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Wednesday, January 21, 1885.

VICE-ADMIRAL THE RIGHT HON. THE EARL OF CLANWILLIAM,
C.B., K.C.M.G., in the Chair.

SIDE ARMOUR *VERSUS* ARMoured DECKs, FROM
A NAVAL POINT OF VIEW.

By Captain C. C. FITZGERALD, R.N.

It may possibly be thought presumptuous for an Officer who is neither an artillerist, a torpedoist, or a scientist, to offer any opinions upon such a technical point as the respective merits of side armour and armoured decks.

It is therefore with great diffidence, and subject to correction, and from the point of view of a practical seaman, and not as an expert in the different modes of construction, that I venture to approach the subject. Moreover, it is with the view of eliciting the opinions of others, more than of laying down any dogmatic ideas of my own, that I do so.

With such very limited knowledge as we possess of the points which will govern the result of a future naval battle, it may almost be said that one man's opinion is as good as another's. At any rate, the opinions of those naval Officers and others, who I hope will speak on this occasion, must necessarily be of some value.

We have such few actual data to guide us towards forming a correct judgment in the matter, that all opinions must be to a great extent speculative; but I cannot help thinking that our shipbuilders, both public and private, instead of being jealous or offended by the fact of naval Officers discussing in this theatre the relative value of different modes of protection, are far more likely to be pleased thereat, and anxious to learn the views of practical seamen, gunnery Officers, and any other geniuses who may have opinions to offer upon the extremely important points at issue.

Nor can I believe that our rulers at Whitehall will look with disfavour upon an independent and honest expression of opinion concerning the points I am about to bring before the meeting, always

premising that in the observations we shall make, we be guided by a due sense of loyalty to the authorities, and avoid anything which partake of the nature of criticism of their actions.

I propose in the present paper to confine myself entirely to consideration of protection against artillery fire, and not to touch all upon protection against the ram and the torpedo. It may be that any discussion which leaves out of account those formidable weapons of attack, must necessarily be incomplete and of little value.

I venture to differ from this view. In the first place, I know of no means of protection against the ram except superior manœuvring power and the subdivision of the ship into numerous compartments; but even with the latter device carried to its fullest extent, I think it most probable that anything like a direct blow of the ram at sea between ships of about equal size will ensure the destruction of one if not both.

Torpedo defence involves the consideration of wire nets, booby-traps, and various other devices, and will, I think, afford enough for another paper; and I hope it will be taken up by some more competent to deal with it than I am. I will, therefore, suggest to the meeting that they confine themselves to the discussion of the point indicated by the heading of this paper—namely, the respective merits of side armour and armoured decks as a means of protecting the ship herself against artillery fire, for I am not aware that any seriously claimed for either of these modes of defence that they form any material safeguard against the ram or the torpedo, and I think that if we thrash this subject out thoroughly we shall find the insufficiency of matter to occupy fully all the time at our disposal.

I will assume at starting, and without fear of contradiction, that the primary use of all armour is to keep the ship afloat; secondly, to protect the magazines, boilers, and steering gear; thirdly, to protect the guns and their crews.

Undoubtedly the greatest calamities which could happen to a ship in action would be to sink, or to have a magazine blown up; the latter would, of course, involve the former, and probably the loss of all on board. Next in gravity to these, I should say, would be perforation of a boiler, or the destruction of the steering gear; either of these I imagine would entirely disable the ship, and place her at the mercy of her enemies; the majority of the crew might save their lives, but the ship would have to surrender or be destroyed. Next in importance to these, I should say, would be the disablement of the guns, and the slaughter of a large proportion of the crew. Under these circumstances, and in the hands of a determined and gallant commander, we can easily imagine her continuing the action, still endeavouring to ram her enemy, perhaps successfully; and, as a last resort, if the odds against her were overwhelming, and suppose her to be possessed of high speed, it would always be open to her to make what the Americans call "a strategic movement to the rear" and save the remainder of her crew from a foreign prison, and deprive the enemy of the moral and material advantages of a trophy.

In order to form any correct estimate of the value of armour, the main point to be considered is the nature of the projectiles which it will probably be called upon to resist. The competition between guns and armour has been going on for a long time, and it will be remembered by many here present that some years ago, when it appeared that the guns were gaining a decided advantage over the armour, and all plates of a practicable thickness were pierced with ease at point-blank range with solid shot from the heavy guns, it was proposed to do away with side armour altogether and to allow the shot to go clean through, thus making less splinters than if they had been imperfectly resisted by armour; and as a substitute for side armour, the device of horizontal armour or armoured decks was adopted in order to protect what are called the vitals of a ship from the indirect blow of partially descending shot, and from the downward effect of the explosion of shell which had passed through the side. This principle has been adopted entirely in some of our cruisers, and partially in almost all our first class battle-ships—"ironclads" I was going to call them, but that they are not, in the strict sense of the word, and they base their claim to fighting power upon other qualities.

Now, with all possible respect for the opinions of those who have substituted armoured decks for side armour, I venture to think that they are wrong, and that they have arrived at their conclusions in error, and without assigning their proper value to the various requirements of a war-ship, and of the projectiles which will be used for her destruction. This is plain speaking, but I am not afraid of offending anyone, as they will know that my remarks are not personal, and are only offered with the view of eliciting a fair discussion of the subject by seamen and others, and if possible of arriving as near to the truth as may be without the actual experiment of war.

I shall be truly glad, in view of the present designs of our fleet built and building, if the advocates of armoured decks as a substitute for side armour can prove that I am wrong, or can show plausible reason for assuming that I am so. I have thought a good deal upon the subject, and I only offer my opinions as those of a seaman, and not as a scientific shipbuilder, so they must just be taken for what they are worth.

In the "Times" of 4th December I find Sir William Armstrong advocating a large increase in the number of fast unarmoured cruisers for the Navy. These are his words—"Every improvement in guns, projectiles, torpedoes, and methods of ramming, to say nothing of the new modes of attack which science is likely to develop, tend to lower the value of armour, and to equalize the risks of armoured and unarmoured ships. Upon these grounds I consider that a lavish expenditure upon armour-clads is to be deprecated, while we cannot be wrong in creating a numerous fleet of swift, heavily armed ships, protected to the utmost extent obtainable without armour."

He then goes on to discuss the thickness of armoured deck necessary to protect these cruisers, showing thereby that he intends to afford them this protection. Now, as Sir William Armstrong's letter was published in the "Times," and is therefore public property, I

presume there can be no harm in criticizing it. First, I der "every improvement in guns and projectiles tends to lower the of armour." The improvement in machine-gun fire, and the six-pounder which fires from ten to fifteen rounds a minute maintain, a directly contrary tendency.

The increase in the size of guns and weight of projectile probably act in that direction; but it should be remembered the number of heavy guns carried by a ship must be few and the slow, whereas the development of the fire of extremely quick light shell-guns, which has received so much attention of late have a directly contrary effect to that indicated by Sir W strong.

With regard to torpedoes, I don't see what they have got with it, except to point in the direction of bottom armour as pointed out lately by Sir E. J. Reed.¹

I am not aware of any improved methods of ramming, nor if there were any, do I see how they could affect the question of armour as to the "new methods of attack which science is *likely* to develop." I submit that so far as we are able to judge of an unknown quantity they are as likely to point in one direction as the other. However, whether my criticisms of Sir W. Armstrong's opinions are of value or not, we know that Sir E. Reed differs from him widely in his appreciation of the value of side armour, and when two authorities disagree, are we not entitled to inquire into the merits for ourselves?

The decision to abandon (either partially or entirely) side armour arrived at in consequence of the impossibility of keeping out solid shot which struck directly with any practicable thickness of armour, appears to me to be erroneous for the following reasons. First, it appears to me to ignore the fact that armour, which will keep out solid shot, will keep out large capacity shell of the same calibre with heavy bursting charges, which, if allowed to enter a ship, will do far more damage than any shot; secondly, it seems to ignore the fact that in actual warfare the great majority of an enemy's projectiles which strike a ship will not do so at right angles, nor at point-blank ranges; thirdly, it appears to underestimate the extreme rapidity and terribly destructive effect of the fire of modern guns and machine-guns, every shell from which will enter and explode inside the unarmoured part of a ship.

To jump to the conclusion that because you cannot keep out solid shot it is therefore no use to try and keep out any, appears to be on a parallel with the action of a man who, finding that his house leaked on a rainy night, turned to and pulled the roof off altogether on the principle that because he could not keep out all the rain, therefore no use trying to keep out any; or of the Captain of a ship, finding that she had sprung a leak, said "Oh, well, if we have any water in, let's have in as much as possible; open all the valves and knock a hole in her bottom."

¹ See Journal, No. CXXVII.

I think that in trying to estimate the true value of side armour as a means of keeping a ship afloat in action, it is necessary to base all our calculations upon the laws of chance, and not upon the exact thickness of plate which has been pierced by a gun of a certain calibre. The term "laws of chance" may be objected to, and people may say that chance has no laws. Well, I am not particular as to terms so long as I can convey my meaning, and it is quite certain that all life insurance companies base their calculations upon the chances of the most uncertain thing in nature, viz., human life, and I believe they come to tolerably accurate conclusions by so doing.

I suppose we might assume that, roughly speaking, the rapidity of the fire of guns is in the inverse ratio of their size. Let us say, therefore, for the sake of argument, that one of the new six-pounder guns can fire ten shots while the 18-ton gun is firing one. I may here remark parenthetically that I make no pretence to accuracy in this comparison; it is quite immaterial to my argument whether it fires ten shots or twenty shots; I only want to prove a principle, and I should say ten shots would be well inside the mark, so let us say ten. Then, I maintain that in all probable engagements (except where a ship which has the speed keeps three or four miles off and plays long bowls) there will be ten times as many chances of hitting a ship with a six-pounder as with an 18-ton gun. I expect to hear this statement questioned by some one who will say, "Oh, but the man who fires the 18-ton gun will be so much more careful over his shot, knowing that so much depends upon it, and therefore he will be more likely to make a hit." I will leave this argument for what it is worth, only observing that I have no doubt many here present have seen the captain of a gun exceedingly anxious to hit, taking a long time aiming and poking round after the target, and then making a much worse shot after all than if he had fired quickly and with his first aim, so that I scarcely think that anxiety to hit need be taken seriously into account as a factor in the case.

