taught there, so that we are really dependent upon this Institution for any information that we may obtain as to the principles of naval tactics, naval gunnery, and collateral subjects. Turning from this subject, I remark in this paper that there is not a single fact brought forward showing that the British Fleet, which costs so much, has done anything to elucidate any of the questions which arise in determining the best way of using the various novel ships and weapons with which it is furnished for purposes of war. I do not mean to say that the Fleet has made no experiments, practised no warlike manœuvres, or gathered no useful experience, but I merely draw attention to this circumstance, that if any portion of the Fleet has elaborated experimentally any facts bearing upon future wars, they have not been brought forward now; and, as far as my information goes, these experimental or other experiences have not been communicated from that necessarily small portion of the Fleet which may have gained the knowledge, to the Officers of that other larger section of the Fleet which has had no opportunity of acquiring it for themselves. Nor do I believe that there is any means in existence by which such experience can be communicated from those who gain it, to those Officers afloat who have not that opportunity. This waste of experimental experience and professional knowledge is a very important point, to which I wish to direct attention. Passing from the absence of facts, it appears to me that the future tactics of the Navy depend upon the relative values of the weapons with which we are going to fight. I concur with a good deal, in fact, I almost entirely concur with what Captain Colomb said as to the dangers that may be anticipated from, and the skill which is required in, the use of the present Harvey torpedo in a general engagement. That is one of the things which it appears to me ought, in time of peace, to have been long ago found out by the Fleet and remedied. The Harvey torpedo has been spoken of before the world for twenty or thirty years, and was adopted as a fighting weapon for the British Fleet about two or three years ago; so that Captain Colomb ought to be able to say that the Channel squadron, and the Mediterranean, the detached, and other squadrons, as well as single ships, have during those three years handled these Harvey torpedoes in every possible way; that they have found out that such and such is the case, and that such and such is not the case. Again, it is twenty years ago since Sir George Sartorius and Sir Bartholomew Sulivan advocated the employment of the ram, and for the last ten years every ship built for the Navy has had her bows fortified and armed for ramming; yet we are theorising on the subject to this hour, without a single ascertained fact being produced able to show that any British ship or squadron has done a single thing to elucidate that subject, or that a single British Officer has gained an atom of

experience in this weapon with which so many of our ships are provided. We are obliged to go to Russia to find out what the ram can do, and to borrow the practical experience of the Russian Navy; the captains of which are regularly trained to its use. I am one of those who think that the Harvey torpedo is right in principle, and that a little money for experiments, a little experience, and a little talent applied to it, would make it a very safe and a very destructive weapon. But, even taking it as it is, it is a very formidable weapon. Look at that diagram No. 6, showing two fleets in line abreast meeting end-on. Only three minutes will elapse after coming within range of fire, before they meet. If at the beginning of those three minutes the ships of one fleet, or of both, were to extend a Harvey torpedo on both quarters, and were to still continue their courses, the consequences would be something fearful. If the Harvey torpedo in its present condition is not powerful enough to break through an armoured ship at the water-line, I do not see any difficulty in enlarging its capacity and introducing a detonating explosive which will readily do so. If we do not employ the torpedo, the Russians will, and I should advise them to put a little more dynamite or gun-cotton into it, and make it powerful enough to perforate armour plates at the water-line. The Harvey torpedo might be doubled or trebled in capacity without any great increase in dimensions and without losing its handiness. As to its safety as regards friendly ships when employed in a general action, I see no difficulty in the application of electricity to the Harvey torpedo as the igniting agent, and then it would be absolutely innocuous upon accidental contact with friendly vessels, as it could only explode at the will of the operator, who would not make the connection with the electric battery till he saw the torpedo approaching a hostile ship, and the wire could be disconnected on a failure to make contact. As to the risk to the torpedo-operators from artillery or Gatling-gun fire during the three minutes that the two fleets are approaching under fire, I do not think it would be very much if the vessel operating was an ordinary ironclad, armed as usual with guns. The difficulty is one that the Fleet ought to have experimented upon and determined long ago. In the absence of practical experience on the part of our Navy, my opinion is that there would be no difficulty, providing there was suitable cover for the operators; and if that was done, the danger from artillery or Gatling-gun fire would be overcome. At any rate difficulties are made to be overcome, and it ought to be the business of the Navy, as a training school for war, to attack and conquer them, and what better training for war than that our sea-going Officers should experimentalise upon their weapons, record those experiments, and communicate their failure or success to the rest of the Navy? Believing as I do that a good deal may be developed out of improved naval torpedoes, and that torpedoes in one form or another will be used against us in the open sea, whether we employ them or not, I think the torpedo will govern the tactics of the Fleet; though, when both sides are armed with it, it will only serve as a defence against rams and against hostile torpedoes, and will thus become a defensive rather than an offensive weapon. It will be utterly impossible for one ship to pass within 200 yards of another vessel towing Harvey's torpedoes; and, if both sides are equally armed, fleets must keep at that respectful distance. Hence it follows that fleets will not attempt ramming, because they cannot approach within 200 yards without mutual destruction. The action will then resolve itself entirely into an artillery contest. Now, we have made tremendous strides in artillery of late. It is only six years ago that we were told by the highest seaman-like authorities, that it was utterly impossible to work guns of more than six tons weight on the broadside. We are now able to work 25-ton guns upon the broadside. The 12-ton guns can be fired once every minute, whilst the 25-ton gun can fire one shot every two minutes. Nothing could be more efficient or more secure than the means by which these ponderous guns are manipulated, so far as training, running in and out, and elevating is concerned. The mounting of guns has a large influence upon their accuracy; a smooth, regular, yet rapid movement assisting the aim very considerably. But the loading arrangements are exceedingly slow, clumsy, and unsafe, and might be much improved, which would increase the rapidity of fire. We were told by Captain Colomb in his former lecture, and I quite concur in the observation, that the accuracy of the fire of our few heavy rifled guns is very small; that not above one shot in every ten was expected to hit the mark. Now, accuracy of fire is a question which it is the province of naval gunners to be able to deal with. I am

