



## De Bathe's And Lynall Thomas' Armour-Plates

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# Evening Meeting.

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Friday, May 31, 1861.

CAPTAIN M. S. NOLLOTH, R.N., in the Chair.

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## DE BATHE'S AND LYNALL THOMAS' ARMOUR-PLATES.

BY LYNALL THOMAS, ESQ.

HAVING attended the discussion at the Institution of Naval Architects without having had an opportunity of taking part in it, I avail myself of this opportunity of exhibiting and explaining a method of affording resistance to the penetration of shot and shell into the sides of a ship, which may perhaps be worthy of your consideration, as I believe, from long and earnest consideration, added to considerable experience, of the effect produced by shot generally, that the solid iron plate on a coating of timber, as adopted in the general service, is one of the worst which could be conceived. My chief reason for this opinion is, that the whole force of the blow coming at once upon the plate, its effect is felt instantaneously through the whole thickness of the plate in the direction in which the shot is moving. An immense thickness of metal is therefore required, and consequently an enormous weight upon the sides of, and strain upon the vessel generally; the joint efforts of which make the remedy almost as bad as the disease. With respect to the strength afforded by the wooden back, I have to observe, that in all my experiments I have found the wooden foundation to favour rather than prevent the penetration of the shot through the iron plate. There are several methods for preventing the penetration of shot or shell into the sides of a ship. 1st. By constructing these sides entirely of iron, thus opposing plates of solid metal to the impact of the projectile. 2nd. By sloping the sides in such a manner as to deflect the projectile. 3rd. By covering the sides with some substance which shall receive the first impact of the projectile, dispersing the force before complete penetration can take place.

The objection to the first of these methods is, that with the continual improvements in the means of attack, so great a thickness of metal would be required, that no ship could carry it without great detriment to her sea-going qualities.

With regard to the second method, namely, the sloping sides, the same objection holds good; for, although a less thickness of metal might be found sufficient to divert the blow of a shot when fired at ships thus constructed, unless under certain circumstances, yet such vessels must, of necessity, lie so low in the water, that in engaging land batteries or vessels much higher out of the water than themselves, the sides would be liable to penetration, unless the metal plates were of a thickness identical with those required for a vessel of an ordinary form, so that a still greater weight of metal would

be necessary, inasmuch as more would be required to cover a sloping than an upright side, the surface being greater.

Up to the present time, I believe that the efficiency of the sloping side has only been tested with "round" shot, which are more easily deflected by the slope than flat-headed shot of an elongated form, for the following reason. The ordinary spherical shot only preserves sufficient force to penetrate an "ordinary" iron plate (*i.e.* 4 inches) for a short portion of its flight. Consequently, unless at point-blank distances, it is useless to attempt to penetrate an iron plate with round shot. With a heavy elongated shot, however, this penetration could be accomplished from a greater distance.

Now, supposing the gun to be fired with some elevation, the sloping sides would be rather favourable to penetration than otherwise, in proportion as the angle of the shot's descent approached that of the sloping side.

It has hitherto been a received opinion that the axis of an elongated shot remains always parallel to itself during the shot's flight, in which case its penetrative powers would be considerably decreased as the distance of the object struck increased. This, however, is not necessarily so. An elongated shot may be so constructed that its axis shall remain a tangent to the curve throughout the whole flight, so that such projectile will always fall point foremost on the object struck.

This has been proved by experiment, in a manner which placed the truth of it beyond a doubt. In fact, I myself made the experiment with a 7-inch rifle gun at Shoeburyness.

What I have just stated shows that the thickness of metal for vessels constructed with sloping sides cannot safely be diminished.

Should the vessel roll (and who can assert that they will not, and that heavily) where will be the use of the sloping sides?

When the guns have to be worked on the top of the sloping sides, the effect of the ricochet of the broken shot, &c., from what may well be called an iron glacis, will probably be most destructive.

The third method, namely, that of dispersing the force of the shot before the latter has time to penetrate the sides of the vessel, appears to me to be the one likely to be attended with the greatest efficiency, convenience, and economy. The "Warrior," and other iron-cased frigates, are examples of this principle in its most primitive form. These vessels have wooden sides, and to prevent the penetration of shot they are simply coated with plates of iron.

The proposition to construct the sides of the vessel with iron, placing wood outside as a protection, is the same in principle, and would doubtless be more efficient in preventing the complete penetration of solid shot; but the facility with which a coating of wood, or indeed of any soft substance, would be destroyed by shells, puts this method out of the question. I entertained the above idea some time ago myself, but discarded it for the reason I have mentioned.