Now, lest I should be misunderstood at this point, and it should be supposed that I am going to advocate doing away with heavy guns in ships, and carrying a large number of light guns instead, I may state briefly that I have no intention of proposing anything of the sort. I think that both heavy and light guns will have their respective parts to play, and one will support the other: but what I do propose to submit to the meeting are the following points:—That in view of the recent development of light and machine-gun fire, no iron ship is fit to go into action at all, or to be called a "man of war," which has not got a complete water-line belt of some sort of armour, and that an armoured deck is no substitute for such belt. Secondly, that a water-line belt of only 3-inch steel will keep out about two-thirds of the projectiles which are likely to be fired against a ship in action; for it will keep out all the machine-gun fire, and most of the light gun fire which strikes obliquely and at long ranges. Thirdly I would submit, that from a naval point of view, it is a grave, nay, a fatal error to leave two-thirds of the water-lines of our line-of-battle ships absolutely unplated, and therefore certain to be penetrated.

in a hundred places, by the terrible hail of light and machine fire which would be poured upon them in action; seeing that in condition their stability and seaworthiness would be at least doubtful. And finally I would submit that even now, at the eleventh hour in spite of personal feeling, and the mortification it might cause clever men to see their designs altered; yet for the honour, safety of the country, and the credit of the Navy, the whole of so-called citadel ships should be altered immediately, no matter it may cost; the whole of the armoured deck should be taken except patches to cover the crowns of the magazines; and if necessary, some other weights taken out, coal, or even guns and ammunition, so as to enable them to be given a complete water-line whatever thickness was found to be practicable; but at least enough to keep out light and machine-gun fire.

I expect that, at first, most naval Officers and all naval architects will laugh at this proposal; and I shall hear the words "impossible" and "not worth it": but yet I beg of them to consider this more deeply, and try to weigh in their own minds what the various chances of a modern naval battle will be; giving special attention to the size of hole which even the 1-inch Nordenfolt gun makes in thin iron steel, and the extreme difficulty of getting at and stopping those if they are in the region of the water-line; and also the great probability of a large number of such holes being in the region of the water-line, even if it is not aimed for.

These citadel ships are no discredit to their designers; for it must be remembered that the development of machine-gun fire, and of rapid firing light guns, has taken place since they were designed; but now that we are face to face with these instruments of destruction, which would seem almost to have been invented on purpose to deal with our battle-ships, we must look at the matter boldly and not attempt to shirk it, but take the necessary steps to frustrate their deadly effect.

It is often easier to convey one's ideas by means of an illustration than by any other means; and as I think that the probability of a belted, or partially belted iron ship being sunk in action, has been very much under-rated, I propose, by way of illustration, to compare the relative chances of success between a completely belted and an entirely unbelted ship. I will take, for example, the "Hercules" and the "Italia." Now, I dare say most of my hearers are tolerably acquainted with the respective arrangements of these ships. "Hercules" is about twenty years old, and may therefore be considered as embodying all our knowledge and skill at that period. Since that time great advances have been made in the size and power of guns, and in the resisting power of armour. Moreover, the "Italia" is nearly double the size of the "Hercules;" and yet I venture to think that in a pitched battle, the chances in favour of the "Hercules" destroying the "Italia" before the "Italia" could destroy her, would be very great. Mind, I say the *chances*, for I am quite aware that the first shot from the "Italia" *might* destroy the "Hercules;" but I say the *chances* are against it. These two ships are fairly typical of an armoured

belt *versus* an armoured under-water deck, though the "Italia" being so much larger and so much newer, ought of course to be immeasurably the stronger.

Their respective characteristics are somewhat as follows:—The "Hercules" has a complete belt round her water-line of 9 inches amidships, tapering off to less at the ends. She has eight 18-ton guns in a battery, protected with armour varying from 8 to 6 inches: her other light and machine-guns, in the tops and elsewhere, would be unprotected by armour.

The "Italia" carries four guns of enormous power (100 tons each) which with their communications to the magazine below the armoured deck, are protected by armour of great thickness; all her other guns, and the whole extent of her water-line are absolutely unprotected, even from the fire of heavy machine-guns.

Now, if the "Italia" and the "Hercules" were to meet at sea as enemies, the "Italia" with her superior speed would have three courses open to her. First, she could run away, which would probably be her wisest course; secondly, she could use her speed to keep out of range of the "Hercules's" guns, which would be a long way, though I am not prepared to say how many miles; and she could fire at the "Hercules," with her four heavy guns. This is a course which we often hear advocated for ships with great speed and heavy guns; but it is a course which I cannot believe would ever prove decisive. I should think that with both ships in motion, and the "Hercules" end-on, as of course she would keep herself, the chances of the "Italia" ever hitting her, would be very small indeed; so that after the battle had lasted for about a fortnight, which I take to be about the time that the "Italia's" ammunition would last, at the average rate of firing of the 100-ton gun, she would have to bear up, and go into harbour for more.

The third course open to the "Italia" would be to close with the "Hercules" and fight it out. Let us, under these circumstances, consider what their respective chances would be. Now, it appears to me that if the "Italia" did not sink the "Hercules" by striking her at the water-line with the very first discharge of her heavy guns, which I submit is a somewhat remote chance; then the "Hercules" would certainly put the "Italia" in a sinking condition before she could fire another shot with those heavy guns.

I am informed by an experienced gunnery Officer that the 100-ton gun cannot be expected to fire more than one round in a quarter of an hour or twenty minutes: during this interval the battle would take place under the following conditions. Both ships would discharge at each other a perfect hail of light and machine-gun fire, so that we might expect that in a quarter of an hour's time, each ship's side would exhibit what gunmakers call a pretty good pattern of of either shot holes or shot marks; and I submit that even if the firing were of the wildest description, and the water-line not even aimed for, that according to the laws of chance that I am so fond of quoting, a very considerable proportion of those shot marks would be in the dangerous region of the water-line; but there would be this

difference, in the case of the "Hercules" they would be shot and in the case of the "Italia" they would be shot holes. It is fair to suppose that the battle takes place either in a gale of wind or in a flat calm without swell; it is fairer to suppose that in average weather, what sailors call a royal breeze, and a slight swell and under these circumstances, with the motion of the ships, and waves washing up and down their sides, I suppose that we might consider a belt of 5 or 6 feet wide to be the dangerous area or region of the water-line. Does anyone suppose that if the "Italia" had received her fair average proportion of shot in this region, that she would not be in a sinking condition?

I think that if we consider the sort of holes that even small shells make in iron and steel, and the great difficulty of stopping them, she most certainly would. She would, however, have the option of capsizing first if she chose it, by keeping the water above her armoured deck, and not allowing it to go below. It is of very little consequence to say that her heavy guns, and the men working them are perfectly protected, if the structure which carries them is sinking, or in imminent danger of capsizing. Moreover, in addition to the duel between the light guns which would go on while the "Italia" was loading, the "Hercules" would have her eight 18-ton guns protected by tolerably thick armour, and firing a round a minute; the large capacity shell from which would pierce the "Italia" all over, except just on the citadel, and exploded inside above the armoured deck would very soon make short work of compartments, cork stuffed coffer dams, or any other devices for keeping these peculiarly signed ships afloat. I think there would be very little doubt as to the result of the action; at any rate I know which of the two ships would rather be in.

It may be asked why I have selected the "Italia" for comparison, seeing that we have no ship of such a type in our Navy. It is true that we have no ship of exactly her type, but she is a fair specimen of carrying to its fullest extent the principle of leaving the water-line or any part of the water-line, of a battle-ship unarmoured.

It is not my intention here to enter into the controversy which has been already so hotly carried on as to what the condition of citadel ships will be with their ends riddled, and the water flowing freely in above the armoured deck; whether they will be safe, staunch and seaworthy, and able to fight their guns; whether they will acquire such a heavy list as to be unable to fight their guns; whether they will be so waterlogged as to become practically unmanageable; or whether they will turn bottom up altogether, as broadly hinted by Sir E. Reed in this theatre a short time ago, are points which do not propose to discuss on the present occasion. They are points which I am not competent to discuss, but I submit that, as experts disagree upon them, they cannot be considered to be satisfactorily disposed of, either by calculations on paper, or by the trial of models in smooth water, or in any other way than by the trial of the ship herself in rough water, with most of her coal and stores expended.

It would be highly presumptuous on my part to assume to speak

the name of the Navy, but I have given some consideration and thought to the subject of these citadel ships, and have conversed with many experienced seamen concerning them; and I have come to the conclusion in my own mind that the Navy does not like them—has no faith in them, in short—and would much prefer to see even thin armour carried completely round the water-line, at the sacrifice of some other weights. I have been informed by an expert (not after calculation, but roughly, and at a guess) that the “Admiral” class could carry armour of about 9 inches thick, as a water-line belt for their ends, if the horizontal armour and thwart-ship bulkhead were removed; and I imagine that most seamen would rather fight them in that condition than as they are at present. No naval Officer, I make bold to say, would have the slightest objection to be sunk by the shot from a 100-ton gun *if it hit in the right place*, but to be sunk or disabled in a supposed ironclad by the fire of every popgun carried by every foreign gunboat, would be more than the honour of the British Navy could survive.

I have had the internal arrangements of the unarmoured ends of the citadel ships carefully explained to me—the various devices by means of coffer-dams, &c., for getting rid of the water which would come through shot holes in the region of the water-line; also the value which is placed upon stores and coal for keeping out a certain amount of the water; and I am bound to say that, with all respect for the ingenious minds which have devised these plans, they do not commend themselves to my judgment, as a seaman, as being practical devices, or at all competent to deal with the destruction, and consequent heavy flooding of water, which I anticipate for these unarmoured ends in action, principally from the fire of very light and machine-guns.

The citadel ships appear to have been designed under the impression that nothing would be fired against an ironclad in action except heavy shot at point-blank ranges, and that therefore, as it was impossible with any armour of practicable thickness to keep out heavy shot at point-blank ranges from the whole length of the water-line, it was better to keep them out from a part, and trust to cork filling, numerous compartments, coffer-dams, stowage of stores, and an under-water armoured deck, as substitutes for armour for two-thirds of the length of the ship.

But I submit that this is a total misconception of what will occur in a general, or even in a single action, and that, as a matter of fact, the *vast majority* of projectiles fired will be of very small calibre, and such as very moderate armour would have kept out. It also seems to have been forgotten that several small holes will let in as much water as one big one, and that the chances of hitting a ship's water-line will be in proportion to the rapidity of fire. I believe, therefore, that I understated the case when I said, a little further back, that I thought a 3-inch belt of steel would keep out two-thirds of the projectiles fired in action, which would otherwise have penetrated an unarmoured water-line.

Must we not also suppose that our possible enemies, knowing the

construction of our battle-ships as well as we do, will give special attention to the development of light gun-fire, so as to take advantage of our weak points? And will they not direct all their shot : shell, too, to our unarmoured ends, leaving the impregnable citadel to be put out of action and rendered useless by the destruction of weak and unstable platform upon which it depended? I think may give them credit for that much intelligence.