sure if good sea-shooting was a military question, we should have had three or four committees appointed, who would have experimentalised for years upon it, and we should have had a great many blue books and exact records of several thousand rounds to refer to; but as it is a naval matter, we have no information upon the subject except the one experiment in the Channel squadron, which Captain Colomb has quoted. Now, good shooting at sea depends, amongst other things, upon knowing the range, Admiral Ryder elaborated tables and methods for ascertaining distances, twenty years ago; and to this day there are no means taken to give effect to those tables and to carry them out by stationing people for the purpose of observing the distances, except when firing at a target from the larger ships. It ought to be done to all vessels on every occasion of going to quarters. There is another serious difficulty in the way of obtaining accuracy of fire under lively rolling motion at sea, and that is that the new rifled guns are very badly sighted. The old 68-pounder in a lively sea can now make better practice than one of our 9-inch rifled guns. This arises from the new guns being so badly sighted, the smallest visual error in taking aim having a much greater effect upon the range than a like visual error in the old guns, owing to the decreased distance between the rear and fore sight in rifled guns. On ordinary occasions the line of vision of the captain of a gun standing six or eight feet from the rear sight, must pass above the tangent sight. The vertical height which the line of vision passes above the rear sight constitutes a visual error, which is the cause of all large errors in the range, when firing at known distances. This visual error may be taken at two-tenths of an inch at ordinary times, but, when in lively motion, the shot falls 300 or 400 yards beyond the target, the vertical visual error is evidently considerable. The value in range due to a given height of line of vision above the rear sight depends upon the distance between the two sights. A visual error of half an inch over the tangent sight—not a very large one to make with lively motion—will, in the 68-pounder, amount to about 180 yards at 1,000 yards' range; but in the 9-inch rifled gun it amounts to more than double that distance. And if the dispart sight be removed, the difference between the two would be such that the 68-pounder would, at 1,000 yards' distance, make about one-fourth the amount of difference in the range for that half-inch visual error. This has an important influence on good shooting from lively ships. The power of the guns may be very much enhanced by a better system of rifling. The present system of rifling altogether fails to give rotation to long shells such as the guns are designed to project. Instead of employing a known system which will give the necessary rotation, we reduce the weight and capacity of the projectile, thereby sacrificing one-fifth the weight and two-fifths the bursting power of the 11-inch guns, and one-half the shell power of the new 35-ton gun. As guns are reduced in number, it becomes more essential to study the effective use of individual guns, and we can scarcely afford to sacrifice so much of their naval efficiency to a bad system of rifling. If I am correct that future naval tactics must be directed to the most effective employment of artillery fire, then the improvement of artillery fire is brought into greater prominence than ever, whilst in our more recent constructions, the number of guns carried has decreased so very much. Many of our older ironclads want re-arming, their armaments being incapable of penetrating the newer vessels. There is no essential connection between weak armour and weak guns, and no reason why an "Agincourt" should not perforate a "Hercules." In the confused *melée* of a general action, it is impossible that hostile ships should seek out the one carrying corresponding thickness of armour, even if the thickness was legibly marked on each broadside. Without dwelling any longer on the subject of guns, it still appears to me that "tactics" depend upon the weapon you make use of. Captain Colomb has thrown over a most important weapon—the gun, and has based the principles of tactics upon its non-employment in general actions. If that weapon is a reality, then all his principles of tactics are wrong; if that weapon is not a reality, then the principles of tactics enunciated are right. I am sorry that in such vital questions, speculative opinions can alone be advanced in discussion on one side or the other, instead of our being able to deal with ascertained facts. It would be far more satisfactory to be able to say that so many ships had under so many different conditions, made such and such experiments with such and such results. But in the general ignorance which obtains afloat as to the capabilities of

modern ships and weapons, I cannot point to the experience gained, but must deal only with speculative reasoning. I want to clear away the ground as to the weapons to be employed, in the hope that those who follow me, and who may have had more experience than I have in antiquated parade fleet movements, may tell us, in the case of a fleet so circumstanced that artillery fire is to be the deciding weapon, and that ramming is rendered impossible because of the use of a safe and powerful torpedo, what are the tactics which should then be employed.

