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Monday, March 18th, 1861.

Captain E. G. FISHBOURNE, R.N. C.B. in the Chair.

IRON-CASED SHIPS—*continued.*

“SINOOM” EXPERIMENTS OF 1849, 1850, 1851—SPHERICAL SHOT AND SHELL.

By Captain E. PELLEW HALSTED, R.N.

In the searching examinations which took place before the Estimates Committee of 1848, much evidence and many opinions were elicited on the moot subject of iron and wood. The experience of the Captains of the “Nemesis” and “Guadaloupe” were there given in several important details with great minuteness, and there the state of the “Ruby” when fired at, was divulged. Several valuable and favourable views of the prospects and properties of iron were also put forth by other able and experienced parties, the relative weight of whose opinions may be easily examined by aid of the admirable Index to the voluminous Report of the Committee. Of course, all favourable views were elicited by the examinations of the late tenants of political Power, while the then holders of it seem to have met this mode of warfare by steadfast allegiance to the results of the “Ruby,” generally referred to under the term of “The Portsmouth experiments.”

In 1849, however, are to be traced the circumstances which led to the next open revival of the struggle, and produced those further and more rational experiments which furnished the condemnation of the use of iron for ships of war as it stands to the present day.

In every Mail contract the vessels to be employed are required to be so constructed as may enable them in time of emergency to be taken for the public Service; and as several of the Steam Companies holding these contracts, and especially the one which still ranks as the giant of the race, had largely adopted the use of iron, and all were steadily increasing the number of such vessels, it seems to have occurred to the anti-iron champions that the victory so gallantly won in front, might be compromised or even lost by this liability to attack by a flank movement, to prevent all chance of which it was resolved to carry the war beyond the sphere of the Fleet Royal and expurgate the foe from its position in that of the Merchant. Accordingly a Committee was appointed under competent authority, which duly came to the unanimous verdict that the terms of the contracts had not been observed by the Mail Companies in respect to the adaptation of their vessels of iron for the

purposes of war; and this verdict was brought into direct application by means of a further Select Committee, appointed by the Legislature in the beginning of the above-named year. The subject thus specially submitted for inquiry was the desirableness of fitting the entire merchant Steam Fleet so as to enable it to be employed as auxiliary to the Navy in protecting the home coasts in case of hostilities; in remuneration for the maintenance of which fitments, certain privileges or payments were to be assigned in respect to each vessel fitted, and the exclusion from these privileges of all vessels of iron was felt to be little less than a tax against the use of that material, and pressed all the more sorely on both the builders and owners of such vessels, as proof of the many advantages they possessed over those of wood was just at that time becoming daily manifest, especially in regard to strength of structure where a constant high postal speed had been contracted for. It was before this Committee that an acknowledgement was forced that the "Ruby" had indeed been a "vessel very slightly built;" and, notwithstanding the sentence which had been passed against iron,—“That no vessel of that material intended for real war had yet been subjected by experiment to any proof of shot whatever;”—the very argument used against the introducers of iron at the time of its condemnation, and which, if not practically refuted, seemed likely to be employed as a formidable weapon against those who had produced it. Thus seems to have originated the next, and the last, extensive series of shot experiments against the material for ships of iron, which began in November, 1849, and lasted on, with intervals, till August, 1851. The first portions are given, with results and illustrations, in the Blue Book No. 787 of 1850, and the entire series, with one most weighty, and perhaps involuntary, omission, in the second part of Sir Howard Douglas's fifth edition of *Naval Gunnery*. I shall quote indifferently from both these authorities, according as I find them to support my own views, and of course shall thereby open my statements to fair challenge by any who may think those views to be controverted, rather than supported, by the works referred to.

The experiments ordered in November, 1849, were limited to ascertaining those relative powers of resistance of oak plank and iron plating which I before had occasion to use when telling the tale of the "Ruby;" but I did not then state, that they go to establish a very remarkable coincidence, if it be not a direct relation, between the powers of resistance to the impact of shot, and the proportional specific gravities (1 to 8) of the two materials. The experiments are also valuable from the regularity of their gradations, and it, therefore, is the more to be regretted that they are not complete. They establish that a $\frac{3}{8}$ plate and a 3-inch oak plank are both musket-proof at 40 yards; that a $\frac{1}{2}$, or a half-inch, plate and a 4-inch plank are both canister-proof at 100 yards with a 6lb. charge from the 32-pounder; and that a $\frac{5}{8}$, or three-quarter inch, plate and a 6-inch oak plank were neither of them proof against grape-shot from the same gun and with the same charge at 200 yards; but we are not told anything further; and it is this incompleteness, of not ascertaining the relative thickness of plate and of wood which is grape-shot proof, that I have ventured to regret. These experiments seem to have had in view a general, rather than a specific, object; but those which

followed, and commenced in June 1850, were specially intended to illustrate the effects of shot on the "Simoom," the largest of the quondam frigates, and which had then been launched since May, 1849, without, apparently, having suggested any earlier test of her shot and shell properties.

In Sir Howard's account of these experiments, I find the description of a great many sorts of sides, all represented as belonging to the "Simoom;" sides varying in material, in thickness, and in nature and mode of construction; sometimes they are of iron plating only, sometimes of iron and wood combined, now with the iron inside, and now with it out; now with iron plates over wooden timbers, and now with wooden plates over iron timbers. In short, many strange devices and structures were fired at, almost all of which are spoken of as "the sides," or similar to the sides, of the "Simoom;" and this makes it necessary for me to point out, that the two experiments described, and which are stated to have taken place respectively "in June, 1850" and "on the 11th of July, 1850," are those alone to which I shall attach any real importance, as these are also the only ones of which the details are given in the Blue Book; and of the targets used on these two occasions, that one used on the last of the above days is the only one out of the whole series which presented a true section of the side of the "Simoom," and for the effects on which, that ship, or any such, can be held responsible. I shall designate these two targets respectively as Nos. 1 and 2, and proceed to observe of them, that No. 1 was a double section, or a section of both the sides of the ship, but of the ironwork of those sides only, and without the wood-work. It was fired at from a range of 450 yards, as was also No. 2, with various guns and various charges, the rear section being placed 35 feet behind the front one; and immediately between the two, at a distance of 10 feet from the front section, was placed a screen of one-inch fir plank, together with a more extended screen of canvas, the one to prove the severity of the splinters, the other to show their number; the plates of both sections being of $\frac{5}{8}$ thickness, and built together, in all respects as regards iron work, in the same manner as in the vessel herself.

But in addition to this faithfulness of representation in No. 1 target, in respect to the iron portion, No. 2 target faithfully represented the true structure of the "Simoom's" sides in respect to wood also; and I think that the following description, as given in the Report, will show that this difference between the two was not unimportant, as the difference of the effects of the firing in the two cases did in reality prove. The Report states of No. 2 target:

It was filled in and made solid with 5½-inch oak timber between the iron ribs, and 4-inch oak planking above the water ways, which were 1 foot thick, and 3-inch fir plank above the port-sills. These were strongly secured to the iron plates by bolts "through all," and clenched; *in fact, the inside timber was that of a frigate, with a casing outside of ½-inch iron plates.*

Rather a naïve statement, it will be admitted, when compared with the description in the Report of No. 1 target, by which it will be seen that this "inside timber of a frigate" had been purposely omitted, "because

... would not have added to the safety of a vessel or crew;" and this — tional omission becomes especially noticeable from the fact, that this — er support had been given to the ship when building, consequent upon the proof of its value as shown by the Woolwich experiments, and for the express purpose, among others, of intercepting splinters, which, as in the Woolwich cases, it will be shown that it was really found to do. It is much to be regretted however that No. 2 was not a double target, like No. 1; and that the use of screens was not resorted to in this case also in order to show the number and severity of splinters, as we should then have had valuable data whereby to assist in determining a very important point of the present day; viz., the practical difference shown, by a similar fire on similar plates, having in the one case a backing of timber, and having in the other none; any practical difference of the effects of *splintering* in these two cases being in truth the point of most value to be elicited from these experiments at all, since the question of *penetration* had been already determined by the experiments of November, when $\frac{5}{8}$ and even $\frac{3}{4}$ plates were shown to be perfectly penetrable by 32-pounder grape-shot with only a 6lb. charge at a distance of 200 yards.

I find that these "Simoom" experiments were again entirely one-sided; and, like the former ones at Woolwich, they furnished no data for determining comparative effects of an equal fire on equal targets of wood and iron—as, indeed, it is more than probable they were never intended to do. But, thanks to the armoury of Sir Howard, this important desideratum I shall, to a considerable extent, be enabled to supply, by resorting to that portion of his work in which he gives us in full detail the effects of a fire of solid and hollow shot, directed from the same gunnery ship in 1838, against the sides of the "Prince George" hulk, for the express purpose of deliberately examining such effects, and which I proceed to use for my purpose thus. I will extract from the details of the firing at No. 1 and No. 2 targets two cases each, such as appear to me to have produced the most destructive effects on the iron plates; and against these I will quote four cases of the most destructive effects on the sides of wood; but, as in the latter case no 10-inch shot were fired, I think it fair also to omit the effects of firing at the targets with this sized shot; hoping that the day is near when this, and many other practical points at length happily recognised as of true National importance, will be made the subject of fair, open, and comparative experiment.

No. 1 Target.

No. 1 shot, 32-lb. solid, charge 6 lb.—Struck the 2nd row of plates, making a hole 8 by 9 $\frac{1}{4}$ inches between the 5th and 6th ribs from the left of the target. The shot split, and there were a great many splinters, which spread very much. The wooden screen behind, and placed about 10 feet from the iron plates, had two planks knocked down, and about 25 splinters passed through it. In the rear target, part of No. 6 rib was knocked away, and a hole made by one of the splinters passing through the plate, 32 splinters struck the target, one broke the 2nd rib and knocked off two rivet heads.

No. 7, 8-inch hollow shot, charge 10 lbs.—Struck the 4th row of plates, making a hole 15 by 9 inches, and curling up the plate at the back, leaving a very ragged hole; the 5th rib was hit, and about 11 inches of it and the flange were very much broken; 4

rivets were knocked away. The shot split, there were a great many splinters, one of which struck about 80 yards, and nearly at right angles to the line of fire.

No. 2 Target.

No. 7 shot, 32 lbs. solid, charge 10lbs.—First graze 8 yards short, shot struck the section, making a round hole through the iron and wood 8½ inches. The shot split into very many pieces; *the wood stopped the splinters of iron plate*, but not those of the shot, which ranged about 300 yards.

No. 9, 8-inch hollow shot, charge 10 lbs.—Struck the section on the left angle rib, shot split into a great number of pieces, which ranged on, covering a space of from 100 to 300 yards in length, and 60 in breadth, diameters of hole 10 inches by 9 inches.

Before putting before you the details of firing at wood, I think it fair to submit for your consideration that, as these were never made for that comparative purpose I am applying them to, it is more than probable that the amount of splinters of all sizes actually made were never counted or noted with the same accuracy and minuteness as was provided for in the case of the "Simoom" targets.

I proceed to quote from the 161st, 162nd, and 165th articles of Sir Howard Douglas's work, fifth edition, as follows, taking the shot detailed in the 161st article as two, out of the four, cases for comparison:—

161st Article.—Two 32-pounder shot fired separately, with charges of 10lbs. 11 ozs. entered at the same place, so as to render it impossible to distinguish their separate effects; together, after penetrating through the ship's side in firm wood, they shattered a sound wooden knee; they then passed across the deck, cutting down a wooden stanchion 6 feet long and 8 inches square; this they shattered to pieces, causing many splinters, six of which were very large, and one of them swept the deck as far as the pumps; one of the two shot penetrated its own depth in sound wood on the opposite side of the deck, and there stuck; the other struck and splintered a port on the opposite side, after which it rebounded against the side which it first entered.

162nd Article. Many hollow shot were fired with remarkable effects from 68-pounder guns, making penetrations which varied from 25 to 56 inches. One of these, with a charge of 8 lbs., penetrated the side of the hulk, passing through 28 inches of good wood, tore out the iron hook which holds the port-hinge, and fractured the after side of the port, driving the splinters about the deck. It rent away the end of a beam, grazed the deck, passing through two planks, and cutting down a stanchion 8 inches square, making several large splinters; it then struck against the opposite side of the ship, from whence it rebounded against that which it entered.