Let us now consider how far an armoured deck is a substitute side armour, for it must be remembered that an armoured deck is considerable weight, and unless it can be shown that the distribution of weight in this form affords better protection to a ship than same weight as side armour, there can be nothing to say in favour of it. An armoured deck protects the magazines from shell-fire, and the case of cruisers without side armour, it protects the tops of boilers, and, I presume, the steering connection; but a very small quantity—small patches, in fact—of horizontal armour would protect the magazines and boilers, and an armoured tube would protect steering connection. An armoured deck, therefore, is intended to fulfil another purpose, namely, to keep a certain portion of the ship intact and watertight after her upper works and water-line have been riddled by shot and shell. Now the question which forces itself upon one's mind is this—is it worth while, at the expense of so much weight, in the shape of horizontal armour, to keep intact a certain portion of the ship already beneath the water, and thus represent no reserve of stability or floating power? In the case of the "Italian" for instance, and in some of our own cruisers with under-water armoured decks, the effect of keeping the lower portion of the ship intact, whilst the water could flow freely in through her riddled topsides, would be simply to capsize her. This must be obvious to the most unscientific mind.

I have already said that I do not propose to enter into the controversy as to the seaworthiness or otherwise of our new first class battle-ships, with their ends riddled. There will always be a difference of opinion upon that point until one of them has been tried, but the best that can be said of them is that they are hermaphrodites—half cruiser, half ironclad; or, as far as their water-lines are concerned, two-thirds cruiser, and one-third ironclad.

To an ordinary nautical mind, it would really appear that an under-water armoured deck, the coffer-dams, cork chambers, and numerous compartments had been specially and ingeniously devised for dealing with water which had been allowed to get inside the ship and which need never have been permitted to do so. It will be like dealing with a very troublesome burglar, whom you have allowed to enter your house, and then have to deal with inside, instead of taking proper precautions to exclude him, and then arguing the point with him, if necessary, while he is outside.

I observe that in some of the new designs the armoured decks of cruisers are to be a foot above water, sloping down to 4 feet under water at the sides, thus:—

This seems to be a step in the right direction, for it must be remembered that any intact space which is above the water represents a reserve of floating power, and that the ship can never sink as long as she has only a few inches of such reserve; neither can the water gain upon her so long as she retains it, no matter how much her topsides and water-line may be riddled, as it will flow out as fast as it flows in. But even with this new design, I cannot help thinking that, in view of the recent development of machine and light gun-fire, the armour used for the deck would have been better distributed as a moderate belt of side armour, with, perhaps, small sloping patches over the crowns of magazines and boilers.

I have laid before the meeting my views upon the question of side armour *versus* armoured decks as means of keeping a ship afloat in action, for, as Sir E. Reed pertinently remarked in this theatre a short time ago, "the first duty of a ship is to float;" and I trust that any naval Officers or others who have given any thought to the subject, will give us their views upon it. I have founded my arguments upon what I believe to be the only reasonable foundation, namely, the laws of chance.

We naval Officers do not claim to be shipbuilders, but we do claim to be seamen, and to know something about the sea and its unruly nature. As a matter of history, we know that our fathers did not rule the waves in tin pots with numerous holes in them; and as a matter of speculation, I do not think that we shall do so, either.

Admiral Sir R. SPENCER ROBINSON: Lord Clanwilliam, ladies, and gentlemen, I have some diffidence in getting up so early in this discussion and giving my opinion upon this matter, but I think at any rate you will agree with me, that the views that our worthy and excellent friend, Captain FitzGerald, has given have shown good sense, moderation, and impartiality which are beyond all praise. In the observations I shall make I will endeavour as much as possible to keep to the subject he has put before us, and not to wander out into many discursive points which are a great temptation to us when we come to discuss our fighting ships. I know very well, nobody knows better, that those parts of the designing of a ship that depend on the naval architect cannot very well or very accurately be discussed in this theatre, first of all because speaking for myself, and I believe I may the same of many naval Officers, we have not the requisite knowledge to discuss matters of pure naval architecture, and, if we had, the time it would take, the drawings we should have to consult, the plans we should have to bring forward, and the various models and calculations we should have to go through to establish any position we might take up against the views of a naval architect when he has designed a ship,

would certainly prevent the result being at all satisfactory. Another thing believe, we are bound by a rule not to go very much beyond 10 or 12 minutes the observations we have to make, but I trust if I go a little beyond my time, it is extremely likely, in order to say what I wish to say, you will excuse me, and permit the infraction of a rule which ought generally to be very well observed. Before I start upon some observations upon the ships, I wish to say how Captain FitzGerald has pointed out that the doctrine of chances is not, and is not to be, overlooked by us in our consideration of naval battles. Every Officer will remember that fine saying of Nelson before one of his great battles that "Nothing is sure in a sea-fight above all others; something must be left to chance, for shot will carry away the masts of friends as well as of foes." So the doctrine of chance will sometimes hit us where my worthy friend wants to be avoided and sometimes it will hit us unfairly, to which he very much objects, and so I hold in my hand a paper, which I will proceed to explain to you. I want to do this. I am going to confine my remarks to the citadel ships, they being the largest number, and of the first class of our battle-ships. I leave other people to discuss the various points relating to our cruising ships, which I think will lead to much discussion indeed. You all know what I mean by a citadel ship, for the phrase is commonly used. First, a citadel ship has a certain portion, in my mind a very limited portion, defended by armour-plate, and a very considerable portion protected by coals, by an armour deck below water, by coffer-dams, by cells, by masts, and all sorts of things. The effect of that protection we shall hereafter consider when I shall compare the effect of a ship defended by contrivances, as we do, with what we all understand as armour-plating. There are eleven of these ships, and I will give their names, and the way in which I have classified them. There is a very considerable difference between the original citadel ships and the later ships, and a considerable advantage in the later ships. The original citadel ships were the "Indeflexible;" then there came the "Agamemnon," the "Ajax," the "Edinburgh," the "Colossus" and (though not exactly the same sort of ship yet somewhat similar), the "Collingwood." The first five are so nearly alike that I may call them of the same type, and call them Class A. The "Collingwood" differs a little from that type; therefore I say our first type consists of five or six. After those are the "Howe," the "Rodney" (Class B), the "Camperdown," the "Benbow" and the "Anson" (Class C). All these ships differ, and the type is very much varied by what has been done. Here are the facts of the case. I have taken from a table from one published in the "Times" the other day, as the result of a lecture given by Mr. Barnaby, the Chief Constructor, at the College of Naval Architecture. The first thing that strikes me as something rather formidable is that in the "Indeflexible" only 42 per cent. of the area of water-line is protected by armour, 58 per cent. of the area of water-line is defended by what I have called contrivances. We go on to the "Agamemnon" and the "Ajax," and we find 45 per cent. of the area of water-line defended by armour, the remainder of the area of water-line being defended by contrivances. This seems rather to have struck the constructors as not being quite a proper thing, and they designed two more a little different, but the percentage of which was only 42½ of the area of water-line protected by armour, the remainder being defended by contrivances. These are the first five ships in my Class A. But here comes another one, the "Collingwood," her dimensions resembling in every respect the actual dimensions of the "Edinburgh" and the "Colossus," but she differs from them in this particular, she has 54 per cent. of the area of water-line protected by armour, and the remainder only defended by contrivances. It seems, therefore, as if it was not at all unusual in us to view with alarm and distrust the very large area of water-line unprotected, as we think, in the earlier ships. It seems that we are right, because the naval constructor has added to the percentage of protected water-line very considerably, and to the next two ships, which are the "Rodney" and the "Howe" (Class B), he has added still more. My argument is this, that the very design of these ships either were horrified or repentant at the very small area of water-line that they had protected by armour, and so they advanced from 42 to 56 per cent. of water-line protected by armour. If they had the same confidence in their contrivances for protection of the ship's ends unarmoured

they designed the "Camperdown" as they had when they designed the "Inflexible," we should not have had any improvement. They have been convinced either by their inner consciousness or by the arguments of those who consider the armour protection of the ships insufficient, to advance from 42 to 56 per cent. All I can say about that matter is, go on and improve; don't stop where you have come to, give us that protection which you evidently think necessary, in a larger measure than in the "Camperdown," the Class O that you have recently designed. But there are other and still more serious features in this table. One is that if the ends protected by contrivances are riddled and destroyed, in one case 750 tons of water will come into the ship; in other cases it diminishes, as in the "Ajax" and "Agamemnon," to 580 tons, and then to 570 tons, 550 tons, 450 tons, and 420 tons. Now here there has been progress made, and I think naval Officers ought to be extremely gratified with it, but I would still say "Go on and improve, correct the errors of your ways wholly, and give us the same proportionate protection to the ends of our ships that you have given to the central citadel." The ends do a certain proportion of the work of the ship in maintaining buoyancy, and stability, and handiness, and they ought to have as large a proportion defended as the citadel part of the ship. Now I do not hesitate to say that it is my opinion, and the opinion of almost every naval Officer with whom I have conversed, that contrivances do not give the same protection and security to the ends of the ship as the armour-plating gives to the central citadel. I say the ends of the ship have a certain part to do in maintaining the efficiency of the ship as a fighting ship, and unless they are given that proportion of defence which they ought to have, the citadel is of no use. I am very much strengthened in holding this opinion by what passed in this theatre a short time ago. I listened, as all present did, with the greatest interest to the thoughtful, careful, unexaggerated view of the case presented to us by my friend Sir Edward Reed. Most eloquently, and at the same time almost pathetically, he showed us the risks that might be run by a ship going from under our feet, and that there might be the loss of honour to our flag, and of a great vessel. There was no exaggeration, no endeavour to drag forward or find fault with the short-comings of other naval designers. He held these things up to us for the consideration of naval Officers, that we might express by such means our opinions as to whether the citadel ship was properly supported and protected by its unarmoured ends being defended by contrivances. We all remember that great and horrible controversy (I cannot call it anything else than horrible, for I never felt more pain than in reading the letters) in which scientific matters that ought to be decided really upon their merits and experiments were made a vehicle of all manner of personal ill-will and abuse. I refer to that no further, except to say that those who took part in the composition of the Report laid before the Admiralty on the state of the "Inflexible" made many recommendations, the whole of which, as far as I know, have been disregarded. You have only to turn to the Report of the "Inflexible" Committee to see that one of the things they laid the greatest stress upon was that proper, thorough, and exhaustive experiments should be made as to whether these contrivances of coal, cork, cells, coffer-dams, and so on, were or were not sufficient protection. Of the under-water deck I speak with the greatest respect; I do not know that I go so far as Captain Fitzgerald in wishing to do away with it. For my part I take off my hat to the under-water deck, and respect it very greatly. It was an extremely judicious help. But we were told by that Committee that no sufficient experiments had ever been tried, as was pointed out by Sir Edward Reed at the time, as to what effect would be produced upon all these contrivances under a heavy artillery fire. Now if it were a question of what effect 500 tons of water would have on the position of the centre of gravity, I would take the opinion of a naval architect or constructor of experience without question. I believe they are perfectly qualified to give answers to that question to the satisfaction of any reasonable man, but I will not take, nor will I ask naval Officers to take, the opinion of a naval constructor as to the ravages of shot and shell. Knowing that naval men will have to risk their lives, I claim that they shall not be sent out without as much knowledge of the possibility of their ships being defended by these contrivances as they have with regard to thick armour-plating. We know very well that thick armour-plate is not infallible, but we have ascer-