Admiral of the Fleet, Sir GEORGE SARTORIUS: I wish to make one or two personal observations with regard to what Captain Colomb has said as to the priority of advocating the ramming principle. It is an old principle. I never dreamed of taking to myself the claim of originality in the matter. It is one of the first things we learn at school in reading of the naval battles of old, the ancient mode of fighting with the ram prow. I was commanding a ship when steam was introduced, and one of the first things that struck us, the young men of those days, was the possibility of introducing the ramming principle through the aid of steam. But there, one soon saw the formation of the ships, and the sail-power unfavourable for the purpose, and that the bowsprit, the cutwater—the two latter were so many buffers to deaden the action of the vessel—whilst the ramming ship would be completely exposed to the raking broadside of the ship attacked. For the time I gave up the idea. It was during the Crimean war, when the French floating battery arrived out—a vessel worked equally under sail or under steam, and at the same time invulnerable;—that it struck me that the moment had now really arrived, when the principle of the ancient ram could be reintroduced. And it was in 1854–5 that I wrote to the Admiralty my views upon the subject, and pressed for a Commission to examine into it.* I shall, however, say nothing more upon that point. With regard to the theory that Captain Colomb has laid down, there is a great deal of excellent good sense in it. It is very necessary that some good theory should be now formed upon the management of fleets and ships and future war tactics, based upon the best materials we actually possess in order to prepare and be in readiness for contingencies before they arrive. The attention of Naval Officers cannot be too constantly kept on the alert on this most important subject. A well based theory once formed, the subsequent perfecting of it becomes a far easier task. I agree also with Captain Colomb that the torpedo is, apparently, a formidable weapon, but when it comes to be brought into practice in actual warfare, there are so many circumstances required to unite, to make it act with certainty, that you could not depend upon it, particularly by the broadside attack. In my opinion no vessel can be better fitted for using the torpedo than the ram, properly constructed. According to my idea, the ram ought to be exceedingly rapid, exceedingly handy; therefore, no other vessel could be better fitted for using the torpedo. In a general naval action it is hardly possible that the torpedo can be depended upon or used with any certainty or safety. You cannot

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* Sir George Sartorius has requested that the accompanying note may be added to his remarks:—

Extracts from Letters addressed to Sir Charles Wood, now Lord Halifax, in November, 1855.

"Let me earnestly draw your attention to a fact which I have no doubt has presented itself to many other minds before, viz., the use of steamers as battering *rams* for sinking ships. The successful experiments of iron plated ships has now removed all objections to, and renders perfectly safe, simple, and efficacious, this mode of warfare," &c., &c. "Let me suppose a steam vessel built without a port or a single gun with great longitudinal strength, that being the direction in which the blow would be given, with bow built in with massive timber, and the vessel covered with iron plates of sufficient thickness to resist that. Then with an engine of 1,000 h.-p. at a speed of 15 or 16 knots, could there be a moment's doubt as to the fate of the largest ship when the concussion took place?" &c., &c. "If the Russians are not able to build these vessels, they will be able to manage it in the United States.

"The Confederates carried out exactly these suggestions in the 'Merrimac.'"

calculate upon the necessary velocity with which the ships must move to apply it in the way that Captain Harvey proposes, particularly if the ship attacked is well armed and swift. I do not say that by-and-bye we shall not come to other modes of using it; but under present circumstances, I think you can never depend with much certainty upon it in a general action. Then, again, I do not think we shall have many fleet actions in the future. The circumstances of former wars, and the blockading of great ports, made it necessary to have a large assemblage of ships to blockade them. But the whole system of naval warfare is now so utterly changed by the introduction of all these new modes of attack, new forms of vessels and guns and torpedoes, that the assemblage of fleets will be unnecessary, and therefore it will be quite a rare chance, the formation of fleets. Our attention ought to be more turned to actions between two or three vessels, or between single vessels, with the ram and with the torpedo vessels if you like. But I think it will be a most extraordinary circumstance if two large war fleets should ever meet again.

Commander the Hon. E. DAWSON: Having of late years turned my attention a good deal towards the manœuvring of fleets, and having had opportunities of observing the practical application of certain theories of fleet manœuvring, I venture to offer a few remarks on the subject of the lecture which we have heard this evening. I would refer first to diagram 6. In this diagram two fleets are represented approaching each other in line abreast. Captain Colomb proposes that A should alter his course in order to avoid the approach of B end-on. Theoretically, certainly, that might appear practicable; but I maintain that any one who has seen two fleets approaching each other end-on, like that, would consider A a bold man if he altered his course as represented in that diagram.

Captain COLOMB: Are you speaking of diagram 6?

Commander E. DAWSON: Yes.

Captain COLOMB: I do not recommend that.