165th Article.—A 68-pounder shot, with a charge of 8 lbs. and an elevation of 1 degree, after two bounds penetrated to a depth of 24 inches, close to the side of a port just above the lower port-sill, in bad wood, started the inside planking, and tore off a piece, which splintered. One of the splinters, a very large one, was thrown beyond the main hatchway to the opposite side of the deck. The shot having crossed the deck struck a corner of the main hatchway combings, and tore out a large piece on each side, destroying the use of the combings. It struck a winch handle which was lying on the deck, and drove one end of it through a port-scuttle. After striking the combings the shot grazed a beam and fell on the deck.

Among the assembly I have the honour to address there are many far more competent than myself to weigh the comparative results I have thus brought together; and it is no fault of mine that I am unable to place before them still more full and varied details of the relative destructibility by shot of wood and iron.

The subject, however, as every one now most powerfully feels, has passed beyond the hands of Professional judgment alone, and has become a National question, if ever a question could truthfully be so called. But the Nation and I might even add the Profession, has never been per-

mitted to be present at—but, on the contrary, has always been sedulously excluded from—every place and scene where decisions so momentous to its interests have been as yet determined; and, as it is my desire and intention to compensate this past state of things in such degree as may be done by the publication of these Lectures, I feel that I cannot shrink, even in such presence, from stating some opinion of my own on what I have now put forth. I think, therefore, that I may expect pretty general concurrence on the following view of these comparative results, viz.: That if there be indeed any difference whatever in the destructive effects shown on the one side or the other, it is so small in amount, and probably of so contingent a nature, that, to propose to base on it any conclusive decision against the use of iron, especially when taking into account its many other great and proved advantages, would be an exercise of reason but little less remarkable than that which four years previous took place in respect to the “execution” of the “Ruby.” And this opinion I beg to support by pointing out that the “spread” of splinters in the case of No. 2 target, stated to have been in some cases as much as from 60 to 70 yards, must not be understood to have taken place within the limited width apart of the two sides of a ship; for in this case there was no second section, and this “spread,” therefore, took place over the broad face of Portsmouth Harbour, and it was measured at distances varying from 100 to 500 yards in rear of the target. I may also observe, that the penetration of a 1-inch fir plank at a distance of 10 feet just represents the “severity” of fire of a tallow-candle. And when I further request you to note that no attempt was made or intended, either then or since, to employ the peculiar facility afforded by iron for the construction—not of screens of canvas, whereby to count the splinters after they had come in, but of *inner sides* or bulkheads of iron itself, for the purpose of keeping them out altogether,—I think I shall have put circumstances before you which will be held to justify, at least, the opinion I have expressed, even if they do not amount to an absolute decision in favour of iron.

But I have not yet finished with these “Simoom” experiments, and, as I fear I may be exciting more weariness than attention, again I must have recourse to my unfailing friend and supporter, and point out how fully Sir Howard also goes into these details, and how earnest he is in pressing attention to them; as I now do for precisely the opposite purpose; but for the very same reason assigned by him in the 173rd article of his book, viz.: “that a distinct knowledge of all the facts established by these trials is a matter of immense importance.” I proceed, then, to compare the different effects produced on the firing at the two targets themselves, as elicited by the difference in their structures, and as bearing directly on that very important point in the iron question of the present day before adverted to.

Great care and correctness is exhibited in the drawings of the effects on these two targets which accompany the Report, as found in the afore-said Blue Book, and any person who will simply put these two drawings side by side will see at a glance the remarkable difference in the effects of the shot on the target without the backing as compared with the target with it, the holes in the former case being so much larger and irregular as almost to suggest that the quality of iron in the two cases could not have

been alike. The same marked difference will likewise be seen at a glance, in the amount of descriptive writing in the case of each shot, although the difference in this respect may arise to a degree, no doubt, from the effects having to be noted for two sections in the one case, and only for one in the other. Still the differences are so apparent, if even limited to surface appearance alone, as to proclaim that iron plating backed by timber, and similar plating not so backed, present conditions of resistance to the impact of shot of marked difference in favour of that with the backing. The details do not inform us of any difference in the two cases of the force and amount of splinters, there being no second section in the case of No. 2 target; but, from the use of the modified term "considerable velocity," when speaking of the No. 2 splinters, as compared with "great velocity," when speaking of those of No. 1, I am induced to think that some corresponding effect was in reality produced by the "backing" in this respect also, although from the absence of "screens" it could not be noted.

The judgment on these experiments is stated in the Report as follows, and is still so maintained to this day:—

The result of these experiments is the reverse of those made of the "Ruby" in 1846, a *small, slight-built iron vessel*, when the great damage was found to be sustained on the shot passing out on the opposite side to that fired at, making clear round holes only on the first side. On the present occasion, the resistance being so much greater, the principal injury has been on the front side; and the fractures made are of that description that two or three shot, and sometimes even a single one, striking under the water-line must endanger the ship. There is also another most serious evil attending this greater resistance which was not anticipated, and which has caused great surprise. The shot or shell [pray mark "or shell"] on striking are shivered into innumerable pieces, passing on as a cloud of langrage with great velocity, sufficient to pass through the 1-inch fir boards, the larger pieces going to a considerable distance (400 or 500 yards), and some through the rear section, making large irregular holes; this would be most destructive, and I firmly believe men could not stand behind it. These experiments, I consider, prove that, whether iron vessels are of a slight or substantial construction, iron is not a material calculated for ships of war.

"Slight or substantial;" alas! for the fate of poor iron: certainly, when it was sent down from London to Portsmouth, it fell among unfriendly judges. First it was so wretchedly weak, that it was knocked all to pieces by the shot; and then it became so abominably strong, that the shot were all knocked to pieces by it; and so, like the man in the fable, who was found warming his fingers and cooling his porridge with the same breath, its judges condemned it as evidently "uncanny." It would never have been released from bondage to this day, had not a certain Personage from the other side of the water "negotiated" for its free release, for his own special and charitable purposes, and so raised it from the degradation imposed by its own native-born masters.

However futile it may appear at the present day, it seems impossible not to express regret from the position we are now in, that this effect of the "Simoom" plates, "in shivering into innumerable pieces" the *shot and shell* which struck them, should have been regarded solely in the philosophic light of "another most serious evil." No doubt it was so for the "shot and shell;" but this, to them "most serious evil," was an omen of the happiest augury, for the "ship," which could not have behaved under these representative circumstances in a more coaxing manner to induce

the application of thicker and thicker plates of iron, ever breaking up the shot and shell into more and more "innumerable pieces;" and then of thicker and thicker supports of timber, ever intercepting more and more of these "clouds of langrage," until she must inevitably have gone on advancing more and more from her penetrable properties as a "Ship of Iron," until she assumed the conditions of complete practical impenetrability of the "Iron-cased Ship." And I cannot help thinking that it would have conduced more to the usefulness and distinction of our great national School for practical Naval Gunnery had the honour of this Invention, which was then so evidently pointed to in these experiments, been secured to England by her means in 1850, instead of its having been then left over for France to impose on us in 1854, and compel our now following in this grand naval Improvement the lead of our formidable rival;—at what expense, and within what time, and with what chance of taking that "lead" back again for ourselves,—who shall say?

In the "Report" we are naïvely told that the result of these experiments was "the reverse of those made on the 'Ruby,'" and that the "greater resistance" of sound plates over very rotten ones was "not anticipated," and "caused great surprise;" it is evident, therefore, that the "Ruby" flag could be no longer upheld; and, if these experiments could have furnished no other standard in its stead, the decision against iron itself must have been *reversed* too. The "un-anticipated" breaking-up of the shot was thus a real godsend, and as such must be carefully guarded, and this is also the only intelligible view I am able to take of any apparent object or consistency in the remainder of this series of experiments, which, in sole deference to the notice requested to be taken of everything connected with them by Sir Howard, I now proceed briefly to notice myself.

On the 13th of August, 1850, practice was made at a section similar in iron to those of No. 1 and No. 2, but with fir plank of two, three, and four inches thickness outside, or in front of the plates, apparently with a view to soften the fate of the shot. But there were the inexorable $\frac{5}{8}$ plates still, and, as we are told, "every shot split in passing through, those between the ribs into a few pieces only, and those that struck on the ribs into a great number." In short, the destruction of the shot was great in proportion to the substantial resistance of the plates. Then on the 10th of October following, another similar section of iron was fired at, but combined with the same composition of cork and India-rubber which had before been used at Woolwich; and again, as we are told, "the result was the same as the former trials when lined with wood; it neither prevented the shot from breaking into numerous small pieces, nor did the hole close up, as was anticipated, after the shot had passed through." From which latter remark I may presume that Sir Howard had forgotten the efficiency, for all such purposes, of his former protégé the "parasol plug."

From this time, iron plates "similar to those of the 'Simoom'" appear to have been given up as incurable, and I find that no further dealings were held with them; but a new sort of construction took place, and was fired at on the 5th of July, 1851. It is called a "butt," and was "constructed of oak and fir uprights, to represent the timbers of a ship; one half covered with $\frac{3}{8}$ and the other with $\frac{1}{2}$ sheet iron." So the shot, this time,

were to be exempted from "the serious evil" of meeting with any more $\frac{3}{4}$ plates. But with respect to this "butt," I will request to remind you that $\frac{3}{4}$ plating had been proved by the November experiments of 1849 to be only just musket-proof, and not canister proof; and $\frac{1}{2}$ plates to be just canister-proof, and not grape-shot-proof, at 200 yards; while by a drawing "to scale" which accompanies the account of this "butt," I find that in a length of 14 feet there are only seven of these so-called "timbers," one only of which has a siding of 12 inches, and only one of 9 inches, the "siding" of the remaining five being 6 inches only; the "spaces" also between these "timbers," vary from 8 inches to 2 feet, whereas a frigate's timbers, besides being all of oak, would all have had a "siding" of 12 inches, with "spaces" of not more than 5 inches between them, and therefore insufficient to allow even a 32lb. shot to pass through. Accordingly, as Sir Howard points to the picture of this "butt," saying of the effects of the shot as shown upon it, that they "*sautent aux yeux*," so it may be observed that four out of the seven "timbers" escaped altogether scatheless from the fire, thirteen out of the eighteen shot fired "with distant charges," preferring to *jump* through the "butt," where they met with no more than the musket-proof and canister-proof resistance of the above thin plates. But even here the $\frac{1}{2}$ plates seem to have left their mark on most of the shot, "splitting two" and "starring" others, so that we have here ascertained the limit of the "breaking-up" power of iron plates. The next trials, however, were so prepared as to secure the shot against even such limited maltreatment as this, and can only, with justice, be described in the following words of the book itself from which I extract them. They were made on the 11th and 12th of August, 1851, "The particular objects being to endeavour to diminish or obviate the destructive effects produced, as above, on plates of iron, by the impacts of shot, and to prevent the shot from splitting into pieces." And it will hardly be believed that the very simple and ingenious method devised for effecting these "particular objects" was that of not having any plates of iron at all to fire at; a device only to be outdone in simplicity by that of having plates of iron, but not firing any shot at all at them; but, unless I grievously misinterpret these following words, such seems to me their true meaning. "For these purposes a 'butt' was constructed to represent a section of the 'Simoom,' [another sort of side again for the 'Simoom,'] formed of iron ribs of $\frac{3}{4}$ iron, $4\frac{1}{2}$ inches wide and $11\frac{1}{2}$ inches apart; instead of plates of iron, these were covered with 5-inch *teak planking* on the outside, and 2-inch on the inside." Not one single iron plate; and then, as if to obviate the possibility of any mistake, the description continues:—"The breadth of the 5-inch planking was $10\frac{1}{2}$ inches, and of the 2-inch planking $9\frac{3}{4}$ inches." And then we find that this time the success was complete; for, although the picture which accompanies the Report shows us that four out of the seven shot would still perversely hit their heads against the iron "ribs," yet all went bounding away with unbroken rotundity, "passing on to 1300 and 1400 yards." And, after giving descriptions of the performance of each of these shot with a minuteness greater than in the case of any other experiments, we come to Sir Howard's general summing-up as follows:—"Thus it appears that the destructive effects of the impacts of shot on iron ships cannot be prevented." A truism which seems to exhibit the very same

misconception as to the object of introducing iron into the Navy which led the commander of the "Lizard" to send home his grape-shot from the *Parana* in 1846,—continued down, and seriously urged against Ships of that material, to the present day.