tained by a series of experiments what armour-plating can do. When "Warrior" was built, target after target of $4\frac{1}{2}$ -inch armour was fired at by guns of those days, and until rifled guns appeared targets were successful. My Sir Edward Reed brought forward a ship, the "Bellerophon," whose armour-kept out even rifled guns of small power, but he went much further. Before "Hercules" or the "Bellerophon" was built, these experiments were made with thicker plates, and they kept out the shot and shell. The "Hercules" was penetrated, and gave naturally to every naval Officer a degree of confidence. I must say they are now without. Repeated experiments were further made and were fired at the "Glatton" with the turrets in their place, and the result was satisfactory. Then we tried whether the device of taking two thicknesses of a plate was equal to one thickness, and it was proved satisfactorily that two thicknesses would resist as well as an equivalent thickness in one armour-plate. I ascertained in a mathematical form what armour-plating will do, its value is when we go into action; we take our ships into action with a certainty that we have in them a resisting power which we know of and can measure, but the least idea of what the resisting power of all these contrivances will be have affirmation, certainly. We have it affirmed that it is extremely improbable that all these contrivances will be destroyed, but if a large portion were destroyed would not the ship's buoyancy, stability, and steering power be lost, and her use as a fighting ship be almost nowhere? We have no satisfactory knowledge as to what will be the value of these contrivances by which alone our first class ships are to be maintained efficient, and I ask my brother Officers, if they think as I use every exertion in their power, by discussion, or by writing to newspapers, any other means they possess of influencing public opinion, to cause thorough searching experiments to be made, which shall give them the same knowledge of the value of the contrivances as they have of the citadel of the ship. I am glad Mr. Barnaby published this paper, for of all the things I should most wish in any discussion, it would be not to be dogmatic, not to take an unfavourable position, nor to act as an advocate or a lawyer, and only mention what is unfavourable to take my opponent's view, and to state why I entirely dissent from the conclusions he has come to. We are told the loss of buoyancy in the "Inflexible" by the total destruction of her ends is only 750 tons of water. That is a nice thing to be rolled about the deck, besides anything you may get elsewhere. I am so doubtful as to whether this is really the maximum that will come into a ship, that I am permitted to make a remark or two upon it. If the total destruction of the system of contrivances ensues, if all the cork and all the cells are blown out of the ship, and then there are only 750 tons that can get into the ship, I should give you some relief, though the matter would be extremely serious; but I think there is a deal more behind it than that, and not having those plans and sections which I should like to have before me, I want to know what happens to a ship, which carries a large proportion of her contrivances for defence dependent upon the coal, to carry and consume, when that coal gives out, because when she is without coal, an action may come on at any moment. The "Inflexible" carries 800 tons of coal as a protection to her water-line; the others do not carry so much; but will it happen when the coal is burnt? I want to know whether those things which are weighed on the constructors, and have caused them to make some improvement. We will take it that the 800 tons of coal is expended, and that the ship goes into action. The coal protection is gone, and there will be 800 tons of water, not fixed in cells in addition to the vacant spaces already filled with water, 700 tons any less amount walking about the decks doing just as it pleases. Anybody who has seen water in motion knows that there is not a more powerful knocking of every obstacle that comes in its way. The percentage of coal in the "Inflexible" which is outside the armour-plating is very much larger than in the others, the very last ships I find 17 per cent. of the whole area of the ship is filled with coal, and outside the area of the armour-plating. That 17 per cent. of coal will be more quickly burnt than the 800 tons. Therefore I think the objection to water running about the ship, although very much less in them, appears to be admitted upon the supposition that only the contrivances to defend the unarmoured ends will be penetrated, and in disregard of the loss of protection occasioned

consumption of coal, so at last they have come down to a minimum admission of 420 tons of water. But I seriously object to that amount of water, increased, as it would be, if you had consumed your coals, and that space had been filled with water by the ravages of artillery. I take it it never has been and never will be doubted that the sides of the ship will be perforated right and left by shell fire. What they bid us trust in, is cork in cells, coals, and stores. The most dangerous protection you can give a ship is a store which you must rapidly consume, and without which you cannot get anywhere. Therefore nothing is so dangerous as the removal of the coals, and that must take place, and then the fighting powers of the ship are very seriously diminished. The question I have asked myself over and over again is, "Is the maximum of water that can be admitted into the ship fairly given us by what is called the total destruction of the contrivances, minus the under-water deck?" If it is, the case is bad enough, but it is not quite so serious now as it was formerly. I have detained you by these observations, and I will not proceed any further, more than to say that we ourselves as naval Officers have a great dislike to the citadel ship. The highest possible authority has described the evils of the citadel ship in guarded and moderate language: I mean Sir Edward Reed. We have our own thoughts as naval Officers, and they have a right to be heard. Not only that, but the opinions of the highest authorities and designers of ships are on our side. We have the strongest possible corroboration that we are right by the breaking up of the extreme principle which was enforced in the "Inflexible," and we have come down now to a very much more extended citadel. I think the citadel in the "Camperdown," the "Benbow," and the "Anson" is 150 feet long, while in the "Inflexible," a considerably larger ship, it was only 110 feet. We ask them to go on in the good way they have begun. We take their admission as candidly as we possibly can without exaggeration; we take the alterations they have made as a proof that our views are worthy of consideration, and that they are partly adopted by the constructors of the day. I therefore say let us have an experiment that will prove what Captain FitzGerald and others have said, but which not only has been denied officially by naval constructors, but I am sorry to say does not appear to have gone down very well with some naval Officers and some experimentalizers, whose positions I should not like to impugn, but from whom I differ very much. These experiments can be tried by our naval authorities. There is no doubt a slighter and thinner belt than that on the citadel can be extended as nearly to the ends of the ship, if not quite, as will make the area of water-line unprotected by armour-plates so small as not to be of very great moment, but at the same time I should like it to be thoroughly understood that the opinion of the Navy will be this, that you should not absolutely insist on this in exceptional cases, but for battle-ships. It may not be possible to continue the armour towards the bow of the ship of the same thickness and weight that you use at the middle and other parts, and we do not insist upon this. I do not know whether any naval architects are present, but I hope that nothing I have said has been in the least offensive to any one. That is the very last thing I should wish to do. I hope the maintenance of my opinion without the advantage of their concurrence will not offend them. Their ingenuity and skill, as I well know, are quite capable of finding the requisite remedies for the evils which I have pointed out. If they do that they will add another wreath to the laurels which they have already won in their most meritorious and hardworking profession.

Colonel HOPE, *W.C.*, Art. Vol.: I rise with great diffidence among so many distinguished naval Officers, but there are certain things in this question which necessarily occupy the attention of artillerists, and as such I have devoted a considerable amount of attention to them. I listened with very great pleasure to Captain FitzGerald's most interesting paper, and there is only one point I venture to take exception to; that is, where he expresses diffidence as a naval Officer in discussing such questions. I think on the contrary that naval Officers should speak out, and loudly, and let their opinions be known, and not allow themselves to be over-ridden by naval architects. The men who have to use the tools ought to be the best judges of what tools they want. Although I have devoted a good deal of time and attention to the endeavour to get through the greatest possible thickness of armour, I am the last man in the world to advocate the abolition of armour. I believe that as the

locomotion of a steam vessel depends on her engines and boilers, and not on sails as in the old days, it is absolutely necessary that those engines and boilers should be protected. But at the same time one error is made in all these discussions and it is this, that attention seems to be concentrated upon the endeavour to out the enemy's shot. No doubt that is very desirable, but there are two things that have to be kept out: the one is the shot; the other is the water. It is impossible, and I am afraid it is, to keep out shot all round the ship from guns of the largest calibre and penetrating power; but it may be possible, at all events partially if not wholly, to keep out the water, and this is how I would suggest it might be done. If the armour were brought in, say 4 or 5 feet into the hull, and the intervening space filled with compressed fibre of some kind rendered incombustible, that would be more or less self-blocking, it would allow the passage of the shot but tend to close up the channel left by the shot in its passage. The latest diagrams of the Italian plates, both the Brown, Cammell, and Schneider plates at Spezia, show that the most powerful guns even if they do not penetrate the plates, shatter them up completely; consequently in a rolling sea there would be a great tendency for the disintegrated pieces and even the plates to fall off. But if the armour were 4 or 5 feet inside, and the intervening space were filled with compressed fibre, the broken armour-plates could not fall off: they would still be there to stop the passage of another shot. It seems to me that another point has been forgotten in these discussions, and that is, that if a shot penetrates one side of a ship some distance above the water-line, it will probably go through the other side very much below the water-line, and that would be a very great danger indeed. The obstruction offered by the ordinary side of an unarmoured ship would not be sufficient to stop an armour-piercing shell with no fuze in it. The passage would be so very easy that the resistance offered by 1 or even 2 inches of iron would be so insignificant that the shell would not burst, and consequently it would necessarily go through the other side of the ship at a very much lower point. I think if what is called ventrue to term fibrous armour were carried right round underneath the bottom of the ship that material would have a tendency to block both holes, and also to give protection against torpedoes.