Commander E. DAWSON: That would apply equally to diagram 7. If A was placed in the position shown in the diagram, I cannot think he would ever have the boldness to make a signal to his ships to alter his course simultaneously to starboard, so as to attack the port wing ship of the enemy advancing in line abreast. If he were to advance in a line in which Captain Colomb has originally placed A, I think he would have a much better chance of success. But I do not think any manœuvre is practicable within the space of three minutes, as described in the lecture. Having taken the times of a great many manœuvres, I do not think it possible that any fleet can make any manœuvre successfully under at least fifteen minutes. I do not think it would be advisable for any Admiral to make a signal to attempt to do so. It could only be done by previous understanding with the Captains of his ships. Next, as regards the torpedo, I think at present the torpedo cannot be an efficient weapon for resisting the attack of a fleet or for attack. At the same time, I cannot but think that its power will be very much developed in future years. A fleet attacking in line ahead could not use the torpedo to the same extent as a fleet attacking in line abreast. It is all very well to assume that a fleet in line ahead will pass through a fleet in line abreast. The first ship may succeed in getting through, but the second or third ships would stand a great chance of being rammed by the ship nearest to them; and that would not improbably throw the fleet into disorder. The fleet in line abreast would probably have ships astern on each wing, that would operate upon the ships that pass through. With reference to the *pelotons* or groups, the *pelotons* appear in some ways to be a very good formation. At the same time, I prefer four ships to three. On two fleets approaching, say one in single column in line ahead, and the other formed in groups (pelotons) in line ahead, you may assume that the line ahead will attempt to pass on one side of, and not through the groups, in which case the argument of Captain Colomb would be perfectly correct, that one ship's fire would be lost, provided always those ships kept their stations correctly. But those who have seen fleets manœuvring even in peace time, will agree with me that two ships seldom keep their stations exactly in line abreast. It is very seldom that it is possible to do so; and when you have the smoke of an action, it is quite impossible it can ever be done. Equally so, I may say, more so, with a fleet formed in one column in line abreast. You may lay it down in theory that the ship that passes through the column first will receive the fire of only two ships; but, practically, she

will receive the fire of nearer four, because those ships will not be exactly in line abreast as they are there described in the diagram. As regards the torpedoes, I think at present it will not be practicable to work with them; but in future years I am convinced we shall be able to use them much more efficiently than at present; that they will form a great obstacle, and if not a great obstacle, they will be a deterrent to two ships approaching each other and trying to ram each other, because of the fear of a torpedo being towed astern.

Lieutenant HUBERT GRENFELL, R.N.: In addressing you I should like to speak with that modesty which is due from a junior member of the profession. At the same time I should like to express that opinion which I know many members of the profession entertain, I mean the opinion which was expressed by Captain Dawson that these questions of the day should be more thoroughly ventilated, and put in possession of the junior members of the profession. At the present moment we feel a great many difficulties in that respect. We have received a very able lecture to-night from Captain Colomb on "fleet manœuvring." I can hardly say myself how many times these things have occurred to most of us who are working in the same way, but, of course, with inferior opportunities. We wish very much to push forward, as far as possible, the profession to which we belong. I may say that, being out with the combined fleets the other day, when they all assembled for manœuvres, the first question almost which rose to the lips of every Officer who was on deck, when they first saw that splendid array of ships on the horizon, was, how should such a collection of ships be arranged for attack or defence? We were present during the manœuvres, which lasted, for I am sorry we were only present in the detached squadron, for one day; but we saw those manœuvres during the whole of that time. We are thoroughly impressed with the importance of these questions being pushed home, and being thoroughly ventilated. We unfortunately suffer to a great extent from what Captain Dawson still more forcibly put, the want of some institution or some place where these questions of a purely naval character might be discussed. Something has been said about the Harvey torpedo. Captain Colomb himself said that the Harvey torpedo had sunk in his estimation. I think it did so mainly from the fact that experiment had not been sufficiently brought to bear upon the point. I think, also, that the country is committed, to a great extent, to many rash endeavours for the same reason. Inventors seem to think that it is sufficient for an invention to be placed before the country, for the country to take it up; that such an important measure as the whole re-construction of our Navy, which was advocated the other day in the *Times*, was to follow immediately from it. The most rash schemes are put forward in that way. I may mention, having been immediately connected with some experiments with Harvey's torpedo the other day; that, in my opinion, on that particular occasion, it totally failed. We were a whole afternoon trying to ram a small ship, and did not succeed, but had to go into harbour with the torpedo unexploded at the end of it. It was not, as many gentlemen might suppose, that the error was on our side, because gunnery people had nothing to do with it; the experiment was entirely in the hands of the master of a tug, and I am sure no one would take exception to his powers of handling it. Be that as it may, still on the general question of experiments we feel that we really are powerless in the matter. I wish positively and particularly to express the craving for knowledge which exists among the junior Officers of the Navy. There is not that apathy as regards their profession which many suppose to exist. We should only be too happy to learn, but really we have no opportunity at the present day. There are experiments of every nature conducted all round. In the sister service, as Captain Dawson said, there are institutions, there are societies, and there are meetings at which all these questions are discussed. I am sorry to say that in the Navy, which ought to be our "first line of defence," we have nothing of the sort. I do not mean to say that this Institution is not very valuable in its way, but beyond this Institution I think a society ought to exist side by side with it. I do not suppose any difficulty is felt about the existence of the Institution of Royal Engineers and the Royal Artillery Institution. They are very valuable to the country. It appears to me that Captain Colomb, in his lecture has merely dealt with the general question of "fleet attacks;" I think he should not merely do that, but that he should accept the Navy as it is, and develop a system of fleet attacks with the Fleet as it is. This