I have now, as I believe, stated most faithfully the whole case against the fitness of iron for Ships of war, as produced from experiments ordered with the view to sustain its pre-condemnation, and as contained in records openly published by its most determined antagonists; and, since my "summing up" at the period of the summer of 1846 I leave to the decision of each of my hearers for himself, how far the adverse judgment at that time pronounced has or has not been strengthened, by any one single fact elicited since the time of the *Woolwich* experiments; the "breaking-up" of the shot, be it observed, being only more fully recognised and noticed in 1850 than it had been in 1845; and its bearings on both sides of the question being fairly balanced with the wood splintering of 1838. And if I be upheld in my own judgment that that condemnation, instead of having been strengthened, has rather been reversed by the experiments subsequently detailed, then, casting into the scale, as before, the question of red-hot shot, the balance of Public decision must be, I think, not in favour of, but *against wood*, as having been proved by experiment to be an inferior material to iron for the construction of Ships of war.

But, before passing from defensive to offensive warfare, I will request you to observe of these last experiments, just as of the previous ones:—First, that many of them were of such a nature as could only be made at all under a secret and exclusive system, and could not have been even seriously proposed to be carried out, before parties representing more than one view of the "immense importance" to be attached to their results. And next, that we are all most deeply obliged to Sir Howard Douglas for having exhumed them from their 10 years' burial, and thus exposed them to a public ventilation.

But the prison-house has not yet been delivered in full; and I must proceed to do so, in the first place, on my own authority, trusting to be fully justified and supported afterwards.

Portsmouth, at the time of the "Simoom" experiments, was rife with the rumour that other most remarkable results had been elicited, besides the acknowledged reversal of those of the "Ruby;" and besides the invariable "breaking-up" of all shot. It was stated that horizontal shell-practice had also been made; and that shells of every description had been found completely inexplosive, or, in other words, that No. 1 and No. 2 targets had been found to be shell-proof. Many others besides myself made attempts to get at the bottom of this rumour; but, although it was not difficult to be furnished with any amount of fragments, to prove that the shot had all been turned into shells; what the shells themselves had been turned into seemed to be steadfastly reserved from the Public, as a subject of consideration for the initiated only. In the summer of 1853, being again at Portsmouth and in company where the subject was again mooted, I obtained information from an Officer who had been one of the shell-firers, that the rumour was a reality, and every detail was then given me of the facts; but, however desirous of giving them publicity, under a strong sense that a most important National interest was

involved in them, I felt that, if challenged for my authority, I must either decline to give it, or do so to the probable injury of my informant, and I therefore refrained. In the beginning of 1854, however, shortly after the outbreak of the Russian war, chance gave me what I had so long desired; and at another "United Service Institution," not 100 miles from the one we are now assembled in, I was made master of every fact, and even opinion; with the most complete unreserve; and by one who was necessarily as cognizant of the whole matter as any other witness whatever to the experiments. This was the statement: that, being in the boat, lying obliquely in rear of the target, for the purpose of noting the effects of the shell-firing, attention was first attracted to the very different sound produced by the explosion to that generally heard; still the shells evidently burst, for there went the pieces all over the water. Then the further remarkable fact was observed, that the smoke of the explosion, instead of being white, was perfectly black; and, as these phenomena occurred as each shell was fired, examination was at length made, and it was discovered that the shells had not burst or exploded at all, but had, like the shot, been broken to pieces by the plates, the pieces passing through them, but the powder of the charge being dashed against the plates into a cloud of black smoke. In reply to inquiry, I was told that this was the case with every shell fired, whether "time fuze" or "concussion," and that the targets were in truth found to be "shell-proof." And further, in answer to a few practical questions, I found that the conclusion held to be established as the direct result of this portion of the entire series of experiments—for they were far more continuous and extensive than is shown either in the Blue Book or Sir Howard Douglas' work—was this, that shell-firing at ships of iron, with sides of $\frac{3}{4}$ plates and upwards, was to be avoided as worse than useless, the shells being as harmless as if charged with sawdust instead of gunpowder, and being nothing more than very expensive and very bad shot. But my informant added, that the injury to material and life in a ship of iron, resulting from a fire of 8-inch and 10-inch hollow shot, would be greater than could be effected on a ship of wood by an equal fire of 8-inch and 10-inch shells; a view of the case which I could accept only as an opinion which never had been, nor has been substantiated, by any comparative trials to this day; but, as he expressed himself content to command in actual fight a ship of wood, although liable to all the destructive effects of shell-fire, I could but accept the amicable challenge by expressing myself equally content to try issue with him in a ship which was liable to no such treatment at all. I will here add, that on subsequently meeting the brother Officer to whom the Country is so much indebted for the present naval "concussion" shell, and whose untimely loss is so generally lamented throughout the Service, a similar conversation on the same subject took place, and with precisely similar conclusions expressed on the same facts, except, that having been himself one of the firers at the targets with his own concussion shells, he thought that in one or two instances explosion had taken place. I now felt myself able to meet any challenge as to "authority," and throughout the latter part of 1854 made every attempt to procure a reconsideration of the whole subject, and induce a series of fair, open, comparative, and conclusive trials

by trying through all channels open to me to procure publication of the following letter:

ARE SHIPS OF IRON UNFIT FOR THE PURPOSES OF WAR?

SIR,—At a time when all the available resources which England possesses will so evidently be required to support the present war, I beg to request the insertion in your columns of the following observations; which I thus publicly submit, in the hope that they may lead others also to reconsider that decision which at present debars our country from employing her ready stores and workshops of iron; and limits her to the use of wood alone for the construction of all "Vessels of War."

That decision is the result of experiments made at Portsmouth in 1850, by firing at iron targets $\frac{1}{4}$ ths of an inch thick, representing a portion of the side of the "Simoom" then our largest iron ship; the effect of which targets was, (as a rule,) to break into pieces whatever shot was fired against them; which pieces of shot, together with the pieces of the target where it was struck, passed through and were scattered about on the other side. Thus showing that the crews of guns fighting behind the side of ships of similar construction would be exposed, on receiving each shot, to a deadly shower of pieces of iron, inasmuch that it has become usual to express the condemnation of such ships for the purposes of war by saying that "every shot which strikes them becomes a shell."

But the same experiments also elicited another fact, equally important and remarkable, the knowledge of which has recently been acquired from a perfectly authentic source. A fire of horizontal shells was employed, as well as that of shot, against these targets, and the effect of the targets was to render the shells *inexplosive*. The shells, like the shot, were broken into pieces; and the pieces, as before, passed through and were scattered on the other side: but, throughout the first experiments (with concussion shells), and, so far as can be learnt, throughout all subsequent experiments, no shell was found to explode against these targets; the shell itself being broken to pieces, and the powder which filled it being dashed into a cloud of black dust against the face of the target—apparently before it had time to ignite.

Subsequent inquiry has only led to the statement that the shells thus, I may say, emasculated, were not "concussion," but were "time-fused" shells. But, as this statement confirmed the fact of the non-explosion, and from full information completes the application of that fact to both description of shells, it would seem that the two most important results derived from these experiments might at first sight be marshalled with equal effect on the opposite sides of the question, thus.—Condemnatory of iron ships:—"Every shot striking a ship of iron $\frac{1}{4}$ of an inch thick becomes a shell." In favour of iron ships:—"Every shell striking a ship of iron $\frac{1}{4}$ of an inch thick becomes *inexplosive*."

But is it indeed correct to pronounce that a shot becomes a "shell" if fired against an iron ship, merely because in these experiments shot were found to break into as many pieces as when a shell explodes? The shot was thus broken by great *external resistance*,—a resistance greater, if measured by this effect, than shot was ever exposed to, before being thus fired against plates of iron; and in direct proportion to this resistance must be the reduction of the shot's momentum, and therefore of the inherent power of its several fragments to do mischief. But when a shell explodes it is broken into pieces by great *internal force*—a force which goes to renew, if not to increase, its powers of destruction, even if the shell have already come to rest;—a force which thus gives to each fragment the character and effects of a separately discharged missile, in addition to the mischief the shell may have done before it exploded, and to the great destruction produced by the explosion itself. It cannot therefore be maintained as correct, either in fact or reason, that a shot, when fired at an iron ship, should take rank among destructive missiles as if it were a shell, merely because the resistance opposed by that ship is sufficient to break the shot into as many pieces as a shell when it explodes.

Neither will experience allow that a shell, if emasculated or deprived of its powers of explosion, should rank among missiles as if it were equal even to a shot; because a shot whether hollow or solid, is heavier than any shell of equal diameter even when loaded, and therefore at equal velocities is armed with a greater momentum for mischief; so that if a hollow shot and a live shell, of equal diameters, strike an iron ship at equal velocities, and both be thereby broken into an equal number of pieces (the shell becoming in-
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plosive), then, the momentum of the solid shot being greater than that of the shell, the power of both itself and its fragments to do mischief will also be greater. If, then, we now suppose the two rival materials of construction to be called on to arm and prove their relative fitness for "the purposes of war" by the ordeal of actual contest: we should certainly see the ship of iron firmly adhering to the use of the shell, as the most destructive missile ever launched against sides of wood: while the ship of wood would most probably select the large hollow shot as the most effective missile for shattering the opponent sides of iron, and so producing with its own broken pieces the deadliest shower on those who fight behind them.

I would here point out, that the decision of the present day against ships of iron is based on results entirely distinct from those which were urged in condemnation of them *prior* to the experiments at Portsmouth of 1850. It was formerly assumed that iron plating could be so rent and destroyed by shot, that any ship so constructed must in action be speedily and inevitably sunk. More extended and correct experience has shown, however, that the condemnation could not be sustained upon these grounds, and that the effects of shot upon sound and substantial plating seldom, if ever, extend beyond the part actually struck; even the sides or lips of such wounds remaining perfectly sound, and affording the most ready and solid basis for at once applying the means of temporary stoppage, or permanent repair. Therefore it is important to remember that the condemnation of to-day does not depend upon objections urged against the destructibility of the material itself, as formerly, but that it proceeds upon the assumption that a greater loss of life must be sustained in action on board an iron than on board a wooden ship. So that while our two belligerents, as above, may be supposed to be preparing for actual blows, it may be well to examine their respective prospects of success by this standard of probable comparative slaughter.

In the Portsmouth experiments, a screen or screens were suspended at a certain distance behind the iron targets, that the piercing of these screens might give a just view of the number, size, direction, and force of the several fragments of iron scattered about at the striking of each shot; and the results thus accurately ascertained and recorded constitute the *garantia* of that charge of "unfitness" so tritely expressed in the terms I have ventured to criticise above. But it is evident that the question to be thus determined was one, not of an abstract, but entirely of a comparative nature; and if to be determined therefore by any peaceable experiments at all, such experiments should have been, not merely abstract, but *comparative*, and in all respects equal.

It is therefore greatly to be regretted that the same simple and effective method of the screens was not also employed for ascertaining the correct amount, &c., of fatal or disabling splinters to be produced from a target representing in wood, a similar portion, of a similar sized ship, subjected to a similar fire of shot and shell: since, however deadly may be the iron shower to be sustained behind walls of iron from a fire of shot—if the mixed shower of wood, and iron, and destructive explosion too, to be sustained behind walls of wood from an equal fire of shells had been proved to be more deadly still—then the Portsmouth experiments must have failed to support the condemnation of iron ships on the ground of their causing a greater loss of life than ships of wood, just as those same experiments did contribute so largely to break down the prior condemnation of iron, based on its supposed greater destructibility. In the absence, then, of all equal and comparative trials, the points under examination must be determined by each party according as his judgment may have been formed from the facts elicited by the Portsmouth experiments on iron, compared with any shell-firing against wood which he may have witnessed or known, either at that place or elsewhere;—bearing in mind, however, that the comparative numbers who may be placed *hors de combat* by wounds are equally conclusive, as to the results of any particular engagement, as are the numbers of the actually slain: on which principle the shell-firing at wooden ships which I have myself witnessed at Portsmouth bids me believe that it must prove quite conclusive *against* that material, and those sheltered behind it, as compared with iron. It is, I believe, an under and not an over statement to say, that an 8-inch or 10-inch concussion shell, exploding in the side of a wooden ship, will more or less destroy it to the average extent of four feet square, and that the mass of splinter thus produced will more or less disable all who come within its sphere; while the destruction to be produced by horizontal "time-fused" shells penetrating and exploding within the ship has recently been most severely illustrated before the walls of Sebastopol. And such effects as these, especially as regards destruction of material, cannot, I believe, be equalled by a similar or any other known description of fire, directed against even $\frac{3}{4}$ iron. Wherefore, upon all these grounds,

and relying on the authenticity of the non-explosion of shells against the targets at Portsmouth, those very experiments may be appealed to, to justify the conclusion that the relative prospects of our two supposed belligerents now ready to engage will stand thus:—

If two equal ships of any size—the one of iron, the other of wood—be brought into action against each other, both being equally well manned, commanded, and fought, the iron ship using the concussion and “time-fused” shells as her most deadly missiles, and the wooden ship using hollow shot of equal diameter as her most deadly missile: then the wooden ship must either yield to the iron one, or be entirely destroyed. And this conclusion must, I believe, have been established by the said experiments, if a target of wood similar in strength and size to the target of iron had been exposed to a similar fire: because the most remarkable feature exhibited by the last of these targets before it was taken to pieces was its still comparatively perfect state, after receiving an amount of shot and shells a portion only of which must, I think, entirely have destroyed a wooden one.