Captain COLOMB, R.N.: Sir Edward Reed rather took me back when I had the honour of speaking to his paper the other day, because he thought from my remarks I made deprecatory of going into the armour question on that occasion. That I did not agree with him; but the fact is I have not differed from most of the Officers on that point. I was in agreement with him and with them at the time. I remain so. The lecturer raises debate as to whether this is a naval or an Officer's question or not. Mr. Barnaby in his recent utterance seems to think it is not that we rather ought to busy ourselves with those questions of high statesmen, which Sir Spencer Robinson referred to so ably in his letter to the "Times." I think it is essentially a naval Officer's question. It is as much a naval Officer's question to arrange for his ships with the naval architect, as it is for the interior owner of a house to arrange with the architect what sort of a house it is that he wants to live in. But I think that this all shows a tendency which I am so sure is rather on the increase; that is to say, we get to be a good deal mixed up about what are the boundaries of proper debate for professional men. We have Mr. Barnaby and Sir William Armstrong, without a thought of incongruity, addressing themselves to questions which are really questions of naval tactics and nothing else. We had the other day an able and gallant Colonel of the Engineers speaking of the relative value of the different elements which control the power of a ship of war, without apparently thinking there was an incongruity in his taking up that line. The result I am afraid is, so far as the question before us goes, that it is getting to be supposed that construction governs tactics rather than tactics should govern construction. I hold myself firmly and strongly that the naval Officer is to say how he proposes to use the ship and the ship is to be built for that purpose, and not for any other purpose. Sir Spencer Robinson has expressed so very strongly the views that I myself hold that there is the less for me to say; but I must remark I think the whole question is one of experiment. When Sir Spencer urges us to press for experiment, he is pointing home the chief point of all. We cannot do wrong by experiment. We do

the least mind spending three or four millions on the biggest experiments going, when we will not spend 50% on finding out whether those experiments are worth trying. I ought to make one remark though it traverses a little what Sir Spencer Robinson has said. I read Mr. Barnaby's manifesto with the greatest possible pain, and with something approaching to dismay. I will say those words because I have to advert to something which he said in his paper. I say the words with sorrow, but I think they ought to be said. I do not altogether share the alarm expressed. Of course when great authorities like Sir Spencer Robinson and Sir Edward Reed express alarm as to these unarmoured ends, I accept it on their authority; but personally I cannot feel the alarm. I think that when we take up the question and use the word "alarm" we are apt to develop heat, and that the better way is to speak very calmly, and reason very carefully with good experiments, and have a very quiet and cool discussion over the matter; I do not think that Mr. Barnaby fully states the question in his address. He seems to put it as if this belt question was entirely one of destruction, whereas as far as I am able to gather it is more a question of disablement. There is the fear of loss of trim, or a heavy list, throwing your powers of offence out for a time, even if you are able to correct it by letting in more water to secure an even keel. I think there is another danger that we face in leaving the ends unarmoured, and that is, we accept the unsteady gun platform. Mr. Barnaby puts it that the inertia is sufficient to get over the difficulty of the high metacentre, but my experience of two of the most recent ships is that they will be very lively. I felt in each of these ships in a light swell, as if I were on board a Symonite, and coming from the "Thunderer," that steady old rock that nothing disturbs, it occurred to me that the fire from the guns would be very uncertain. Anyone who recalls the literature of rolling will agree that it is not a question to be left out of sight altogether. I am entirely in accord with the way the lecturer has dealt with the subject. I think he is right throughout, that the doctrine of chances should govern the armouring of your ship. I do not know that you can make any armour impervious; I never heard of any except in very small patches in a ship, and I take it a certain number of shot must enter, but my experience of heavy gun fire is that it is very uncertain. It is very much slower, and we know that the number of heavy guns carried is very much reduced; therefore I think that you will be seldom hit by heavy shot in any vital part of the ship unless you are at very close quarters. In the old wars ships were very rarely sunk; a shot between wind and water was quite a rarity, and yet you had then what you have not now, ricochet shot. You have abolished ricochet, and so, I think, you are less likely to be hit about the water-line. I made a calculation taking the best German guns at 2,000 yards, and I found if you had everything absolutely accurate, with a target 3 feet high above the water, and fired at the water-line, when the gun was accurately laid, the target would not be liable to have more than 16 per cent. of the shots hit it. The other day in the "Excellent" a target 15 feet high, at 1,400 yards distance, allowed 75 per cent. of the shot to pass either above it or below it, though the gun was fired by very careful hands indeed; so that I do not think the danger to the water-line from heavy shot is a matter to be very much feared. It may happen of course in cases that you will get a heavy shot between wind and water, but as the lecturer has said, the shot you must fear are the light shot, because of the numbers that will be fired at you. You must expect to be struck a good many times about the water-line by light shot when you need not at all expect to be struck by the heavy shot, and the doctrine of chances is that which must govern your defence. You may carry the thinner belt round the ship with an absolute certainty that you are doing the best for the ship, rather than very thick plating at one part and none at another. But there is one thing you must do, that is, carry your deck, armoured if possible, from the top of your armour across your ship fore and aft in order that shot passing above the belt may not pass out and make a hole below water on the other side.

Admiral Sir GEORGE ELLIOT: My lord, ladies, and gentlemen, I do not intend to detain you beyond the ten minutes which are allowed, and I will endeavour to say what I have got to say in five minutes. In the first place, I agree with the lecturer in his remarks with regard to the ships with central citadels and unarmoured ends, because if side armour is to be used, there is the strongest reason why it

should be continued as a belt fore and aft, and more especially that it should cease to exist at the bow. But I cannot agree with the lecturer in this one of his, "No naval Officer, I make bold to say, would have the slightest objection to be sunk by a shot from a 100-ton gun if it hit in the right place." I should have the strongest objection, and I reckon that every naval Officer would be being blown up, whether by a 100-ton gun or by a 60-ton, or a 45-ton or a 30-ton gun. If that gun should penetrate the armour and strike the boilers or masts, I say that it is a result greatly to be dreaded, and I do not think any naval Officer would like to be in a ship where he would be subject to such a peril. The main point of difference that exists between those who are in favour of side armour and those who are for deck armour. You have to look out for the safety of magazines and boilers, and the safety of your buoyancy; but I must remark that this lecture the maximum of merit is claimed for side armour, no matter how it may be, and, on the other side, the minimum of advantages is allotted to the other mode of protection. The deck alone is referred to, and all the advantages which might be applied to that deck are totally disregarded. The deck without the cells and coffer-dams, certainly is an insufficient protection; a system of deck protection, if carried out in its perfection, offers certain advantages, and I certainly still adhere to the opinion that the ship with that and cellular water-line construction would be safer going into action than a ship with a thin coating of side armour. It is impossible to discuss a question of this sort at so short a time, and therefore I will not attempt to do it. I only wish to express my opinion that I still adhere to the advantages which can be obtained from a system of deck protection if properly carried out, that is to say, supplemented by an elaborate cellular construction at the water-line.

Rear-Admiral J. C. WILSON: I will not say much to-night, for in fact all has been said, beyond that I think the paper, whatever its merits or demerits may be, commends itself to all naval Officers. It is straightforward, sensible, and clear, and it points out to the world and those who read our Journal the objection we naval Officers have to the system of shipbuilding at present in vogue. We have all been taught that the first principle of war is to attack your enemy at the vulnerable point, and therefore, supposing we attack ships with these soft ends, it would be our duty to concentrate our fire as much as possible on these vulnerable parts of the ship, and knock a hole in her as quickly as possible, all guns, large, being equally available for the purpose. Then (as Sir Spencer Robinson said) I think 750 tons, or even 420 tons of water washing about from side to side on every roll or movement of the helm may prove to be a very disagreeable shipman's experience. Sir Spencer Robinson said, what must recommend itself to all thoughtful naval men, that it is not our province, nor are we capable of discussing intricate questions of naval architecture, nor do I think naval Officers often attempt to do so, but we have our own particular notions of the machine we would prefer to fight, and those ideas I think we are bound to express, and have a perfect right to do so in this case we are not arguing upon our own opinions, but from those clearly set down and forcibly expressed in this treatise by no less an authority than Lord Edward Reed, and I think when we heard what he had to say, when we heard him distinctly express an opinion that those vessels unarmoured at the water-line were not safe, we have a perfect right to come forward and state what I believe the bulk of us think—that we concur entirely in his views, and that we have confidence in these ships. Now, it may be said, and I daresay a great number of naval architects say it, that we cannot have a belt of armour all round, because ships won't carry it. I say where is your "Dreadnought," your "Thunderer," your "Devastation?" They have a belt of armour all round, and if you take that belt of armour and replace it by composite steel, you can have a belt of armour of the same weight which will resist almost any reasonable size gun, or, at any rate as large as any we should send afloat, except possibly in some exceptionally powerful vessels. Here also we come to a point in which I agree with Captain Fitzroy. He has not pointedly said "I do not like too big guns," but he has intimated a preference for small ones, and I entirely agree with him. I think the system of putting 100-ton guns into your ship with a very few small ones is a mistake, however powerful your guns and your armour, or however strong your ship.

cannot make steel men, and the whole fighting power of a ship is thus concentrated in one or two men. If these men happen to be a little nervous, where is your ship? I should like to see the fighting power distributed about the ship as far as possible. I do not think I shall say more on this subject, but we have got now some very good types of vessels in the Service, and it is a great pity if we do not perpetuate them.

Admiral BOYS: My lord, ladies, and gentlemen, I will not occupy my ten minutes, but there are one or two remarks I should like to make—some in corroboration of what has been said, and in some, perhaps, I may hit on a weak point or two in the lecture. The subject of the paper is "*Side Armour versus Armour Decks*." My impression always has been, and I do not think I am singular in it, that armour decks are simply a substitute for side armour—that armoured decks were resorted to because side armour could not be carried in ships in which other conditions were considered necessary, therefore it was simply a substitute and not in preference. Whether that substitute is a good one or not is now being discussed. There is one point I should like to touch upon which Captain Colomb referred to, and that is the doctrine of chances in reference to hitting a ship at the water-line. We have never had any definite experiments in that line. Some years ago, when I was gunnery Officer in the flag-ship on the coast of Africa, I had an opportunity of firing at the water-line of an empty slaver which we had captured and were ordered to sink. She was anchored at 100 yards from the ship. There was a moderate swell on. Our broadside consisted of two 10-inch and two 68-pr. S.B. guns. One whole quarter's allowance of ammunition was fired at her without being able to get a single shot in at the water-line on account of the ricochet. One or two entered 2 or 3 feet above it, through which some water occasionally lapped in, but we could not sink her with shot and shell. We had to place a bag of powder at the water-line inside, and ignite it with the "Bickford fuze," which had then been newly introduced into the Navy.

Captain FITZGERALD: Was it an iron or a wooden ship?

Admiral BOYS: It was a wooden ship.

Captain FITZGERALD: Had you any machine-guns?

Admiral BOYS: We had no machine-guns. That does not bear on the doctrine of chances, but my experiment shows the difficulty of hitting a ship immediately on the water-line. On the other hand, there is the instance of the "*Alabama*" and "*Kearsage*," where the "*Kearsage*" did place a shell exactly where it was wanted, but if the "*Alabama*" had been constructed with the arrangements of a modern man-of-war she would probably not have sunk, because her compartments and pumping power would have kept her afloat. Then, the main point in Captain FitzGerald's argument is that large ships with unarmoured ends are to be disabled and probably sunk by the fire of light and machine-guns. I do not agree with him on that point, for I think that although numerous small holes may possibly be made near the water-line of vessels like the "*Italia*" if fighting the "*Hercules*," that the slight damage that would be done inside of them would not admit that large quantity of water which is necessary to affect the stability of the ship, therefore I think his argument there is not quite sound. But, on the other hand, if it were possible to make tremendous holes with large projectiles and blow away the contrivances inside (which I should), it becomes a question for constructors to say how far the stability of the ship is affected by the introduction of the immense amount of water mentioned by Sir S. Robinson. There is one other remark I should like to make. Captain FitzGerald says, "I am informed by an experienced gunnery Officer that the 100-ton gun cannot be expected to fire more than one round in a quarter of an hour or twenty minutes." I do not think that can be taken for gospel in any way. I maintain that with proper arrangements and drill, and everything in good order, as it is supposed to and can be, certainly not more than five minutes should be taken to fire one round. I take this opportunity of expressing my dissent from the plan which I hear is to be adopted of putting two 100-ton guns in one turret, tying them together as it were, thus taking probably half the value away from both. I would certainly advocate the necessity of any reasonable amount of money being expended on experiments in order to arrive at something conclusive on the subject of the able paper we have just heard.