point struck me the other day, viz., the extraordinary diversity of our ships. Mr. Reed specially noticed that point, and, I think, cleverly slipped out of it, because he said he could leave it to the intelligence and ingenuity of British seamen. That is the way the authorities get out of the difficulty. The powers of attack and defence possessed by the Navy of the present day are so widely diverse that it is almost impossible to study and develop the particular powers of every ship. The question of bow fire, of broadside fire, of attack by ram, and of torpedo attack, in connection with each ship, demands, as it were, a special and particular study, so that it is almost impossible to develop a system of tactics which is applicable to the Navy of the present day. In talking about this matter I have met with, I will not say extraordinary opinions, because I should be very sorry to apply such a term to the expressed opinions of Officers who are my superiors; but one Officer advocated attacking in the order of peloton, with Harvey's torpedo on each quarter. All I can say is, that I should be sorry to be in the leading vessel of the peloton, if that is to be the system of attack. I instance that, because it shows the extraordinary crudeness of opinion which exists even in high circles on these matters. I agree with Captain Dawson that after what ought to have been twenty years of definite experiment, we should have had the whole thing at our fingers' ends. I would just mention, perhaps I ought not to mention it here, that at Portsmouth, at our Naval School of Gunnery, we have endeavoured to establish a little society intended to supply these needs. We merely mean to read a few papers on professional subjects, and discuss them, and so forth. I appeal very strongly to members of my profession who may be present this evening to support such a movement, if they think it for the good of the service to do so.

Captain Robert Scott, R.N.: I will only mention one or two points in connection with what Captain Colomb has said, so as not to take up much of your time, because until we have got the results of actual experiments with different ships, there is a great deal of difficulty in deciding upon the best formation for battle. Although I concur with much that Captain Colomb has stated in his valuable paper, I cannot concur in what he says as to the small value of bow fire. I believe a powerful bow fire will be found to be very advantageous, but until we get a diagram showing the actual amount of error in aiming at the hull, and how many hits might be expected in vertical fire, and in firing down upon the upper deck of a vessel (I believe you will have a great deal of plunging fire), you cannot arrive at a just conclusion. In proportion as your guns are large, so will your shot be effective. We know that even at a very small acute angle, heavy steel shot hitting the bow would produce great effect, and if the point is arrested by the shot's biting in the armour, its base is carried forward, and the shot becomes more perpendicular to the plate as it continues to penetrate; but to effect complete penetration of thick armour you require very heavy shot. I would suggest that those who are able, and there are several Officers present to-night who are well able, should get up the subject of the powers of penetration of the different guns, together with a description of the ships, in order that all the facts may be laid before the Institution. By this means we should attain to very considerable knowledge of the value of the different ships of our Fleet, and hence be enabled to come to a much better conclusion as to the mode of using it in action than we can at the present time. As the School of Gunnery has been alluded to, I would remark that instead of being a disadvantage, it would be a very great advantage to the naval service to have a place where the younger Officers could assemble and discuss these questions. Except Captain Colomb there are as yet only one or two Officers who have taken up any of the questions relating to "naval tactics." It would be very advantageous to the profession if some Officer would lay out the models of the different ships here before us, and then show the relative amount of hits that could be anticipated both in bow fire and in broadside fire; this would enable all of us to arrive at a much more definite conclusion respecting the value of the guns than is possible with our present limited information.

Commander Pusey, R.N.: Captain Colomb has stated that the Harvey torpedo has fallen in his estimation. I should like to ask Captain Colomb, if the British Fleet were brought into action to-morrow against a Russian squadron in the Baltic, and he were Commander-in-chief, and he knew that each of the Russians opposite to him were towing a couple of torpedoes whether he would feel himself justified in taking

the British squadron into the close action that he has spoken of to-night? My impression is that if he did, and the iron-clad Fleet came to grief, the British public would stigmatise him as the murderer of our seamen. More than that, although the Harvey torpedo has been spoken of slightingly, and has been spoken of as being towed astern of vessels, yet in the experiments I have seen tried with it, the torpedoes have been on the quarter of vessels, and at right angles. I see no reason why the Harvey torpedo, by means of slip ropes, should not be towed from the bows of a ship. Many of us have been towed in a cutter from the paddle-box of a steamer, and gradually we have found ourselves abreast of the paddle-wheel. There is no reason why the Harvey torpedo should not be towed well forward. In that case I maintain that a vessel ramming, or attempting to ram, and missing her aim, would certainly come foul of the torpedo, and would thereby come to destruction. I am only a junior member of this Institution; but I offer these remarks for the consideration of those present, who, of course, will take them for what they are worth.