It is equally to be regretted that these experiments also fail to furnish information on the ability of iron plating to sustain a fire of hot shot,—a trial from which the targets appear to have been entirely exempted, but one which might have had a direct bearing on very important questions of the present day. The two special advantages now possessed by stone walls over wooden ones, which are at once the most insurmountable and conclusive in their favour, consist in the fire of shells and red-hot shot,—which being of the most destructive nature as directed from batteries against ships, are at the same time of the least destructive nature as directed by ships against substantial batteries (I do not include mortar fire). But the Portsmouth experiments, which have shown that the plates of an iron ship are able to reduce a shell-fire to a smaller destructive effect than a fire of shot, *might*, had they been so extended, have also shown that they could reduce a fire of red-hot shot to be equally innocuous. It is the lodgment of hot shot in the solid timbering of the side, and the difficulty of either extracting or cooling it there, which constitutes its chief danger to ships of wood: and from this danger it is clear that an iron side is free. The hot shot, like the cold one, would doubtless penetrate such side; but in doing so would it not be broken into smaller fragments still, the power of cohesion being reduced by the heating? And if this were so, then these smaller fragments must certainly cool down sooner than larger ones; and the open deck, where they would fall under observation and treatment, would seem to be their principal sphere of even this limited mischief.

But there is no need for the aid of conjecture. Enough has been said to show that the Portsmouth experiments, important as they were, were yet so incomplete in themselves, and admit, now they are known, of such opposite conclusions being drawn from their results, that they cannot be admitted as a satisfactory or final settlement to a question of such grave moment. They impose at this time a complete barrier against the employment of resources which it may be of the greatest advantage should, at least, be ready to be called forth; for not a gunboat can be built of iron whilst the decision of these experiments proclaims that all who serve in her must be exposed to a greater sacrifice of life than if she were of wood: whereas, I have endeavoured to show that there are substantial grounds for belief that an open, complete, and comparative system of experiments would establish the *superiority* of iron over wood for the “purposes of war,” both as regards its greater indestructibility and its greater protection to life; and I need not observe, if such prove the case, how great an addition would at once be gained to our available resources for war—and doubtless not in gunboats only.

I am aware that, even in such a case, time alone could bring about the employment of iron for the construction of the larger ships of war; but time is also precisely the very remedy required to abate and remove prejudices; to acquire experience and confidence; and to complete those changes and additions, which the extensive use of that material would doubtless call for. But such changes would be no greater, if so great, as many which this age has already seen and now greatly benefits by; neither would the additions be greater, if so great, as those which have been requisite for the somewhat cognate purpose of converting the whole British Navy into a “Screw Fleet.” In such case also, there would still remain, *at present*, the very grave objection against iron bottoms, of their liability to foul, and the consequent frequency of resort to the operation of docking. But has not the barrier I seek to remove been a chief cause why this grave objection *does* exist at present? Could there have been a greater discouragement to deter eminent talent from devoting its attention to remove this objection than the knowledge that if removed there remained an impassable barrier still, to prevent the advantage from having any practical application to our great “National Fleet?”

I have thus endeavoured to submit my views on this whole subject firmly and clearly, that my purpose as at first avowed should admit of no mistake; and I have done so thus fully, because it is my intention not to enter into any controversial correspondence. It has also been my endeavour to write—not dogmatically, still less offensively, to the most sensitive of those who, like myself, exercising an independent judgment, may choose to think differently on a matter of such national interest. Need I add, finally, that I should be unworthy of my Profession if, in thus writing, I could be charged with any want of true allegiance to the ennobling history and traditions of our “Wooden Walls.” It is, however, a plain fact, that those “walls” have long since ceased to be built to any great extent of “British heart of oak,” while supplies of foreign growth are gradually becoming more difficult and expensive. Wherefore I believe that I am no “recreant,” either to my Country or my Profession, because I avow both my hope and conviction that the noblest and most natural substitute to be found for “British oak” exists everywhere around us in our stores of “British iron.”

Such, then, is my own, and, as I believe, the only statement of a personal nature I shall have to make throughout the more historical portion of these Lectures, and the necessity for having done so, even in this case, will presently become apparent, as a means of rendering more intelligible the obscure manner in which this most vital point in the whole question, namely “shell-fire,” has been referred to in any published records; but by which, nevertheless, as I now proceed to show, every particular stated to me is fully substantiated.

In the Report of musket, canister, and grape shot experiments of 1849 I find this sentence in the summing up:—

Iron offering no lodgment for shells on passing through the side, if made with single plates, it will be free from the destructive effects that would occur by a shell exploding in a side of timber.

A remark which I cheerfully accept, as showing how keenly understood was the importance to either side of the question, which could establish any difference in its own favour in respect to shell-fire. This sentence, however, is limited to the superior security of “ships of iron” against the lodgment of shells in their sides; but in the Blue Book Report of the firing at No. 1 target we are told—“The shot or shell on striking are shivered into innumerable pieces.” And just in a corner of the details and plan which accompanies this report I find this very unostentatious note: “Six 32-pounder shells were fired—two burst, four broke.” Not, be it supposed, that this represents all the shell-firing which took place, any more than that the picture of the target shows all the effects of all the shot-firing; for these targets afforded practice for months, and, when done with, scarce a hand’s breadth of sound plate could be found between the shot and shell holes; and yet I am assured these targets were still perfectly capable of repair. So that the statements of the Blue Book itself, besides establishing the non-lodgment of shells, amply corroborates that shells were fired, and that they were broken into those “innumerable pieces on striking the plates which produced on them all the effects of emasculation; and the only point which in principle the Report itself omits is that of telling us what became of the powder. But may it not in truth be matter of surprise to find this Report telling us so much, instead of so little, when it is considered how obviously the experiments must have been ordered, not for the purpose of “reversing,” but of supporting those of the “Ruby,” and that, by the *wording* itself of the Motion

for the Return, though made twenty-four days after the date of the Report of the firing, its demand is limited to the "effects of shot" only?

Still, I cannot feel satisfied without the support of Sir Howard's important book, and it is astonishing how reluctant that book seems to be to give it. In collating the detailed account of the No. 1 target-firing, with that contained in the Report about the same target, I find these words—"Another most serious evil is, that the shot breaks on striking into innumerable pieces;" overlooking altogether the "or shell" of the Report itself, from which, nevertheless, the sentence is so evidently taken. And I am equally foiled again on searching through the "Conclusions" stated in article 454, which I find are directly derived from the list of "preceding experiments," all of which were made on "armour" plates, the thinnest of them being $1\frac{1}{2}$ inch thick. I then turn to the "Postscript," which contains two tables of shot and shell practice at plates—one on pages 12 and 13, and one at page 60; but the thinnest of these plates, again, is $1\frac{3}{4}$ inch thick, besides that the experiments detailed are all of dates much more recent than those of the "Simoom." At length, at page 15, I find a repetition of those same "Conclusions" set forth in the main work, but with some alterations, and in the second of these I find as follows:—

2nd.—*That thin plates of wrought iron even $\frac{5}{8}$ of an inch thick [mark, even $\frac{5}{8}$ of an inch thick] are proof against shells or hollow shot in an unbroken state, but that the fragments of the shot or shell pass through the plate, and produce an effect perhaps more formidable than any shell.*

Now this is exactly what I have been looking for, and I at once proceed to appropriate it as my "choicest weapon." I eliminate the latter part of this "conclusion," by observing that it is no part of any conclusion at all, its basis being nothing more substantial than a "perhaps." And I proceed to illuminate the obscure expression "in an unbroken state," by translating it into its plain English meaning, thus: "That a shell, in order to be such, must be "unbroken" by anything but by the explosion of its own charge;" the corollary of which is, that when shells are fired at substances which break them up "on striking into innumerable pieces," dispersing to the winds the powder of their charge in a cloud of black smoke, they then cease to be shells altogether, notwithstanding that such of their pieces as have a force equal to that of a grape-shot may pass through the substance which inflicts on them "this most serious evil," and this corollary Sir Howard himself undoubtedly applies in those first 16 words of his above "Conclusion."—Not a mere account, be it observed, of a single, or even of "six," individual instances of the sort, but deliberately set forth by our great Artillerist as arrived at by him.—How? "After a close examination of all the facts established, and the results obtained from these experiments." What experiments? The "Simoom" experiments. Why the "Simoom" experiments? Look through every page of Sir Howard's "book" and "postscript" too, and see where you can find any other shot or shell experiments made at $\frac{5}{8}$ plates, except those he declares to be of "such immense importance," and which he therefore so minutely describes as having taken place at Portsmouth from 1849 to 1851, at the many-sided "Simoom."

And now I proceed to apply Sir Howard's weapon in breaking down

therewith his own position and in establishing mine in its stead, taking as exponent this very "Simoom" herself, the ship built "wholly" of that material pronounced perfectly unfit for all the purposes of war.

At page 256 of the "Naval Gunnery" may be read a graphic description of the effects of an accidental shell explosion on board the "Medea," in 1840, whereof it is said, "These are portentous proofs of the terrific effects, physical and moral, produced upon a ship by the explosion of shells at rest within her, *and the like effects must be expected to ensue, should an enemy's shell be planted or lodged in the ship before the explosion takes place.*" From which "terrific effects," the "Simoom," as a ship built "wholly of iron," is doubly secure.—First, as the Blue Book Report states, because "iron affords no lodgement for shells;"—and next, because, as Sir Howard's book tells, "thin wrought-iron plates, even $\frac{5}{8}$ of an inch thick, are proof against shells."

And now from contingencies to realities; at page 617 may be read,—

The damage sustained by the combined fleets was caused chiefly by the Russian shells, which were fitted with time-fuzes, as were those which they used at Sinope. The "Albion" received several shells close to the water-line, three entered the cockpit, and she was once or twice on fire. Having ceased firing in consequence of being compelled, when on fire, to close the magazine, and having signalled for the assistance of a steamer, the "Albion" was towed out of action stern foremost, by the "Firebrand," in effecting which both vessels were severely damaged. The "Arethusa" was set on fire several times, and severely damaged by the Russian shells. One burst on the main deck, and knocked down a considerable number of men of the adjoining guns' crews; another shell burst on the lower deck, and set fire to some material close to 200 live-shells placed there for immediate use! Another shell blew out portions of several planks in the bends, and had there been any sea the ship must have sunk. A shell lodged and burst in the timbers at the water-line. An officer and five out of seven men standing together on the upper deck were dangerously wounded by the bursting of a shell. After having retired out of fire it was found necessary to heel the ship to plug shot-holes below the water-line. The "Sans Pareil" suffered severely in men and spars. The "London" suffered considerably in her hull from shot and shells fired from the Telegraph Battery, and was three times on fire in two hours. The "Queen" was also forced to withdraw, a red hot shot having set fire to her.

From all which effects actually sustained by ships built of that material judged to be best "fitted" for all the purposes of war the "Simoom" must have been shielded under Sir Howard's ægis, that " $\frac{5}{8}$ plates are proof against shells."

Let us now turn to another modification. At page 35 of the Postscript may be read:—

The affair of Sinope was much more serious. The whole of the Turkish squadron was burnt by firing time-fuzed shells into them, from which they were set on fire from the ignition of powder circulating on the fighting decks, and which, there is no doubt, produced so much panic among the crew that they were unable to extinguish it.

Here, again, Sir Howard's ægis shields the "Simoom," as a ship built "wholly of iron," from the fate of the Turkish frigates.

But to bring this practical difference between wood and iron as the material for ships of war into still clearer comparison. If the frigate "Simoom," built "wholly of iron," had been alongside her sister frigate "Arethusa," built "wholly of wood," receiving, in sympathy, shot for shot, and shell for shell, in the same places, would she also have been "set on fire," by shell explosion, "near a store of 200 live shells?"—would she also have had "several planks blown out of her bends," so that "she

must have sunk had there been any sea?"—would another "shell have lodged and burst" in her timbers at the water-line also?—would she also have been compelled, from these and such like causes, "to retire out of fire?"—and would it have been "found necessary" in her case also to "heel the ship in order to plug the shot-holes below the water-line," more than it had been found necessary to do so, eight years before, when the little "Lizard" secured the leaks from her seven shot-holes "below the water-line" with Sir Howard's "parasol-plug?"