Lieutenant TUPPER: My lord, ladies, and gentlemen, as Captain FitzGerald has done me the honour of asking me to give my opinion on his excellent paper, you will not think it presumptuous, owing to my junior position in the if I give it. In the first place, in spite of Mr. Barnaby's expressed opinion the contrary, I have often discussed with Officers of about my own standpoint question, and long before the introduction of machine-guns we looked with distrust upon the modern construction. With the introduction of machine and the quick firing 6-pr. our views have been much strengthened, therefore very glad to see that even Mr. Barnaby seems to be coming round to our case in suggesting an armour-belt for the "Agamemnon." Sir Spencer R in his remarks on the loss of buoyancy of ships did not mention the "Conqueror" which was mentioned in Mr. Barnaby's table. The "Conqueror" is a new ram. She is armoured all round, excepting just at the stern. She, with under stern perforated, only loses 32 tons of buoyancy, and as this puts her down stern at any rate, it would not diminish the steering power, and might increase it, e.g., the "Agamemnon." Captain FitzGerald advocates that we at once alter the existing type of ships by placing an armour-belt round the hull, have now got something like seven of these ships very nearly ready for the sea, and he says "let us put on the armour-belts at once at any cost." I have to differ from him; we have at least these ships ready now, and very many more ships. If we put the ships into dockyard hands to have this done, they will be laid up there for eighteen months or more I should say, and will therefore be of no use to us if any complications should suddenly arise, whereas if we go to sea we can at least hope they will give a good account of themselves before they sink, and if they do not sink all the more honour to those who command them. I have always looked upon the "Dreadnought" as the best type of battle-ship. The "Thunderer," "Devastation," and "Dreadnought" have seemed to me splendid ships. They are most formidable ships all round except at the stern, although they were built so long ago as twelve years. As regards the masts fired at close quarters, I think it has the great advantage that the man who can alter its direction and elevation in a second as he is firing. He is able to see pretty well where his shot are going, and so he can alter the elevation at once to make hits. If we put an armour-belt round the ships, we must do away with some of the other weights. Captain FitzGerald advocates away with the horizontal armoured deck. I agree entirely with his remark at that point, but I think that thicker horizontal armour should be put on the vitals, such as the boilers and magazines, than is the practice at present. I think, with Colonel Hope, that there is much danger of the shot of machine going through the armoured deck and out through the bottom of the ship, you have several decks for it to go through at any rate as well as the bottom. I would also say we might get rid of some of the weight by doing away with fore and aft bulkheads. Excepting in the engine and boiler rooms we see much use in them, because with a fore and aft bulkhead, supposing two compartments penetrated say on the starboard side, you would at once list to starboard, which in a turret ship would probably put the guns out of action on that side, and therefore the Captain would at once want to admit water on the port side diagonally opposite to right her. It is quite possible that the ship knew how to admit this water could not be found, and therefore without manœuvring power and gun power the ship is at the mercy of the enemy. The primary object is to keep the ship on an even keel in order that she will, well, and longitudinal bulkheads seem to make the chances of heeling great, would, therefore, do away with longitudinal bulkheads except for the engine and boiler rooms, and if possible put more transverse bulkheads in so that the ship would be kept on an even keel. I will summarize my remarks by giving you a list of what I should like to see as a battle-ship. The citadel should have the armour they could put on it, and this citadel should be a regular sort of citadel containing magazines, engines, boilers, and steering arrangements, its top being with 5 or 6-inch horizontal armour. The ends should be armoured with 4 to 6 inches of steel if you could manage to put it on; all the deck should be of about 1-inch steel, and the decks should all be fitted with horizontal

tight doors. The guns should be mounted in two turrets in the fore and aft line, perhaps only one in each turret, and the bases of the turrets protected by circular towers rising from the citadel, the top of which need only be about 4 feet above the water-line. Between the towers you should have your secondary battery of 6-inch guns, as many as possible, which is a very important thing, and which is to be unprotected by armour, instead of which you should have steel shields on your guns, and have as many transverse bulkheads as you can in your secondary battery to keep the splinters from flying about the deck as much as possible, and you should have all the fighting arrangements and telegraphs of the ship in one impregnable position, inside which the Captain stands, having a good all-round view, and communications, protected by armour, to all parts of the ship. The ship is to be as small as compatible with these requirements, as I consider two ships, each carrying two of the heaviest guns, vastly superior to one ship carrying four of the heaviest guns, and the smaller she is, the less chance she has of being destroyed by gun, ram, or torpedo.

Sir EDWARD REED: Lord Clanwilliam and gentlemen, I had not any idea, on entering this room, of speaking to the paper, because I thought it much better that naval Officers should express their opinions on this subject, for I regard this meeting as one of the most important I have ever attended, because it has been opened by a very thoughtful and carefully written paper by a naval Officer, on questions on which it is of immense importance for the naval architect to know the naval Officer's views. I am bound to say I believe the naval constructor is made a great deal too much of in these debates. I agree with Captain Colomb when he says that it is the duty of the naval constructor to design the ship which the naval Officer requires. Now there is not the shadow of a doubt in anybody's mind that the Admiralty staff as it has been constituted for many years past is perfectly capable of designing any ship whatever which the naval Officer wants, and therefore if wrong ships get introduced into the Navy it can only be because the naval Officers, of whom there are many within the Admiralty, seem to fall short of their duty, and give too much scope to the naval constructor in turning his office into a place for inventing ships of his own, instead of for building the ships the Navy requires. Lieutenant Tupper in the interesting remarks which he has just made, in setting forth to design his own vessel started with what, if I may be allowed to say so, I regard as the fundamental error which all persons fall into when they start to design a ship-of-war. He said he would make the ship as small as possible; but what you want in your ship is what should determine the size of the ship. You cannot start by saying you will have the smallest ship you can get, and then go to work and put the utmost protection possible upon it. What sort of system is that—to start with a very small ship, and try to put into that all you require? I lay down the very contrary proposition, and regard as lying at the very basis of this whole question the fact that the country has not been under the necessity of defining the size of any ship by any other consideration than the qualities which it is necessary to give to it. I think I shall be borne out by many naval Officers in saying that putting pounds, shillings, and pence aside, there is no particular advantage in small ships. Some of the largest ships we have are some of the handiest, and in every way fit to fight the country's battles. But the real fact is that you start with the idea of spending as little as possible on the ship, and then you get into some miserable alterations into which Captain FitzGerald has been driven, namely, how are we to get the weight we want to put on the first class battle-ships,—how are we to get enough armour even to keep out the shot of machine-guns? The whole state of things is preposterous. Nobody ever need have first defined the size of the "Ajax" or "Agamemnon" and then have said, "Even if we cannot protect the ship against machine-guns without making her a bit larger, we will not do it, but will rather expose her to destruction by these machine-guns." The next thing I want to say is this: that in so far as any danger to these ships is concerned, the introduction of machine-guns has nothing whatever to do with the question, because everyone must have known what I often pointed out, viz., that when the designer produced a first class ship for the British Navy which a small gun fired quickly could destroy, he would assuredly have that ship destroyed by small guns fired quickly. The invention of the gun is the result of the invitation which has

been held out to our enemies. Allow me to explain in a word or two how this whole matter has arisen, and where we really stand. I do this the more readily because I shall bring into view in a word or two the differences of opinion which prevail between some distinguished naval Officers and myself. There is at the present moment a correspondence going on in the "Times" on the question. Supposing we take Fig. 1 to be the water plane of a ship; supposing she is a fine-lined vessel

FIG. 1.

intended for great speed. I am very strongly of opinion that there is no necessity to carry the armour out to the ends at A and you might well form your armour in the way shown at B and leave the ends without armour to something like that extent. Captain Colomb has very properly pointed out that there are two things involved in this question, first, the element of danger, and secondly, the element of disablement. Now as regards the element of disablement, it is clearly a question which the naval architect has nothing to do with, and about which he cannot know very much, unless he consults with naval Officers and finds out, he cannot be a good judge of how far it is safe to bring this armour away from the bow of the vessel. A naval architect will tell you perfectly well how much water you will let in when the ends are injured, but only the naval Officer can tell how the ship will behave under the conditions of letting different quantities of water into her. Up to this time, although I have been so much concerned in this controversy, I have never anywhere expressed an opinion as to how far you could bring that armour away from the bow, and still avert everything like speedy disablement. What the Admiralty did was to go to a most extraordinary extent of contraction all at once. That is the question which has been before the country for years, and has caused me the greatest pain and anxiety of my life. I initiated the question at the Admiralty as to how far it was possible to contract the armoured part of the ship and still leave its citadel big enough to possess sufficient stability to keep the whole ship upright. While I was discussing that question and making preliminary investigations about it, I left the Admiralty; but when I had clearly made up my mind that there was a limit beyond which it was not possible for any one not absolutely out of his mind to think of going, on the other hand the question remained to be determined by careful investigation and consideration, how far can you go between that limit and the other limit of a complete belt, still retaining not only safety but reasonable precautions against disablement? That is the course which I should myself have taken had I carried the system out. But what did the Admiralty do? Instead of dealing guardedly with that problem, beginning by shortening and gradually approaching to what I regard as the element of danger, only always taking care to keep a long way from it, they made a clear sweep of the bow and stern armour, and armour-plated one-third only of the ship, as shown in Fig. 2; and filled up the rest partly with cells, and coffer-dams, stores, coal, and other things. With all deference to Lieutenant Tupper, Colonel Hope was perfectly correct in saying that in these ships, where so many guns are capable of penetrating the unarmoured ends of the ship, they will be attacked by depressed fire, and the shots will go out of the ship on the opposite side of her and below the water. Then this question arose—and this was the whole of the "Inflexible" controversy so far as I was concerned: I said "There is not even enough of that ship armoured to keep her upright as regards stability when these ends are riddled." Then the answer was, "Oh, but there are coffer-dams, and cells." But I

FIG. 2.