Captain COLOMB: I think I may generally answer the criticisms on my paper in a few words. First of all, I have restricted myself to dealing with what were so far established as facts. I have endeavoured to deal with no fictions. Those who have read my former papers on this subject will see that my opinions have very much changed, and I am quite prepared that they shall change again as soon as new facts are presented to my notice. I wish it to be understood that I take a sort of impersonal view of the question. I have been trying to collect such facts as are obtainable, and to put them together, so as to fit them into some sort of theory of attack and defence, which might set my brother Officers' minds more at work than they are at present. I have not the slightest objection, to use a nautical expression, to "Come up all I have said" about the Harvey torpedo as soon as it is different from what it now is. The state of the Harvey torpedo as it at present exists is, that if it explodes at the water line of an iron-clad ship it is held to be almost harmless. If it is charged with dynamite, or some explosive compound not yet discovered, which, on exploding at the water-line, blows the side of the ship in, the Harvey torpedo will be very different from what it is now. Then it would require less skill to manipulate. Then, as a member said, a fleet towing a number of torpedoes one on each quarter, as he describes, would be very much more dangerous than it is now. As the case at present goes, if I were suddenly promoted, as has been suggested, and were put to attack a Russian Fleet, I should, as far as I can see at present, assume the formation in line-ahead, and go at him, trusting to chance for the rest. At any rate, only one ship would be blown up the first time, to say the worst of it. I quite agree with the general expressions which have fallen from Mr. Grenfell, Captain Dawson, and Captain Scott, about the necessity for experiments. Dealing with the subject as I have dealt with it here, I can only do it most imperfectly, because there are few experiments and few facts to be got. Captain Scott upholds bow fire on grounds which are, doubtless, satisfactory to him, and he deems it much more destructive than I do. Neither of us have any facts to go by; it is simply matter of opinion. If I were dealing with the question myself, the very first thing I would do would be to go to sea to ascertain what the power of the bow-fire actually is. At present we have only some data to tell us that from a sea-going ship firing at another ship, broadside on, at a thousand yards, only about ten per cent. of the shot strike. When we know that that is the effect of shot at a fixed distance, and that ships moving, are altering the range 100 yards in 10 seconds, it seems to me, on the face of it, that without further experiments "bow fire" cannot be held effective. Of course it is hardly relevant to the paper, still we want very much indeed the circulation of even such information as is now to be got. It is most difficult to get information upon any point connected, at any rate, with subjects such as I have been dealing with to-night.

Captain WHEATLEY, R.N: Captain Colomb stated that the Harvey torpedo exploded at the water-line. I know Captain Harvey, and I know he intended his torpedo to explode some feet under water, and then it is most formidable. I think, therefore, there must have been some mismanagement if it exploded at the water-line.

The CHAIRMAN: I have no doubt that the meeting will depute me to return our most grateful thanks to Captain Colomb for his valuable paper. He has frequently come before us on questions affecting our own profession. I should very

much like to see these experiments carried out. I was delighted to hear the speech of the gallant young Officer (Lieutenant Grenfell), and to learn that the junior Officers are starting a society at Portsmouth for the discussion of professional subjects. If it were not so late I should like to have asked him whether, in the projected college at Greenwich, he thinks they will be able to carry out all these experiments in tactics and with torpedoes, which some writers in the *Times* suggest should be made in the Thames! I only hope that before it is finally determined to establish a Naval College at Greenwich, the Admiralty will duly weigh all the advantages which Officers, who have studied at Portsmouth, have found there. The college is in the dockyard, where most of the new ships can be seen from time to time, and near the "Excellent," where our gunnery instruction and experiments are carried on, and we are there among many of our brother Officers, both on shore and afloat, with whom we can discuss naval matters somewhat in the same manner as these young Officers propose to do; thus we have many means of acquiring professional knowledge, which will clearly not be available at the proposed Naval College at Greenwich.

HOLMES'S "STORM AND DANGER SIGNAL-LIGHT."

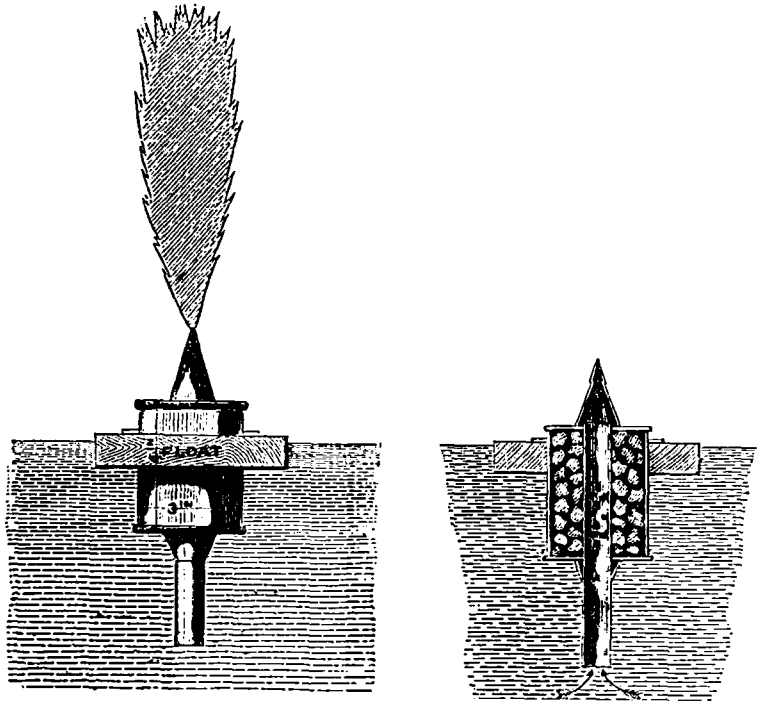
By Mr. NATHANIEL HOLMES, Electrical Engineer.