But one step closer still in this practical comparison. How would it have fared differently with the "Arethusa" herself, and with all her wooden friends and allies at Sebastopol? How with the Turkish frigates at Sinope? and, on the other hand, how with the Russian foe, in both cases, had each wooden side been closely clothed with Sir Howard's shell-proof ægis of a $\frac{5}{8}$ plate of iron, or more?

And to move on from the past, to the present and the future,—not from Moorsom to Martin, not *from* the explosive shell *to* the shell incendiary, but to explosive and incendiary shells combined. And who can fail to see that the first half-dozen of each which can be, "planted or lodged" by the ship built "wholly of iron" in the sides of the ship built "wholly of wood," must convert her, not into "lucifer matches" certainly, but only because even lucifer matches cannot be converted out of ashes? And on this inevitable deduction from what we have now been enabled for the first time to put together I declare my own conviction that, in the event of war, every ship of wood, being of sound material and capable of bearing the weight, which shall not be clothed with Sir Howard's ægis against explosive and incendiary shells, spherical and conical—in other words, with iron plates varying from $\frac{5}{8}$ inch in the one case to $1\frac{1}{2}$ inch in the other—as stated in article 446 in these words—

No shell penetrated in an unbroken state, and did not therefore show the effects that a live shell would have produced by bursting between the decks; or, what is still more destructive, lodging in the side and there bursting.—

Every ship, I say, so unclothed, and coming to grief accordingly, must have that grief, however humiliating, attributed to the want of due and serious consideration of that which practical proof, as well as experiment, has now bid us to know. And the awkwardness of thus building "ships of wood" first, and then building over them, as it were, ships of iron afterwards, however inevitable at present, points to the equally inevitable deduction for the future,—that no ship, of whatever size, intended for "purposes of war" ought ever to be built wholly of wood again.

I will just try to support this conclusion at once by the following considerations of a more peaceable nature, inserted as an episode on—

"Strength of Structure."

By the Parliamentary Return of the mercantile Steam Fleet, made up to the beginning of 1860, I find that out of the entire number of 1,863 British registered steamers, 862 are of wood, while 1,001 are of iron. Of this whole number, again 1,291 are paddle vessels, and 572 are screws; and while of the paddle vessels 729 are of wood, and only 462 of iron; 539 of the screws are of iron, and only 33 of wood, sixteen of which are

under 100 tons gross burthen, four of 500 tons or more, and only two of the gross burthen of above 1,000 tons. And the practical cause of these latter proportions of wood and iron I illustrate by the following statement:

Not long ago a company of shipowners (Foreigners, for English merchants would not be found foolish enough,) built a fleet of first-class wooden Screw-ships to perform regular Transatlantic voyages. These ships were built by one of the most reputed Thames ship-builders, and supplied with the engines and boilers of a most distinguished Engineer. The Company started their fine fleet with a Government Mail Contract, and everything in their favour. It happened three years after they started that I was called upon professionally to make myself acquainted with the fact of the entire failure of the Company, and to report on the value of their fleet. I found that they had carried large and remunerative cargoes; that they were full of passengers both ways; that their revenue was larger than that of any profitable working Company in England in similar circumstances with which I was acquainted. At last, in the "Bills for Repairs," and the losses by delay and by damage, the whole mystery was solved. It had been found impossible for the ships to make two successive voyages across the Atlantic without receiving afterwards a thorough repair, or leaking so badly as to damage the cargo. When I saw them I was obliged to recommend my friend to have nothing to do with them on any terms, as to run them would be certain ruin, and they have accordingly not been running since.

And now, to apply these facts to our own Navy, what have we to rely upon, under the similar circumstances of continual work, which in war will be inevitable, that the wooden frame of the Screw-ship of War will be better able than the similar frame of the Screw-ship of the Merchant to endure the continued stress of its own machinery? I will acknowledge superior care of construction; a better selection of better material; and even superior shipwright carpentry; but are these more than sufficient to compensate for the heavier stress arising from far greater topweight of structure, and of masting, together with great weights of artillery, all operating above the centre of gravity, to be added to the effects of far more powerful machinery below? For if they be not *more* than sufficient to compensate these special burdens on the frame-work of the Ship of War, then in due course, "successive transatlantic voyages," or, in other words, the constant sea-going of War-service, must produce on the wooden frames of the Fleet Royal of England precisely that same state which the same work did produce on the wooden frames of the Fleet Mercantile of the Foreigner. Let us then see how far we have any indication that this more than sufficient strength of structure to meet the special stress I have pointed to does really exist. On a trial, in the basin of Sheerness, of the 600-horse power engines of the "Edgar," a perfectly new 90-gun ship, the whole stern-frame was so sensibly put in motion, and the caulking so entirely driven out in streamers from every seam, by the action of the screw, that it was only under the emphatic demand of the chief Shipwright Authority, "For God's sake stop those engines, or you'll drive the sternpost out of the ship," that serious mischief did not occur. In the case of the "Nimrod," also a new vessel, the same effect on a similar occasion took place, and a proportion of her steam-power, and therefore steam-speed, was removed. In the cases of the "Queen" and "Trafalgar," both razed into Screw-ships from sailing three-deckers, the same effect on their new stern-frames was produced, though to a less degree; not on trial of the engines in the basin, but on the trial itself of the speed of the ships outside. And what in these, as in all the other circumstances and similar cases is, and always has been, the remedy applied: more wood?

not at all; but the wood-work which "is," carefully examined to see how much more "iron-work" can be brought to support it. So that we are perfectly aware we are building our ships of two materials, the distinctive properties of which are, that the one is too weak for the purpose, and the other amply strong: and that our only hope of getting the entire structure to do its work at all, depends upon the amount of the strong material, which, by cunning device, can be embodied into a support for the weak; but a small portion of such "cunning" being sufficient all the time to enable us to build of the strong material altogether. But, I forgot; yes; there are the experiments on the "Ruby" and the "Simoom" to tell us, that shot can only make holes in ships of iron, and that ships of wood can make no splinters!

And now to apply these facts to some particular case; let me ask with respect to our Frigates, of which we are so proud; our screw-frigates of from 600-horse power to 1,000-horse power, our "Immortalités," and "Ariadnes," and "Merseys," and "Orlandos;" who knows whether they are or are not "frigates" at all? I speak of their substance, not of their show; the beauty of which, like all the rest of the nautical world, I deeply admire. But "frigates are the eyes of the Fleet," and in proportion as the Fleet itself, by its superior powers of locomotion, is able to extend the limits and sharpness of its own eyesight, by so much must its auxiliary "eyes"—in order to be as useful as formerly—be sharper and more ubiquitous still. And for this they are accordingly provided; but this provision has never yet been proved; for I doubt if it can be shown that any single frigate of the steam-power I have named has ever yet tested the ability of her frame to bear the stress of her machinery *at full work* for any forty-eight consecutive hours, perhaps not even for any twenty-four. May it not be well then that we prove our armour of this description before the day of battle actually arrives; since, to defer the first proof of it until then cannot be wise, and may be found not a little hazardous. I venture then to suggest, that some 600-horse-power frigate be put to test, by a "Transatlantic voyage and back;" a single and a short comparative proof of what such ships ought for their cost to do. Let her fill up with fuel at Plymouth, and steam at Full-speed direct to Halifax and back again, under the assumption of most important State interests, connected with the present disturbed conditions of our Republican relatives. Whatever be the full stowage of fuel, let the first two-thirds of its amount be shown by the "Register" to have been expended each way in continuous work at Full-power; and, as no frigate ever yet built in England carries fuel for 2,000 miles "full-steaming," let the remaining one-third be economized, so as to complete the two passages "under Steam." All Sail to be used, with whatever amount of Steam, whenever practicable. Let an 800-horse-power specimen, and a 1,000-horse-power specimen, follow in due course, and on the same terms; and then, on the same terms, put forth the powers of the "Himalaya," over the same race-ground, that the value in work; the cost in price; and the casualties in repair; may be publicly seen in a case of the same work, done by wood and by iron. If it be said that the "Himalaya" is of a superior form for speed, and of a less bulky material of construction; the answer is, that the inferior form for speed of the ship of wood, and the bulkier

material of construction, have both been matters of deliberate choice; and it is the wisdom of this choice which is precisely the object to be thus practically tested. The "strength of structure" of the "*Himalaya*" has been proportioned to the work intended to be performed by her, as is that of the frigates intended to be proportionate to their work, and long ere now the "*Simooms*" and "*Vulcans*" of 1845 must have grown into 50-gun frigates, and most likely into *line-of-battle ships too*, but for that violent and sudden action of 1846, which crushed the steady progress of professional improvement.

But to resume this part of my subject, and in respect to any supposed inconsistencies of the title of these Lectures with what I have hitherto put before you, permit me now to bring to your notice how intimate is the connection—nay, the very existence—of the quondam condemned "Ship of Iron" with the present approved "Iron-cased Ship." Let me show you that the latter is but the former with its coat of armour on; just as formerly the "man," became the "man at arms" by precisely the similar process of donning his suit of mail. In building the "*Warrior*" and all her congeners, we have simply again built "*Simooms*;" larger and stronger, no doubt, than the prototype of 1845, just in proportion as 6,000-ton ships, and 4,000-ton ships, are larger and stronger in all parts and proportions than ships of only 2,000 tons, and also, no doubt, with the requisite additional strength and arrangements to enable the 1,300 tons of the armour and its wooden "padding" to be duly carried; but, with these modifications, and with whatever improvement the past fifteen years has wrought in producing the material, and framing the construction, there, in each case, is the condemned "*Simoom*" of the summer of 1846, dignified into the "Iron-cased" "*Warrior*" of 1860. And in this instance, as also in those of the "*Black Prince*," "*Resistance*," "*Defence*," and the ship to be built at Chatham, the identity in respect to fitness for the "purposes of war" is even closer than the identity in construction of hull. Whoever will look at the picture in the Blue Book of the effects of the firing at No. 1 target of 1850, not No. 2, will there see, and may there read of, precisely the very same effects as must be produced by shot and shells and grape, and 10-inch Paixhans too, whenever the "*Warrior*," or her sisters, take into the thickest fight, not their own special armoured sides only, but those identical unarmoured $\frac{3}{4}$ sides of the "*Simoom*," which constitute an inseparable portion of each ship I have named, to the extent, in round numbers, of one-quarter the whole length before, and one-quarter the whole length abaft that portion, which alone is armoured, and which thus occupies, roundly speaking, but one-half the entire length of the ship: and whatever circumstances of condemnation, or of justification, in the employment of such plates for "ships of war" may have been elicited and determined, out of the only experiments which have ever yet been made on any such plates at all, must of necessity apply as faithfully and as directly to the above portion of the sides of all these semi-"*Simooms*," as they applied to the entire sides of the original Ship; with this difference, however, in favour of the original, that the sides of these more modern "*Simooms*" have the backing or timbering omitted—

but whether for the same reason as is given in the Report of the firing at No. 1 target, I cannot say. But does not that Report, it will be said, pass an unqualified condemnation on the employment of any such $\frac{3}{8}$ plates, and even say of the "large irregular holes" made through them; and of "the clouds of langrage" produced from the splintering of the shot by them; that it is "firmly believed men could not stand behind them?" Certainly it does. And is it possible that the one-half, in round numbers, of the sides of five out of seven of our "Iron-cased Ships," representing an aggregate cost of not less than 1,500,000*l.*, are constructed out of these condemned plates of 1850? Certainly they are, unless where the plates are $\frac{5}{8}$, instead of $\frac{3}{8}$ thick, in which case the shot or shell will be broken up into rather more splinters still. And were there no circumstances elicited out of the experiments of 1850 which could compensate for the destructive results produced by firing at such plates, and thus justify their employment to so large an extent in these most costly ships? Search carefully throughout the "reports" and "details" of the Blue Book, and throughout all additional details given in the work of Sir Howard Douglas: it is an important search; for whatever can there be found to justify the use of such plates of iron now, must necessarily have justified their use then; and whatever can there be found to condemn their use then, must equally condemn their use now. I can find no word of justification for the use of such plates in the works referred to. Can you suggest none other which may afford more success? None other, unless it be in Sir Howard Douglas's recent "Postscript," and in those sixteen mystical words contained in his second Conclusion, in the fifteenth page: "That thin plates of wrought iron, even $\frac{3}{8}$ ths of an inch thick, are proof against shells." If those words do not contain the justification sought for, then is the use of such plates in the batteries of such ships at all, *utterly unjustifiable* but if they do contain that justification of their use in 1859, then do they with equal force overthrow the condemnation pronounced on those same plates of iron in 1850. I feel I can add nothing to the force with which truth has thus vindicated itself;—nothing to this entire justification of the long-sighted memory of Sir George Cockburn;—to this tribute to his far-seeing sagacity, and the establishment of his unimpeachable title to be regarded as the "Father" of our iron "Fleet of the Future."