say that any shell from the smallest gun that then existed, as also from the smallest gun that now exists, will penetrate the cells and coffer-dams; and I ask Officers to remember that there is no power in any cell or coffer-dam made of thin steel to keep out any shell whatever. They are capable of being perfectly riddled, and when Admiral Boys speaks about water not readily flowing in, upon my honour I am at a loss to understand why a number of small holes will not let in as much as a single larger one, and how any hole will not let water in until it is stopped. It is absolutely absurd to suppose that under the conditions of closely contested naval actions you will be able to send men out of the armoured citadel into the unprotected parts, to stop all these little holes. It is entirely preposterous. Thence arose the controversy. Now what I say is, it was never right—no reasoning, no arguments, can ever have made it right for one single moment—to build first-class ships with citadels which were in themselves insufficient to keep the ship upright, and afloat. That proposition I lay down with confidence. But if built, it was certainly not right to call them first class British ironclads, and send British Officers and men into the line of battle to fight in them. That is the only thing I have ever contended for in public—that the British Navy should not be condemned to go to sea and into battle in ships with so much armour denied them as to leave the citadels too small to keep them upright. I think there is a great deal of truth in Captain FitzGerald's paper, all through it, but I do think that even now the danger of capsizing is not understood. I believe it is not understood in the Italian Marine. I believe that no man in his senses would ever have designed such a ship as the "Italia" if he had fully realized the danger of the ship capsizing when but little injured. Now Admiral Sir George Elliot said just now that he stood by his view about the armoured deck. I want to make a remark about even such a deck as Captain FitzGerald sketched on the board; because an element of danger creeps in there which naval Officers would not recognize so readily as a naval architect. Captain FitzGerald drew a vessel of the kind shown in Fig. 3 with an armoured

FIG. 3.

deck of the sort shown, and I believe it is that kind of deck that Sir George Elliot intended to favour. Roughly speaking, as is well known to many here, we may say the stability of the ship varies with the cube of the half breadth of the ship. Now supposing the ship is 60 feet broad, and only 50 feet broad where the water plane cuts the sloping deck; that is a difference in breadth of 5 feet on each side. Now what is the half of 50? 25, and the cube of 25 is 15,625. What is the half of 60? 30, and the cube of 30 is 27,000. Now observe what has happened. By letting the sea in, and thus reducing the virtual breadth from 60 feet to 50 feet,

you have reduced the stability from 27,000 to 15,625; that is, you have only half the original stability left. I believe persons who advocate the letting the ship above these armoured decks do not realize the effect upon the stability of the ship. Now I am weak-minded enough to care a great deal about stability. I agree with Captain Colomb about disablement, but I do think the preposterous thing in the world is to build ships with a great deal of armour devoted to the protection of their boilers and their guns, and then to leave the themselves at the mercy of any gun whatever to turn them bottom up. Can madness go further than that? Sir Spencer Robinson referred to extensions of the citadel which have been made in more recent ships of the Admiral class, and I wish to call attention to a matter connected with that. It is quite true that in recent ships the citadel has been somewhat extended in length, but it has been lowered a great deal in height, and the fact is, if you take one of the Admiral ships and put her afloat in front of you, and give her a list (and at a loss to know how you are by any contrivances to prevent her listing or injured) of 5 or 6 degrees towards you, all the armour will disappear from your view; so little armour is allowed. I do not at this moment complain of that, but I am only endeavouring here to state the issues that have been and are at stake in this question. Now in answer to that it may be said that just as it is true that the ends of a great many devices have been resorted to for the purpose of keeping the water out, so a great many devices have been resorted to above the armoured citadel of the Admiral class for the same purpose; but there we come to another question which naval Officers only can answer. Will the naval Officers here say it is quite clear in the course of this debate whether they think that mere subdivision of the citadel, the dividing of the unarmoured part exposed above the armour protection into thin armoured cells, is sufficient to keep the water out, or whether shot or shell will not riddle them and render them useless? Of course I know watertight chambers and cells are excellent devices to apply to a ship below the armour, and also when you have imposed upon you the sad necessity of keeping down the armour to the lowest possible point. But what is the object of that? How is it that we cannot give our ships more armour when they require it? No other circumstances than naval weakness, want of courage, want of determination to keep this country in its proper position have driven us to this necessity. Nothing has happened to us yet—Heaven knows what may happen—to make us incapable of building the ship we want, and if 10 feet deep of armour will make a ship safe we must have 10 feet and not 5 feet only. I am not speaking of second class ships, but of the armoured line-of-battle-ships of England, which are to seek out and not to run away from the enemy. It is against the genius of the country and of the naval profession that they should run away. We must seek the enemy, and close with him; and I say it is a wrong, I would even say in my opinion it is a shameful thing, to withhold from such ships the necessary amount of armour. If we correct any error on this point, for Heaven's sake I make it on the right side, and put a little too much rather than too little armour upon our first class ships.

Lieutenant TUPPER: I only meant by a small ship that it is better to have ships carrying two guns each than one with four guns. That is the principle, in my remarks about the penetration through the deck I was alluding to plunging fire of machine-guns.

Admiral SELWYN: My lord and gentlemen, I wish to attack the subject of paper directly in this matter. Captain FitzGerald has given us apparently a choice between two things, to both of which he assigns a certain value, side armour and under-water deck armour. I do not think there is any Officer in the Navy who would not be delighted to have both, and I only rise to say there is no other reason whatever except prejudice why both should not be employed. The only obstacle to be overcome is the addition to the weights, for we cannot consider the question of the expense when talking of the safety of vessels that have cost millions of money. The question of the weight is the whole question. Is it possible or is it not to have engines which weigh 112 lbs. per indicated H.P., instead of engines which weigh 308 lbs. per indicated H.P. I say that has been proved to my own knowledge during the last 10 or 12 years. We can have engines weighing per H.P. at

one-third what they actually weigh in the best compound engines. Again, we can have armour properly made of which 9 inches will suffice to keep out any shot that will ever be used on board ship; but we have not sufficiently devoted our time to making experiments on these subjects, therefore we are still arguing over the disposition of a few tons of armour that we think ourselves able to carry. What we ought to do so is to push forward with great attention all these economies which have reference to weights. If a compound engine has given us more power and less weight than we had formerly, a still further advance in the same direction has been proved possible under our own eyes, which will give us what I speak of. If you calculate 5,000 indicated H.P. at 308 lbs. per H.P. and reduce it 200 lbs. on each H.P., you will see what a considerable weight you have saved. If you go a little further and calculate the economy of fuel which may be made in these engines, if you see that these new engines can do and have done for years with 1 lb. of fuel per H.P. instead of two, then you have another economy of weight which you may dispose of as you please. These things should be made the subject of steady experiments, not on the scale of 12 inches to the foot, for that is a sort of experiment which I totally despise, and not experiments which are going to cost a great deal of money, although I consider any such money so spent would be wisely spent. At the root of all this difficulty is to be found a false maxim of political economy, which tells us that the expenditure of money within the country is to be avoided by all means, and to be taken credit for if economized by either party in power. This is the root of the whole question. Once persuade the Cabinet that no expenditure within the country is unwise which produces good effect in supplying accurate knowledge, and then you will find each party taking credit for having spent more in this way than their predecessors. When that is done we shall get results which until then we cannot hope for. Then we can have under-water deck and increased armour in every direction, and there is no earthly reason why we should not, except what I have pointed out.

Mr. W. H. WHITE (late Chief Constructor R.N.): My lord, ladies, and gentlemen, I stand here as the professed friend of the Admiral class as they are being built. I say that at the outset, and I do not pretend to be able, in the time at my disposal, to justify the opinions I shall express; but I repeat what I said here in the debate on Sir Edward Reed's paper the other day, namely, that it would be difficult if the ships had to be designed over again, within the same limits of cost, to produce a better combination of speed, armament, and defence than is to be found in those vessels. I would like to add that I do not now challenge Sir Edward Reed's main position, that for this country it may be desirable to put aside questions of cost. I only say that the naval architects at the Admiralty invariably have that condition of limited outlay put in the forefront in carrying on their work. As one who until recently was at the Admiralty, who has undoubtedly to bear a considerable share of responsibility for the designing of the Admiral class, I would like to say, on behalf of my former colleagues, that I am sure none of them shrink in the least from criticism of those designs, they believe them to be honestly good ships within the limits in which they were compelled to work. Then it must be remembered that the naval architects in the Admiralty are not such despotic people as seems to be supposed from some of the remarks made here to-day. Of course that has been put right by other speeches. The facts are that the constructive staff in the Admiralty are always working under the direction of the Board of Admiralty, a majority of which Board consists of naval Officers. At the time of the designing of the Admiral class a number of alternative propositions were considered and put before the Board, of which Lord Clanwilliam was then a distinguished member, and the Board having before them a full statement of what could be done within the limits of cost, selected this design for a barbette ship as the best which could then be had. It may be true to some extent that the conditions are varied by the subsequent introduction of machine-guns and rapid firing guns. My own opinion is entirely in accord with that of Sir Edward Reed, that the development of such guns has grown largely out of the shrinkage of the armour. But that has gone on everywhere; it is not confined to our ships. It is perfectly true that in our ships the ends have been left unarmoured for a certain shallow depth below water.

It is true that in the French ships the belts are carried from end to end; but what seems to be sometimes forgotten, and what, so far as I am able to judge, is almost entirely omitted in the paper, is that armour has been shrinking in its vertical extension as well as in its longitudinal. In some of the French ships the armour is only 2 feet above the normal draught. What about keeping the small shot or shell out of the parts of the ships immediately above the belt? Do not let us, while paying such special attention to the longitudinal extension of the armour, forget to admit that there has been a vertical shrinkage. If you admit the principle that armour should be used to protect stability, which is the principle Sir Edward Reed maintains, and which he has a perfect right to maintain, but which I do not accept, and which is not universally admitted, then I say this vertical shrinkage of the armour is a much more serious matter than the longitudinal diminution of its extent. I have no time to argue that matter out now. I let the statement stand, and at a proper time and place I shall be quite prepared to justify it. But take the facts as they are. Here is the water-line [drawing]; here the protective deck; here is the armour; here is the upper deck; and here ordinarily in a detached battery stand the guns, whether in turrets or barbettes. Whether the belt goes to the end or not you have all the volume of the ship situated above the belt and below the uppermost deck, into which shells from the lightest guns can pass. I think that is a very important fact, and I say as regards the "range" of stability, the French ships are practically no better off than ours, notwithstanding their longer belts of armour. I myself made the calculations for the Admiral class, and should be prepared at any time to produce them, and I should hope that after the discussion that has taken place to-day, there will be some proper investigation, and an authoritative statement, which shall show that these ships are not such cripples as we are asked to believe they are. These ships of the Admiral class have "initial stability," supposing the whole of their ends to be thrown open to the sea and waterlogged. As regards the use of armour to protect the ship against upsetting, which is the great point Sir Edward Reed laid stress upon, I say the belt from end to end is not an important factor in the problem. As regards the stiffness of ships of the Admiral class, I say the armoured citadel has in itself sufficient exclusion of water to give them that stiffness. In reply to Sir Spencer Robinson's remarks about a gradual improvement in grace on the part of the constructors, I may say that the lengths of the belts in the various ships were determined by the lengths requisite to protect the machinery, boilers, and communications from the magazine to the guns, the growth in length arose from changes in these conditions, and not from a desire to protect a greater percentage of the water-line area.