AT this late hour, I can do no more than bring before you a short explanation of a new "signal-light" which may be applied to many very useful purposes in the Navy and also in the Army. The peculiar properties of this "signal-light" are, that it is non-explosive; it is not affected by heat; you may throw it into the fire; you may melt the case, but you will not injure the composition that is inside the case. It is not affected by concussion; friction does not in away damage it. It is not affected by anything but by water. If you throw it into water it bursts into flames spontaneously, and burns with a most brilliant light for a considerable length of time. The small "signal-light" which I hold in my hand, will burn for nearly two hours; it will give a very brilliant light for forty-five minutes, and neither wind nor water will put it out. For use in connection with marine purposes I need hardly explain its many advantages. It is now adopted and in use by the Peninsular and Oriental Steam Navigation Company; by the Messageries Maritime Imperiales; and by most of the large lines of deep sea steamers. The Royal National Life Boat Association have also had some of these "storm-signals" supplied to certain of their stations for experiment. At sea it will be found invaluable. Suppose a man falls overboard, all that has to be done, is to take a knife, cut the top off the pointed end of the case, pierce a hole in the end of the bottom tube, throw the signal into the sea, when it immediately flames up and marks the spot where the man has fallen, while the boat is being lowered, and the vessel brought up in her course. If the man can swim, he swims to the light, and the boat pulls to the light; it becomes the rendezvous where to pick him up. That is one very important use of this "signal-light" at sea. By means of it, the position of a ship's boat in a dark and stormy night is accurately ascertained, and the frequent, tedious, and at times unsuccessful groping about for hours to find her, is avoided. Incidents of this kind are of frequent occurrence. Another use at sea is

where the light is placed in a small water reservoir, and used about deck as an open lanthorn for furling sails on a dark night, or for the purpose of lowering over the side of the ship in cases of fouling anchor-chains, accidents, or repairs, or at the masthead as a "flash-signal." The light at its maximum is so intense, that it may be seen for thirteen nautical miles from a ship's mast. With your permission I will now ignite one of the lights, first explaining its construction and composition; the principle of its self-ignition will then be understood.

The case is composed of a stout tin cylinder 3 inches in diameter and 4 inches high, from the lid of which a conical brass burner projects, the perforated apex of which is hermetically closed by means of a soft metal-cap soldered securely on. Through the bottom of the cylinder, a metal tube, 1 inch in diameter, passes into the interior of the case, to within $\frac{1}{8}$th inch of the upper lid, which carries the cone. The portion of the tube within the case is perforated with holes, while the tube projects outside the case $3\frac{1}{2}$ inches. The opening at the bottom of the tube is likewise hermetically sealed by a soft metal-cap. The interior of the cylinder surrounding the perforated tube is filled with the chemical ingredients.

The chemical material contained inside the "signal-light," consists of common chalk broken into small pieces about the size of bits of lump



sugar; these chalk-lumps are then heated to a white heat in a crucible containing a certain proportion of phosphorus, which being converted into vapour by the high temperature, is absorbed by the chalk when at a white heat, much as a sponge absorbs water. The chemical material thus formed (phosphate of calcium) is, when cool, placed in the signal-light-case, and the whole soldered down air-tight.

All that is required to be done, when the signal is needed for use, is with a knife to cut off the soft metal-top exposing the perforation in the brass cone for the escape of the gas, and by piercing the lower soft metal cap, to make an opening to admit water into the body of the case. On placing the signal in water, the flame immediately bursts forth, the water coming into contact with the chemical ingredient through the perforations in the inner tube. This signal-light has already been approved of by the Board of Trade for use at sea, as a substitute for blue-lights and port-fires, and some experiments have recently been made by Mr. Thomas Gray, the Secretary of the Marine Department of the Board of Trade, with a view of ascertaining how far the light could be employed in cases of shipwreck as a means of assisting the rocket-line-apparatus, by being projected in the form of a shell from the ordinary $5\frac{1}{2}$-inch mortar. These experiments, suggested by Mr. T. Gray, were quite successful, the signal light being uninjured by the percussion, and blazing away on falling into the water. I place on the table the form of the light and shell to be employed for projection into the sea from the $5\frac{1}{2}$-inch mortar; the two extremities of the case are of course pierced before it is fired from the mortar.