Thus I have been brought safely through all my own conclusions chiefly, I may say, by those of Sir Howard, and in now taking grateful leave of him with the same respect and honour as that with which I commenced our "amicable differences," I again presume to express my sense of what I believe to be a deep public obligation in the means which his research has afforded for an entire review, and as I trust I may say redecision, of this great question; and in which, if it result in public benefit, I again repeat my sincere conviction that none more than Sir Howard himself will rejoice. And I may therefore now proceed to avow what has been one primary object in undertaking this review at all.

I have long felt that "Iron-cased Ships," although destined, as I believe, to supersede, as chief exponents of "naval force," at least the wooden Screw-ship-of-the-line, were, like them, unfitted by bulk and costliness to perform all the various duties of British men-of-war throughout the

world's waters ; and yet, that to continue the building of ships wholly of wood, even for the performance of these more general duties, would be, in the face of the present features of modern artillery, to build them for certain destruction. It therefore appeared to me very desirable to attempt the removal of those obstacles to A GENERAL USE OF IRON FOR OUR FLEET, which I have ever regarded as being in themselves purely fictitious. How far I may have succeeded, or may succeed, in effecting such removal, now remains, of course, for the action of that "opinion" to determine, but I have faith that I have done so at least to this extent, that any reasonable doubts or misgivings yet remaining, will be found entirely to disperse before any well devised, faithful, and open experiments, that may be directed towards doing so.

At this point also I claim to have vindicated the National recognition of the value of our iron resources for every maritime purpose. I have endeavoured to show, not I trust presumptuously, that in the assumed unfitness of iron for "purposes of war" as well as commerce there has indeed been no anomaly in the gifts of Providence, and in the mode of maintaining that assumption, none, alas, in the frailty of man. And I have exhibited how great is the power of our present system of "secret and exclusive experiments" on great national objects, to set up and to pull down; to uphold and to withhold; and to reverse, wholly or in part, any required thing.

And now permit me to remind you of two things. First, that the main course of my history is not yet brought to its close, it having been quitted for a time in order to trace out to its conclusion the "Simoom" branch ; and next, that this branch itself has not been traced to those natural conclusions so inevitably to be drawn from the features it presents. Were I fully to do so, I should have to enlarge on the equally ungrateful task to both of us, of pointing out how the most valuable truth of the "Simoom" trials, that truth which badger-like had to be drawn forth out of Sir Howard's little six-word sentence, still continued to be rigidly withheld from public light, *and even so continues still.*—I should have to give weight to the omission from the "Return" 737 of the effects of "shells" being demanded as well as the effects of "shot."—I should have to point to the negotiations and communications throughout 1851 and 1852 between the ruling Administration over Naval matters and what was then known as the "Shot Association,"—an association organized out of the larger and still-existing "Steamship Owners' Association," and composed of gentlemen deeply interested in the judgment pronounced against the use of ships of iron for Mail contracts; and the grounds of whose organization are expressed as follows:—

That the experiments made by order, as particularised in the Reports published in pursuance of an order of the House of Commons, No. 737, appear to have been insufficient to test conclusively this important question, for the following reasons, viz. :—That on the "Ruby," from the very slight nature of the plates and framework, and from the circumstance of no corresponding experiment having been made on a wooden vessel ; that on the target representing part of the side of the "Simoom," whether lined or unlined with wood, because no experiment was made at the same time and in the same manner on a target representing part of the side of a wooden vessel of similar size, in order to show the relative effects on iron and wooden vessels ; because no means were used to test the practicability of remedying the making of splinters by other means than wooden lining, nor of stopping shot-holes between wind and water in iron vessels, by inner plates or other contrivances, considered by competent persons to be practicable ; and because of

the inferior quality of the iron employed, the quality of the iron being a most important consideration in all such experiments, as the best iron would not be injured to the same extent as inferior iron by shot or shell.

And I should have to show how the demands of this Association for a fair open trial of iron against wood, shot for shot, shell for shell, hot shot for hot shot, when pressed so inconveniently as to make it necessary to victimize some wooden hulk against their large section of a "ship of iron," were at once gotten rid of by the removal of the "ban" complained of. I should have to show how in 1851 a direct "Motion," in connection with the objects of this Association, for "copies of any report made to the Board of Admiralty on or about the 18th of August and 11th of October, 1850, of experiments made for testing the merits of wood and iron-built ships for resisting the effects of shot and shells," was at once complied with by a "Return" which, when produced, was found to be "still born," and "ordered to lie on the table." All these and other historic data I should have to criticise and inflict on all in proof of what? That the experiments ordered in 1850 were never intended to overthrow those of 1846; and when such a discovery as would have had that effect did in reality occur, that it was equally an object to withhold it from publication as much as possible, lest indeed it should produce the open "overthrow" it certainly would have done, with all its awkward consequences.

I now, therefore, arrive at that portion of my Lecture which I have long looked forward to with a pleasure all the greater that I feel it will be one of equal relief to many others besides myself. I believe I have faithfully adhered to my self-imposed interdict against the mention of all names; but I feel nevertheless as conscious as any who may hear, or may read these lectures, that, in prosecuting with what I feel to be no more than strict and necessary faithfulness the investigation of a subject truly described as of "immense importance," it has been impossible for me to avoid presenting views which at first appearance might seem as if calculated to occasion reflections upon individuals.

In respect to "experimental" transactions, I need scarcely say that they all, of necessity, and as in every case is expressly stated in the records of them, emanated, not from those who executed them but from the orders of Superior Authority; and such orders, I again need scarcely say, are wont to be obeyed, as I trust they ever will be, with a zeal which regards it as a duty to adopt the very sense, in which what is required, is expected to be done, even if the judgment of the doer of it dissent from the merits of the requirement itself. I, therefore, claim that, in dealing as I have done with all such "transactions," as set forth in published records, I may be considered,—as also I have faithfully made myself to feel,—as not even to have known the names of the parties to them.

I just notice the purchase and employment of the two iron gunboats during the Russian war to observe that here we have actual proof of the recognition of the merits of iron for ships of war, on a small scale certainly, but still the principle was thereby fully admitted.

But I at once bring the most undeniable proof of where all responsibility for our position lies, by reference to transactions of the present day, and in the identical matter itself of "Iron-cased Ships." I will beg you to notice that the date of the letter I now read is that of the 15th

November, 1855, and the letter itself was addressed, as was due, to that "Department" whose special duties the subject of it concerned.

November 15th, 1855. This model and drawing show the internal arrangements by which the greatest strength is to be produced. They were designed by me for the construction of a shot-proof corvette. You are aware that from the beginning I have been a believer in the shot-proof quality of vessels made of iron plates of great thickness. About five years ago the eminent steam-ship builder of America, Mr. R. L. Stevens, communicated to me the result of a long series of experiments made at the expense of the United States government by himself, the chief practical result of which was, that iron plates of 5 inches thickness were absolutely impenetrable to the heaviest shot fired by the longest guns in the service, the heaviest charge of powder, and the shortest distance.

The model I submit shows the manner in which I propose to build a shot-proof corvette which would possess all the qualities of our present steam corvette, but would be of larger size and armament, and of perfect impenetrability. When I first made this design and model it was my intention to have taken out a patent for such construction applicable to war-vessels in general, but, as a patent involves publication, of which other countries would be able at once to avail themselves, I thought it better to keep my secret, and submit the matter in proper time in confidence to our own Admiralty, and which, accordingly, I now beg leave to do. *I beg at the same time to express my conviction from what I have reason to know, that if such vessels be not built by us they will speedily be built in other countries.*

Prophetic words truly, and it had been well with us had they been received.

But what became of this letter and the accompanying model and design? They were laid by. Where? In the "Hades" of the "Department." Why? Because it was of no use to present them. How long were they so laid by? Three entire years. Did the Designer ever inquire after them during that time, or endeavour to procure a presentation of his design? Frequently. And with what success? Always with the same answer, that it would do more harm than good to present them before the right time. Did the right time ever come? Yes; on the 10th of December, 1858, official correspondence took place on the subject, after personal interviews of a favourable nature, with high authority, and the project was then entertained. Did anything grow out of it? The "Warrior," the "Black Prince," and the whole British-born iron family, are the direct progeny of this official correspondence of December 1858, and therefore might have been of that of November 1855.

I claim to have now shown you, as I at first undertook, that the question of "Iron-cased Ships" was so mixed up with that of "Ships of Iron," that no intelligible separation could with truth be made in their history, I have shown you that in 1845 the Woolwich experiments gave results, the prosecution of which *might* then have led to "Iron-cased Ships." That the experiments of 1849, 1851 *must* have produced "Iron-cased Ships," had they not been controlled within that vicious circle of too thin and too thick, by which alone the pre-condemnation of iron altogether, could be and has been maintained. And I have shown that which is tantamount to their actual rejection, at least two years before "La Gloire" was begun.

I say, then, that from the summer of 1846 to the present day, England, in this great question of iron or wood for the national Fleet, has suffered one long, persistent, and grievous wrong. Years will not right it. Millions will not pay for it.

THE CHAIRMAN.—The Council are of opinion that it is desirable to confine the discussion to the subject-matter of Iron Ships versus Wooden Ships, and not to go on the question of iron-plating, as Captain Halsted has not entered into that yet. It is desirable that in the discussion one on each side shall speak alternately.

CAPTAIN SULLIVAN, R.N.—With respect to the “Harpy” and “Lizard,” mentioned by Captain Halsted, the reason I venture to make some remarks upon them is because I myself gave those two vessels the directions for passing that very place where these accidents happened. In going down past it just before, in a small sailing vessel, we succeeded in passing close under the battery, without a shot striking us. We went close under the muzzles of the guns, and I advised these two iron vessels to do the same. To quote the “Harpy” as an iron vessel fitted for war, it would be just as reasonable to quote my little tender-vessel that was not struck by a shot; because the “Harpy” went in so close under the cliff that every shot from the battery passed over her, though after she passed, and they got a gun to bear in a raking direction, one shot struck the Commander’s arm. The only shot quoted by Captain Halsted to prove her fitness for war, is one that must have been fired in an oblique direction, because it went through two of the paddle-floats, and therefore it could not have been a direct shot. Her case does not apply in the least. The “Nemesis” case does not apply in the least to the question, as only one shot struck her. But the “Lizard” is a case so decidedly applicable, that up to the time of reading this statement of Captain Halsted I had always supposed it, as I believe all present had supposed it, to be conclusive against thin iron vessels as fitted for the purposes of war. She had only to pass five eighteen-pounders. There was a tide of three or four knots against her; she had nothing in tow. She could not have been long under the fire of these guns, because they were so confined in their training by banks of clay it was with very great difficulty, with the vessel passing even at the short distance she did, that they could get more than a couple of guns to bear whilst she went past; yet the damage done to her was so great, that before she had passed she had three-feet water in the hold. I did not see her, but those who wrote to me described her as having proved the utter unfitness of iron vessels to be trusted within reach of shot. The men and officers were sent below. A shot struck one of the ribs in the gun-room. I believe the shot broke up against it: at all events the splinters the iron shot made were so bad, that one shot killed one officer and two men. Some round shot passed clean through and struck the opposite side; but I understood that her principal danger from sinking was caused by the fire being from a height downwards, driving out the plates under water. I have no doubt from all that occurred, that had she been a few minutes even under fire, she must have sunk before she could pass. All those who saw her gave such a very decided opinion, that it at once settled the question that these vessels were utterly unfit for war. To show how much damage she received, compared with wooden vessels, I may mention that a few days before, I met a wooden vessel, the “Allecto” of 700 tons, with three heavy schooners in tow full of troops. Just after I passed this place, she took these schooners past. She was so long under fire, in consequence of not being able to tow the three vessels round the point, that she got a great many shots in her hull. At last she stuck opposite one gun—the last gun; and that gun kept throwing down shot after shot—eighteen-pounder shot—at the pivot-gun that was on her fore-castle, till it was knocked over by a shot from the pivot-gun. Yet, with all these shots, that vessel had not one man killed or wounded.* It was astonishing from the way in which the steamers passed, from the crew being scattered, and the comparative size of the deck, that there was no serious damage. The only case in which there was any serious damage in proportion to the fire was in the case of this iron vessel. One wooden vessel, the “Delphin,” had forty-six shots in her hull, principally 32 and 42 pounders. She had one-third of her crew cut down entirely by the plumping of round shot. She had her wounded laid on the deck just above the water-line, so that the shot passed over where the wounded lay. Some of the operating men were killed, but the wounded escaped, from being under the line of fire. Can any one doubt but that the wounded would have been all destroyed, had there been splinters of iron? I have not the slightest doubt of it. To bring the case of the “Lizard” forward as a proof of what an iron vessel can stand, is really contrary to the opinion of every person who was present and saw it. Then again with respect to these very experiments, I never heard of them till Captain Halsted read them; but the experiments seem to me to justify the report which was come to. We read of the shot splitting the iron into fragments, and driving them across the deck like a charge of grape. When