Sir SPENCER ROBINSON: You do not object to the growth?

Mr. WHITE: I only say it was not a question of stability or sinkage, but of length required to protect communications. There are so many points to refer to, and it is getting late, but what I want us to be clear about is, I would not for the world have it thought that an expenditure of something like four or five millions has been incurred with our eyes shut to the dangers and possible risks which ships of this class may run. No ships can fight without running risks, and I say the balance of risk in the Admiral class is a good one. That is my opinion, and it was the opinion of the Boards of Admiralty which ordered these ships, and the ships were accepted after one of the most careful and extended discussions by the full Board I have ever known. With all respect for the great body of naval Officers, I think it may well be doubted if with equal numbers you could at any given time obtain any Committee better fitted to discuss questions of this kind than is to be found in a Board of Admiralty. The question of the use of armour seems to me to be at the root of the whole matter, and the sooner we get this question investigated by a competent body, naval architects will be able to proceed with more certainty. Is armour to be used to protect buoyancy, stability, and trim, or to protect the vitals from shell fire? The sooner these questions are answered the sooner will it be an easier task for the naval architect to proceed with his work than he has had for many years.

The CHAIRMAN: I only want to say a very few words. Mr. White has just remarked that these vessels were built by the Board of Admiralty. Of course there were no machine-guns in those days, and I very much doubt if the Board of

Admiralty would have passed such a vessel if they had known it could be turned into a pepper castor in a very short time. Supposing we are on the enemy's coast blockading a port, and are attacked by gunboats. The fore end of the ship is riddled by the gunboats; it is filled with water; it is that part of the ship in which the crew live; then the other end of the ship has to be filled with water to keep her on an even keel. Then she draws very much more water, becomes very unhandy, very difficult to manœuvre, and totally unfit to keep the sea as a British man-of-war.

Captain C. C. FITZGERALD, R.N., in reply, said: I will begin at the end if I may. Mr. White, the great champion of the citadel ships, has given us his opinion, and I must say I am a little disappointed that something more has not been said in favour of them than Mr. White has been able to say. I do not profess to be a naval architect, but I will point out one or two things in Mr. White's statement. He says it is a question of money. No doubt of it. That is entirely correct. He says that a fair proportion of risks have been overcome, that he has struck a good balance between the different requirements, and that if he had to design the ships over again he could not do better.

Mr. WHITE: Under the same given conditions and cost.

Captain FITZGERALD: Then he points to the shrinkage of armour on all ships. The point I take particular exception to is his comparison with the French ships. He has drawn only a section of the ship here. A French ship has a complete belt of armour. I am not entering into the question of the thickness, though I believe they have armour almost as thick as we have. He says it has shrunk vertically in the French ships, and that it is no higher in the French ships than in ours.

Mr. WHITE: Lower in some cases.

Captain FITZGERALD: There appears to be just this difference. If I stick to my citadel, and then make the other part armoured deck only [drawing on black board]. But in the French ship, completely belted, the top of the armour is covered by an armour-plated deck, so that the space below the deck is as safe as in the other ship. And although she may be wanting in stability under sail, the buoyancy represented by what is covered by armour and armoured deck is greater than is necessary to float the ship. There is a reserve of 2 feet, which represents about 1,000 tons. In the English ship, however, you take away that and let in some 500 tons of water. That is in her best state, with her coals and stores in; and I maintain that that is a misleading statement, as her condition will be worse under some other circumstances.

Mr. WHITE: May I at once explain, because I am sure Captain FitzGerald would like to be put right. I believe Mr. Barnaby's figures represent the ship as she would be if starting from her loaded draught and water were admitted. If the coals and stores were out, of course the ship would start with a lighter draught before the water was admitted, and therefore the water which can be admitted from the water-line down to the deck will be much smaller than in the other case. I think Sir Edward Reed will admit that the worse condition is water falling in.¹

Captain FITZGERALD: It is not really the point. 500 tons of loose water would be admitted into the "Collingwood" with her ends riddled. Mr. White then led us to suppose she would be in an equally good condition with the French ship. 500 tons of loose water! Does any one suppose the ship is going to remain upright with it? Surely that water alone will double or quadruple any list she may acquire even in turning. She cannot be compared to the French ship for safety. The French ship has got floating power enough to keep her upright and intact as she is, while the English ship has 500 tons of water in her. Why a little list must be enormously increased, and the smallest shot hitting her unarmoured ends can put her in this condition. I do not know whether there can be any answer given to that. Mr. White has made a very able defence of the citadel ships, and there can be no doubt the whole gist of my lecture was an attack upon them. I want to put

¹ Pressure of time prevented me from stating that instead of twenty minutes being the interval required for loading and firing a 100-ton gun as supposed by Captain FitzGerald, about four to five minutes are sufficient.

together a few points which I think may have some weight in the matter as sh that not only naval Officers, but architects themselves, do not appear to be per satisfied with these citadel ships. I have here the Report of the "Inflex Committee. I need not recapitulate what Sir Edward Reed says here. It i clear, and he points out that he has the gravest doubts about these ships. is a large mass of evidence, but after they have summed up and said that ships under all probable circumstances of battle will be safe, they point out t three things which throw a grave doubt on their conclusion; and I suppose if I a lawyer I should apply for a writ of error on the ground that the verdict contrary to the evidence. It really is as plain as that. You are told that you not run your guns out on the same side, and you must be very careful how yo your helm over for fear of upsetting the ship!

Mr. WHITE: The Admiral class were not designed at that date.

Captain FITZGERALD: It is only a modification of the other, and the Ad class are almost as bad as the "Inflexible" class, because if the ship abo armoured deck is full of water, the list will be sufficient to bring the armour o citadel under water. I do not question but that they are an improvement. ought to be, of course. There is another question which has not been broug now, but it is a very serious one, that is, the longitudinal stability of these What I mean by longitudinal stability is that they tip under these condition the "Inflexible" received in her unarmoured bow near the water-line half-a-shot-holes of the shape of a scoop—the shape that might reasonably be sup to be caused by ordinary gun-fire—she would go down by the head entire have to stop her engine. She absolutely tips to that extent that at a speed of knots, if she has one or two holes in her, she must stop or sink. That seems a point somewhat lost sight of. Very exhaustive experiments were carried c Mr. Froude at Torquay, and I cannot imagine that the ship itself could s worse condition than was shown in the model, so that they are very dist wanting in lateral stability and longitudinal stability. Another point about ships is this. We are told that one element of safety in them is that loose on deck checks rolling and extinguishes it, and the Chief Constructor did r honour to describe to me an experiment made in the "Inflexible." He went Gibraltar in the "Inflexible," and let in 70 tons of water, and he says you not have known it was there if you had not been told. But it has the rema effect of extinguishing the rolling, and they say she will keep upright becau will not roll. That seems to be based on a very minor experiment. I cannot see what 70 tons of water has to do with 500 or 600. It seems to have no re or connection. It is just the same as if a doctor ordered a patient to take a of strychnine or arsenic; it might have a very good effect, but that is no why ten times that amount would not kill the man.

Mr. WHITE: If Captain FitzGerald will read through the "Inflexible" R he will find appended there the details of an experiment where the full quanl water that could come in in the model did come in.

Captain FITZGERALD: I have seen the model, and it conveys nothing mind. In the first place, it is not a correct model. I do not dispute th centre of gravity is in the place where it ought to be, but they have lower top weights and brought up the bottom ones to get it there, and the mode not represent dynamical stability, only statical.

Mr. WHITE: I am not speaking of the Admiralty model, but of the me the Committee.

Captain FITZGERALD: It has nothing to do with the behaviour of the s sea with 700 tons of loose water on the deck, and naval Officers will ne satisfied until it has been proved. I cannot read private letters or mention, but I have a letter from a Chief Constructor in one of our principal dockys which he says, "I wish I could assure you that this ship (naming one Admiral class) was perfectly safe under all circumstances when the bottom w pierced, but I cannot go quite so far as that; in certain remote continger should quake for her; but I do say that there must be a combination of unt events, which are very improbable, before the ship would be dangerously ur Now, that combination of untoward events is just what naval Officers thin

occur, and that naval architects have made up their minds will not occur. Another point is the fact that the Chief Constructor in his manifesto absolutely proposes to put 2-inch armour on to the unarmoured ends of our battle-ships by leaving out one-third of the ammunition. To me that was a startling concession. Either those ships do not require that armour or else they do. If they are safe without it, why is the proposal made? May not we assume that the very man who designed them has doubts about them? I cannot help thinking that that is one of the strongest points against them ever put before the public. Supposing the naval architects could prove to us by most elaborate figures that these ships were perfectly safe, I still think naval Officers would have something to say upon their merits. They would say, "It is an untried machine; you put this invention before us, you tell us to take the ship to sea and into action, and here is a printed paper of what we are to do when our ends are riddled." "Fill all compartments of after deck aft except coal space." This is an official memorandum of the "Agamemnon" and "Ajax." "Fill all compartments," &c.

[Captain FitzGerald here read the printed instructions as to the amount of water which was to be voluntarily admitted into the "Agamemnon" and "Ajax," in order to restore their trim in case one end was riddled by shot, and not the other.]

To tell a Captain with his ship half sunk to let in more water! I really thought it was the duty of the enemy to sink our ships. It seems to me you are going to help him. Mr. White laughs, but it is no laughing matter. I do not think any Captain would let in more water when he thought his ship was sinking, but he would do his best to keep it out. It really seems to me that these devices are not practicable; they are certainly unproved. It presents itself to my mind somewhat as if somebody told me he had invented a brand-new flying machine by which I could fly to Cherbourg and come back in time for dinner. He might prove it was strong enough. He might say, "This wing is made of Bessemer steel, and this one of whalebone, and so on," and tell me that all I had to do was to turn a tap and cock my tail when I wanted to come down, but my remark would be, "Go and try it yourself." There is only one other point. One thing they claim for these ships is that they have concentrated the armour; because they cannot keep the shot out altogether from the whole part of the ship they make this certain part impregnable, but really their argument is cut from under them; because the 16-inch armour is not impregnable—it can be pierced, as Mr. Barnaby himself tells us, the Spezzia target over 2 feet thick by the heavy guns of our enemies, so that they have not made any part impregnable. So far from having struck the best conditions, I venture to think, with all respect to them, that they are quite at fault. They have not done what they intended to do in keeping one part impregnable, and they have left the ends, as Sir Edward Reed said, so little protected as to endanger the safety of the whole ship.

The CHAIRMAN: I think you will all join me in thanking Captain FitzGerald for this opportunity we have had of discussing the subject. I am only sorry it has been so short.