The third form of the "signal-light" on the table is, one to be used as a powerful flash and danger-signal for lifeboat services; it is contrived to produce a very powerful light for a shorter length of time; it burns for fifteen minutes or more. This modification of the signal is made, as it has been sometimes urged as an objection, that it burns too long, and cannot be extinguished. In this form there is a larger surface of the chemical material exposed to the water at the same time, more gas is therefore given off, and you obtain a brighter flame; but it burns for a shorter period.

Mr. Holmes then exhibited the mode of using the lights; two signal-lights were selected, the tops cut off, and openings made in the bottom. One was plunged under water, the other was floated on the surface, and the moment the water came in contact with the composition, a brilliant flame burst forth from each signal, and continued to burn for a long period with increasing intensity. In the case of the signal under water the flame rose to the surface, not in a continuous stream, but in a succession of gulps as it were, while the light from the signal on the surface of the water burned with the steadiness and force of a strong gas flame. The only drawback to the experiment in the room was the quantity of vapour which the lights emitted during burning. At sea this is considered an advantage, from the smoke being illuminated by the flame and seen at an immense distance.

Admiral RYDER: How long does the flatter form of signal light burn?

Mr. HOLMES: The flatter form burns about fifteen minutes with an intensely bright light. I may state that this signal light has been taken into custody twice; once at Inverness last July, when it was exhibited before the Railway Clearing House officials, and once at Brighton, when it was exhibited before the Emperor of the Brazils, the Coast Guard thinking it to be a signal for some illegal purpose.

Captain WILLES, R.N.: Does damp injure the light?

Mr. HOLMES: No, the case is perfectly air-tight, and water-tight.

Captain COLOMB, R.N.: About the storage on board ship?

Mr. HOLMES: There is no danger, and besides there is little heat in the flame; it is warm, but there is not very much heat.

Captain COLOMB: But if through damp it caught fire?

Mr. HOLMES: It cannot catch fire from damp. If it becomes damp you will perceive a disagreeable odour. Nothing but water will set it alight. Dampness will only decompose the material.

Captain WILLES: How about it if it is in a hot damp climate for six months?

Mr. HOLMES: The greater the heat, the safer the storage of the light. The damp will not affect it. Some of these lights I have kept under water three months; they are all carefully tested before they are packed, and sent out from the works.

Admiral RYDER: What is the intensity of the light as measured by gas candles?

Mr. HOLMES: It is considered to be about thirteen times the illuminating power of ordinary street gas; but I must confess to a little ignorance upon the precise relative illuminating power, for I have been so busy that I have not had time to compare it with more than the ordinary blue light at a mile and a half. This light has been burned and the blue light has been burned at the same distance. The comparison between them is remarkable. In a shipwreck, you often cannot light your blue light from damp and water, but with this signal light you are independent of the sea washing over your boat: the more water, the more light; it is inextinguishable as we have seen by water, and wind cannot put it out, though it may partially separate the continuity of the flame. With regard to the expense, I consider the expense of this light to be one-half the expense of blue lights, which are about 14*s.* a-dozen; the price of these lights is 6*s.* each; but then from one signal-light you obtain a better light, which will burn for 45 minutes, and have a light independent of water washing over it. I question whether the whole dozen blue lights would burn for 45 minutes; certainly not if they get wet. This light has been tried at Shoeburyness, under the direction of Mr. Thomas Gray, and fired out to sea, a distance of about 810 yards, from a 5½-inch mortar, with charges of 3½ and 4 ounces of powder, to see if concussion would destroy the igniting power of the light.

A VISITOR: Has the light been used as a flashing signal?

Mr. HOLMES: No, it has only at present been adopted by the Peninsular and Oriental Company, and other important lines of deep sea steamers; but I consider, when it becomes better known, that it will prove to be invaluable for certain purposes connected with Naval and Military tactics; for instance, as a signal light for the protection of torpedo lines, when flashed by a reflector across the range; for deceiving an enemy at night by false signals; for discovering what is being done under cover of darkness by an enemy's boats, by projecting these lights into their position; for protecting a shore or battery from surprise at night, by means of their illuminating power; for target practice at night; for marking the position at night of buoys, and for laying down torpedo-bearings at night; and for all other such purposes whenever a powerful light is required out of doors, simple, portable, and free from danger in transit. For military purposes it may with equal advantages be applied to pontoon-bridge building, trench work, fortification defences, camp equipments, horse picketing, and flash signals for special manœuvres, and also for balloon signals; its extreme lightness and security enabling any and every soldier to carry one or more when engaged upon special service. For shipwreck it is equally useful. Three or four thrown upon the sea will illuminate the surrounding darkness, and enable the shore rescue parties to direct their endeavours in the most practical manner. At such times the value of a brilliant inextinguishable light is beyond belief; it means the saving of many lives.

The thanks of the meeting were then voted to Mr. Holmes for exhibiting and explaining his signal-lights.