* We presume owing to the absence of iron splinters.—ED.

the experiments on wood were made the shot struck stanchions and caused many splinters; but those stanchions would have been in the rear of the men working at the sides. We did not hear of any such destructive splinters except from the opposite side and mid-ship part of the ship; yet these iron shot would, breaking up in passing through the side of an iron vessel, begin to spread the moment they passed through, and mow down the men just the same as if a charge of grape were driven through the hull. Therefore I think there cannot be anything in these experiments which can at all justify the opinion that the officers who made them did not give an honest report of the result of their experiments. With reference to the strength of these ships, which I think is included in this portion of the paper, I am leaving out the question of plating ships, because that is now a settled question—there is now no difference of opinion. The only question is whether those plates can be better placed on strong wooden ships or on iron ships. Up to 1850 certainly all the experiments had been made only on thin iron ships; the plating of them with shot-proof plates had not been thought of. Even the corvette which was proposed to be built in 1855, you will find, was after the floating batteries had been built—a year after the French Emperor had begun them. I think in November, 1855, those floating batteries had been tried against the forts at Kinburn. Therefore it at once explains why, when some one proposed the building of iron ships, it was merely adopting what had then been an experiment made principally with another form of ship. Then again when these ships were built in 1858, instead of party having anything to do with it, it seems to me they were built because it was found that France had got the start of us in building iron ships—and that anybody would have done the same whoever he was. But suppose the iron plates to be a costly thing, the only question then remains whether it is safe and right to put these expensive structures on an iron bottom. Letting bygones be bygones as to all these experiments, I think this is a most serious question, because we are going to a very great expense in putting very expensive structures on a bottom that I for one believe to be decidedly unsafe and unfit for the purpose. I have a strong opinion even with regard to iron vessels. I allow that, for sailing vessels, where they are not carrying passengers, and not very likely to be wrecked, where they gain in stowage, and are somewhat cheaper, it may be very desirable; but, after the results we have had of the wrecks of iron ships, after the numerous cases I have had before me during the last four years of inquiries into the loss of iron ships, my conviction is, that it is not safe to entrust the lives of men in any numbers in ordinary iron ships if there is a question of taking ground. It may be said, this is an old obsolete prejudice in favour of wood—in my case it certainly is not. The conviction has been forced upon me more and more as I have gone into the inquiry into the causes of the wrecks of iron vessels. They are all very well at sea, but directly they strike rocks, they go like brown paper. Take the instance of the "Birkenhead" for one. Not long since there was the case of the "Royal Charter;" she broke her back across a little ridge of rocks, where the worst wooden steamer would have perhaps hogged and bent, yet have held together long enough to save her crew. Not long since the "India" was lost on the coast of Newfoundland. She was one of those fine new steamers built for the Canadian mails. She had a number of passengers. It was not a gale of wind, nor a heavy sea. She went on a ledge of rocks so level that the report states there were two and a half fathoms of water in the fore-chains, amidships, and abaft; therefore she was nearly on a level bed. Can anyone suppose that a good wooden ship would not have stood a little grinding before she broke up? And any man of war would have ground there for days and days before she came to any serious mischief. This ship working on this ledge in a very few minutes broke in two in the centre. The two parts fell in opposite directions; and, before the boats could be got down, seventeen of the passengers and crew were drowned in these few minutes. Now there is not a wooden merchant steamer in the world that would have done that, much less a solid man-of-war steamer. Then again in the case of the "Birkenhead" she ripped up by trying to back astern. Not long before there had been an old paddle-wheel steamer, one of our old sloop steamers, on shore on a rock near the same position in a much heavier sea. As she lifted and bumped she was backed off by her engines, and, not having an iron bottom, they were able to keep her floating along the coast till they found a safe place to beach her and save the lives of the crew. Had she been in the "Birkenhead's" place she would certainly not only have saved them, but probably have come off with little serious damage. I could instance the case of the "Pique." We know she was aground twenty-four hours in a heavy sea on the rocks of Belle Isle, and yet she came home across the Atlantic with three-sixths of her timbers ground away. Suppose the strongest iron ship ever built, if she had a double skin with three feet between them, even the three-feet soles of the "Great Eastern," will any man believe that those blows which ground away three-sixths of a wooden bottom would not

have gone clean through both skins and everything of the iron ships? On one occasion in the Baltic one of our old forty-gun ships that had been built for a steamer, and had all the heavy engines and boilers of a three-hundred-horse-power steamer in her, which made her strike more heavily, stood in for the land. She found herself in a wrong position. She stood off, not knowing exactly where she was. There were dangerous rocks outside. Those rocks had a fathom less water than she drew and she ran right on the centre of them. The captain was a good masterly hand, and he knew the only chance was to take advantage of the lift of the heavy gale, for she was under a close-reefed topsail, and force her over this patch of rock, a mile in extent. At every lift he pressed on sail, which carried her forward, and at last got her off. The blows on the bottom were so heavy that her top deck bulged up at every blow. That vessel went over those rocks, stayed out, and did her work to the end of the season in the Baltic. Can anybody suppose that the "Warrior" under those circumstances, with her tremendous weight of 7,000 tons, going down on her bottom, would have stood that for ten minutes? Her ribs would have been broken; and, if she did not drown all hands, the \$300,000 she cost would have been lost. Now it is a serious question, the employment of these ships in time of war. They are all very well to run across the Atlantic, not entering ports any time after dark; but when you come to a time of war, these ships must keep on an enemy's coast night and day. A man knows if he has a wooden ship under him, and she hits a rock that she will get no great damage; but if he has one of these iron ships under him, however anxious he may be to keep in and risk a few rocks, I do not think that there is any man in the service who would dare do it, if he has at all the conviction that I have as to the unsafety of iron ships; because he would know that, not only would the ship be a total loss, but in all probability he would lose the lives of the whole crew. When these iron vessels do fill they settle down. When sunk they may remain, owing to their weight, more steadily on the bottom than a wooden ship; but they settle down so rapidly that the sea breaks over them in such a way that no one could live on their decks, and the chance of getting them off would be hopeless. There is one case, often quoted by the advocates of iron-cased ships, that of the *Tyne*. She went into comparatively smooth water on the coast, to the east of Portland. She struck, not very heavily at first, and she answered her helm and kept getting off till she had come round from about E. N. E. She was steering off to S. E., and her head was nearly E. There are many of my friends here who have been in ships in that position, and they know that as long as a ship is moving, however hard the strikes, she will come off, and there will be very little damage done. In this case there was no shallow or water outside, but the moment she struck she drove in her bottom plates; though she was coming round and answering her helm, she was settling down from the rapid filling of one compartment; and where she was in a position that a wooden ship would have come off, she would not move. That ship lay there. They had to build off the compartment where the damage took place, and then with immense lifting power to lift her, with the additional weight of the water in this compartment. When the "*Sphinx*" went on shore on the Isle of Wight, she beat over rocks with much less water than she drew. As far as I recollect, she beat over at first a reef of rocks. She then went into deep water, and was brought up by an inner reef. That vessel lay there exposed to the whole swell of the Channel for months. The only difficulty was to take her out over this reef. She came off after all these months of grinding, having been kept clear by her own pumps. Again, the "*Great Britain*" went on shore on a sandy beach, with one lump of rock there. She had no rock outside, and as she settled down on the sandy beach the rock went through her bottom—she settled down over it, there being a great weight of iron with the water in her. With breakwaters outside her she managed to lay there for some months. But they had to lift up and repair her bottom, and get this rock out of the way before they could think of getting her off. The "*Gorgon*" beat over a reef of rocks nearly half a mile from where she grounded. She beat on this reef of rocks with much less water than she drew, in a heavy sea, and she tore off her bottom, but she made no water. The consequence was she went over the reef in safety and drove up on the beach, and lay there as long as the "*Great Eastern*" did. But she was got off, and was so uninjured that she went and did her work for a twelvemonth on her station, and then came home. But put an iron ship in position just as the "*Gorgon*" was; in beating over that reef, if she did not settle on it, is quite certain the rocks would have driven some of the compartments in; and in passing in she would have sunk before she got in, and there settled. I feel that as a certainty. Any one who thinks of the difference in the cases, and thinks of the way in which that rock went through the bottom of the "*Great Britain*" would know that if she had beat

on a rock of less water than she herself drew, as the "Gorgon" did, she would never have reached the beach. There is scarcely an instance of a wooden man-of-war being lost from getting on shore; the cases are so few in which they are not got off again, that there are only a few exceptions. But when iron ships once strike on the rocks, the exception is when they are recovered. Not only is my feeling strong about placing these expensive structures on iron bottoms, but if the responsibility rested with me I should feel it a positive duty not to send out even troops, emigrants, or any men whose lives were at stake in one of these iron-built merchant ships. I allow that there are some advantages in combining the wood and iron in these iron-bottomed ships. But we must recollect another thing, viz., that we have to get over the question of keeping the bottoms clean. Even at the Society of Arts, one of the iron-ship builders stated it was necessary to find some plan of sheathing them with wood outside and coppering them. I had it from the same officer whom I have quoted, that the "Himalaya," if her bottom is not cleaned every year, would have her speed considerably reduced.

Mr. SAMUDA.—Captain Sullivan has thought proper to refer to a subject on which I had no intention of making any observations this evening, but to which I now think it necessary to refer for a few minutes before I come to Captain Halsted's paper. I scarcely imagined that at the present time it would be necessary to rise in defence of the question, whether it was moderately safe, or whether any sane person would take upon himself the responsibility of allowing valuable lives to be trusted in iron ships performing ordinary voyages? That such a question should be raised by a gentleman who holds the position in the Board of Trade which Captain Sullivan does, is one of the most extraordinary things it has been my good fortune or misfortune to listen to. I will only just put it in one practical point of view, and then I will dismiss that part of the subject altogether. I will first of all mention this circumstance, that while Lloyds, who ought to be pretty good judges of what is the ordinary value of ships' risks, charge something like from six to eight guineas a-year for insuring the ordinary wooden craft, which, according to Captain Sullivan, perform all these voyages with such admirable superiority, the Peninsula Company perform the office of their own insurers; and I can speak from information received from the managing directors, when I tell you that from twenty years' experience their insurance account has not yielded them a charge of two per cent. upon the cost of their shipping—their fleet being entirely an iron fleet. I will only add further, that when it is attempted to disparage a mercantile marine of universal application throughout the world, by quoting such cases as the "Birkenhead" and the "Royal Charter," I think Captain Sullivan ought to have explained how very exceptional those cases are from those which might reasonably be looked for under an ordinary state of good and efficient and well-built vessels. The "Birkenhead" was a vessel built very many years ago. The destruction—the absolute destruction of the "Birkenhead" was due, to what? To an iron vessel—I will admit improperly constructed—not being able to possess herself of a means of security, which a wooden ship has not yet been able to possess herself of at all, of bulk-head divisions, to separate entirely one part of the ship from the other. These bulk-heads when improperly placed in ships, or placed without the amount of experience which may reasonably supposed to have been obtained since the building of that ship, are, I say, a source of weakness to a ship on the occasion of her taking the ground, though they are a source of great security to her on the occasion of one portion of the ship being perforated. I should not say they are a source of weakness, but I should say the way in which they were placed in the "Birkenhead" was a result of weakness. I believe the same observation applies to the "Charter." I am not at all defending the "Charter." I do not want to say a single word about the "Charter." But when that is quoted as an instance of the inferiority of iron ships, I will just inform Captain Sullivan of what has taken place in three or four cases with iron ships that have come under my own knowledge. In the first place, there was a vessel I built myself, which, after she had been at sea for two or three years, got on shore in the entrance to Neath Roads. I was telegraphed for to send down men to see what possibly could be done to save this vessel, her destruction being considered imminent. She was loaded with 700 tons of iron ore, a full cargo, and she had taken the ground in such a position as to leave fifty feet of her after end unprotected, that is to say wholly unsupported. The weather was extremely bad, so bad that there was no possibility of going to the vessel and lightening her; and the tides were taking off so that she could not be floated. The only answer I was able to telegraph back was, "I can do you no good; let her take her chance." That vessel lay upon that shore for seven days, with two or three days of most severe gale. It was so severe that no craft could go to her to lighten her. At the

end of the third or fourth day she was lightened sufficiently to float, when the returning tides of seven days took place. I had sent down in the meantime a foreman and two or three men, with instructions to get as many more as was necessary. The whole cost of the repairs of that ship was 127. The first thing after she floated her own engines were put to work, and she steamed forty miles before she could get on to a gridiron in order that it might be seen what was the matter with her. A few plates were strained; they were caulked, and the vessel went on her service and worked for two years after that. Now, is it not too much for any gentleman to quote iron ships as being unsafe for people to be in, when so many know of what they may be made, and when we all know that the best services performed under the sanction of Government and by many of the first commercial countries in the world, are done—not partially—but wholly with iron ships? I am really surprised to hear any one make assertions to the contrary. (Hear, hear). The destruction of the "Paramatta" which took place the other day, and which must have come under Captain Sullivan's notice, was about as good evidence as any one could wish of the enormous strength that could be given to a good iron ship. That ship was placed in a position on the rock from which it was impossible to release her, and she remained there for months. Not more than a fortnight ago the observation was made to me by one of the managing directors, "I believe a large portion of her remains there still." She remained there undestroyed for months and months during the heaviest weather. It was perfectly impossible from the position in which she took the rocks to get her off again. That was the description given of her to me, and I believe it was perfectly true.

Then we have got the fact and the knowledge, in spite of the experience of the last speaker, that the Peninsular Company's ship, the "Northern," went on a rock in precisely that position which was described by Captain Sullivan as certain to be fatal to an iron ship; and yet she is as good a ship as they have in their fleet at the present day. Therefore, I think it is wasting time, after the examples, not only that I have put, but the world-wide and notorious examples that everybody has within his own observation, to attempt to decry iron ships as being useless, when they are found to be as useful and practical, if properly made, and as strong as any structures that ever floated on the waters.

Now, to refer to the matter which is more immediately the subject of this evening's debate, which all of us and the country generally take an enormous degree of interest in, I think it necessary to say that to deal with the mere question of an iron ship by speaking simply of a ship constructed of iron plates in the way in which we construct merchant ships, would be to throw ourselves a quarter of a century back; in fact, would not be raising any issue which would be useful for the practical purpose of the question of advancing our navy. To make this question useful, you must deal with the question of what profit, what advantage, we should have by constructing the vessels protected in the way, or somewhat in the way, in which it is intended to protect them at the present moment—whether these vessels be of wood, or whether they be of iron. I do not think the observations Captain Halsted has made with reference to the $\frac{1}{2}$ plate shivering shot and shell to pieces would induce any person (if the mere question required to be resolved by this answer had been, "Are these the only ships—the only mode of construction—which you propose to adopt?") to come to the conclusion that vessels with sides of $\frac{1}{2}$ plating, or something approaching to it, were the right things suitable for vessels of war. We have got a great many stages beyond that. I think we have got completely into the right direction by taking iron hulls, and protecting those hulls so as to make them shot-proof. Now, there are certain points which appear to me to be most essential—in fact, fundamental elements in this question. Granted that a vessel cased in iron plates is a right thing to meet the artillery of the present day, what are the conditions—and that I think is the most important thing of all to start with—what are the conditions which are indispensable to enable that vessel successfully to be a ship of war? The first condition which I think absolutely indispensable is, that it should have at least equal speed with, and that it would be far better if it had greater speed than, any ship it is likely to contend with. That I believe to be essential because, shutting out altogether the question of speed, if you protect these vessels as well as the weight you can afford to carry upon them will allow you to protect them, you run a great risk, with the means at your disposal to make a successful result, of destroying that result, and thereby throw yourselves back some twenty or thirty years. Speed being the first point essential in all iron ships of war to make them successful, the next is to protect them entirely from one end to the other. If we must have the fastest ship, and must have a ship wholly protected, the question then arises, how are we to do that? I will not go the length of saying it is impossible to do that on a wooden hull; but I do go the

length of saying, it does involve so large a vessel, and so much strength of structure, to enable that ship to be practically useful, that I really believe you are shut out from the possibility of any other hull to build on than an iron hull. Now, the "Warrior," and vessels of the "Warrior" class, combine in a great degree the requisites which I have laid down as the necessary qualities to start with. The "Warrior," I believe, will be a faster vessel than any vessel whatever in our own navy, or in any other navy in the world. But, then, the "Warrior" does not possess the second requisite, that of being entirely protected from end to end; it is only protected in the centre. But the question of the protection of a vessel is after all what I may term a ship-builder's question. It is not a question connected with the gentlemen of the navy, except in one respect, that is to say, they would all of them be disposed gladly to accept it if the thing could be done, but they imagine probably that the thing cannot be done. Now I believe the thing can be done. I have no doubt in my own mind that a vessel of the size of the "Warrior" may be successfully covered from end to end with an armour as perfect as that which she has on, nay more perfect, and yet draw no more water, or rather less than she does at present—in other words, be no heavier, for it is a mere question of weight. With reference to those reports which Captain Halsted has brought forward, of the firing on the two targets, one of a simple plate, and the other of a $\frac{1}{8}$ th plate, backed with a great quantity of wood, though they really are not very useful for present purposes in the present day, contrary to the conclusion which Captain Sullivan came to, they seem to me to convey the same result. In both cases they appear to have thrown a large quantity of splinters, and to have made holes in the side of the plating nearly identical.

CAPTAIN HALSTED.—I was comparing those with the wooden ships, not comparing them with each other.

MR. SAMUDA.—I am comparing them with each other—the two sides, different portions of the same ship. It appeared to me there was a very slight difference in them. The experiments I have made myself corroborate this view. I have fired at iron plates, and then at plates with wood at the back of them, and I can find no difference in the size of the hole, nor do I find the slightest difference in the fracture made by the bullet, whether the wood is behind the iron plate or not. And, if you reason upon the thing, I think you will find it is reasonable to come to the conclusion that there should not be a difference. Now what is the meaning of "backing?" "Backing" means support. If you take an iron plate and put behind it something, the object of which shall be, if this plate gives when it is pressed with a great amount of force, to enable it to resist the pressure, it follows that that which is behind it will come to its assistance. Now, if I put two iron plates accurately planed one against the other, it is perfectly clear that the particles of the back plate would be in as close contact with each other as the particles of the front plate, so that the particles of the front plate, being pressed against the particles of the back plate would receive some assistance from them; and the assistance would probably be this: if the front plate were 2 inches thick, and could give a resistance, without the back plate, equal to a force which we will represent by 4—the square of the thickness—the back plate would come to its assistance with another power of 4, and the two together would give resistance equal to 8; but, if I take away this back plate and put on at the back of the front plate a substance which would yield to a much greater extent, from its particles not being in such close connection with each other, than the front plate could do before it broke, it stands to reason that that would give a very modified, if any, assistance to the front plate. That is the case with a piece of wood. A piece of wood will bear a squeezing up, a pressing before it reaches the ultimate point of breaking; it so moves away that a $\frac{1}{2}$ -inch plate would have to be distorted out of its form to a considerable extent before it could receive assistance from this piece of wood. That would necessarily cause it to break; consequently, it would receive no assistance whatever from this piece of wood. The wood, it is true, would be a second defence, it would prevent the shot going into the ship, but it would afford no assistance to the iron in preventing it from breaking. If instead of this piece of wood you put a piece of metal, whose particles are equally in close contact with each other as the particles of the iron plate itself, you would receive an assistance equal to doubling or repeating over again the amount of resistance of the iron plate itself, that is to say, if the front iron plate had a resistance of 4, the two together would give a resistance of 8; but if, instead of putting two, one as a support to the other, you made the whole in one plate of four inches thick, instead of a resistance of 8 you would have a resistance of 16, because you would have a resistance equal to the square of the depth of 4 inches, which would be 16. Therefore, by carrying the same weight on your ship's sides, you would get exactly twice the amount of resistance you would have with the iron backing; and that I have shown is much more effective than the wood backing.

If you follow out that principle, by substituting for all that large amount of useless wood a plate in weight equal to the wood, then, with that and a $4\frac{1}{2}$ inch plate you would get a 6-inch plate. Incorporating that 6-inch plate into the top side of your ship, you first of all get an armour which will give you nearly double the amount of resisting power that you get in the present "Warrior." But you get a great deal more than that; you so reduce the weight by doing away with all the top side of the ship to which you hang all this armour, that instead of making the top sides of your ship weak you make them extra strong, by the top sides of the ship being both constructed of, as well as coated with, armour. You would be able to cover the vessel from stem to stern with a plate 6 inches thick and 5 feet below the water, and have 270 tons less weight, and your vessel would float 6 inches higher than the "Warrior" does at present, yet covered from end to end with armour. Now I ask, when such things can be done on an iron ship, and when any one analyses the way in which an iron ship is put together, and the way in which a wooden ship is put together, can there be a doubt as to the comparative strength of the two structures, or a belief that iron structures will be done away with? Mark for one moment what necessarily takes place. In putting an iron ship together, if the thing is well put together, you really produce exactly the same result as if you had formed the entire structure of one plate of iron from end to end. You do not do that with a wooden ship at all. Every seam of the iron ship is rivetted and fastened together; and if properly done the strength of each seam is equal to that of the solid plate itself. Now in wooden ships the strength depends upon the strength of the fastenings which you put through the timbers. A very good plan when vessels are kept continually floating, and up to the time of iron ships the best plan you could get. But when we have arrived at a point where we are able to make iron vessels so strong, that we might make them, if necessary, equal to stand a pressure of fifty or sixty pounds to the square inch—for that is really the strength we might apply to iron vessels if properly put together—and where wooden vessels would not stand a fourth of that pressure without yielding in every direction, it is a little beyond the mark to talk of iron ships being unfitted to convey valuable lives. I would mention another instance with regard to iron vessels which you cannot hope to get with regard to wood. I recollect a vessel going down the river one day in a fog. She came back the next day to my works to be repaired, cut down by another steamer having run into her to four feet below the water's edge. The engines brought her back to the works. No part of her cargo was damaged. The accident was confined to the compartment which was struck—the bow compartment. That was full of water 'up to the water-line; but beyond that there was no water in any other part of the ship. Surely, these are advantages which are of no small amount. With regard to the vessel I told you of, the *Paramatta*, I believe at the time and for a long time afterwards, during which they hoped to save her, they got the water completely excluded from every compartment except the compartment in which the rocks had penetrated her bottom. I do not speak with certainty as to whether that was so in the first place, or whether that was the result of some additional security and help they gave to the bulk-heads afterwards. But, be that as it may, whether at first or afterwards, the bulk-heads in the ship enabled them to do this; and they did it so completely that for a long time the water flowed in and out only at that portion which was penetrated, and in no other part. I think the points we have got to deal with in this discussion resolve themselves very greatly, not so much into what was done some years ago, as into what has got to be done to complete our present doings with regard to these vessels. Though I have spoken thus strongly with regard to the observations and experiments which I have made, I would suggest, that the wisest course in this case would be merely to accept them as the result of so much observation, so much experiment, or so much speculation on the part of one who has had some opportunities of making some experiments and thinking a good deal upon the subject. I say, let experiments be tried. Let two or three targets, not of a small size, but of a very large size, be tried, having these different qualities of armour placed before them. I fancy the whole thing resolves itself into this. The great question, the great point of anxiety, will be to determine which is the best way, when we have got these iron hulls, of dealing with them—whether to put one description of armour upon them, or to put another description of armour upon them. All I hope and sincerely wish is, that the result of these deliberations and discussions here will be, to convince the Government that the wisest, and cheapest, and quickest course will be to get an elaborate set of experiments made on several descriptions of armour as from a reasonable consideration of the matter seem likely to produce a good result; and then to avail themselves of the assistance of such of their officers as may be likely to lead them to a correct conclusion as to which of these kinds of armour is the best.