With respect to the wooden vessel coated with solid iron plates, there appear to be several almost insurmountable objections to their permanent adoption. In the first place, it would appear to be necessary, after a ship of this description has been laying up for some time, that she should be stripped of her armour from stem to stern before she can be honestly pro-

nounced fit for service again. Furthermore, in order to ensure the requisite protection, the iron would have to be nearly, if not quite, as thick as if she had no wooden sides at all.

The method which I have now to submit to the consideration of this meeting is one which I believe will be found better calculated to attain the desired ends than any of those which I have mentioned. It is, I believe, quite a new idea, and consists of protecting an iron vessel with iron armour. This armour, to which we have given the name "louvre-plate," on account of its similarity to a louvre-board, or, what will be more easily understood by most, a "jalousie blind," is the joint invention of Colonel de Bathe and myself, and is the result of much careful consideration, coupled with some knowledge of and experience in the effect of heavy rifle projectiles.

The diagrams will show more fully the arrangement and disposition of the metal, and may be thus briefly described. Upon the sides, say  $2\frac{1}{2}$  or 3 inches in thickness, of an iron vessel, are placed the plates one above the other in the manner shown, leaving an interstice between each which might advantageously be filled with an elastic substance, such as New Zealand flax, junk, &c. In this instance the plates are supposed to be  $2\frac{1}{2}$  to 3 inches thick, and the interstices  $1\frac{1}{2}$  inch; but this, as well as the thickness of the plates, is arbitrary, and will depend entirely upon the size of the vessel and upon the relative protection which it may be considered desirable to afford her.

By this means we get rid of a very large portion of weight; in fact, reckoning that of both the iron and wood, in such ships as the "Warrior," the weight would be over one-fourth less.

It will be perceived by this peculiar disposition of the metal, that the force of a shot's impact is felt, not in the direction of its flight, as in the case of a solid plate, but at the point above it, and therefore the effect upon the hinder plate is enormously reduced. Very little solid resistance is offered to the first impact of the shot; but the quality of elasticity, so largely possessed by iron, is made subservient to resisting the effect of impact in a very great measure.

I would further draw your attention to several other advantages which this arrangement possesses in a high degree, one of the most important of which is the ease with which any damage may be repaired by means of spare plates; so much so, that a vessel may carry them and repair her damages at sea.

Again, the effect caused by a shot striking the side is confined to a smaller space than is the case when a large solid plate is struck (more especially when the plates are not penetrated), since the whole plate, which may have a surface of 70 or 80 square feet, is affected by the blow. An elongated shot, from the unequal resistance which it would encounter upon its fore-end, would have its penetrating power very much more lessened in striking plates of this kind, than in striking those presenting a surface offering a uniform resistance, from the greater ease with which the equilibrium of their axes would be destroyed. It will however, I believe, be found impossible to entirely prevent the sides of a vessel being penetrated by solid shot. There is a limit to the thickness and weight of iron which a ship can carry; but the limit to the weight of the projectile, and the

force with which it can be driven, has not yet been reached. All we can at present hope to do is to prevent the penetration of the very destructive elongated shells which are now coming into use. The best course to be pursued, as it appears to me, would be first to ascertain what extra weight ships of each class could carry on their sides without much impairing their sea-going qualities, and then to distribute that weight of metal in the most efficient manner for her protection.

The experiments made upon the "Trusty," as described by Captain Halsted, although extremely valuable, I look upon as being far from a conclusive proof that that description of plate would afford so great a protection to ships as alleged. In this instance, *single* guns only were fired each time at her. Now, in order to form a correct estimate of the efficiency of these plates, or, indeed of any method of protecting ships of war, the vessel experimented upon should be moored, or placed in a position where a large frigate could steam past her, delivering her broadside as in action. It is highly probable that the effect produced by two or three shots striking the same plate simultaneously, would prove more destructive to it than if it were struck by them at separate intervals. Two or three broadsides of heavy guns well delivered, at a distance of 50 or 100 yards, might possibly from the sheer force of the concussion so damage or loosen her plates that a few well-directed shots might suffice to place her at the mercy of her antagonist.

It has been stated that a solid 4-inch plate offers a greater resistance than four 1-inch plates placed apart—that the resistance, in fact, is as the square of the thickness; that is, in the case of the 4-inch plate, this resistance is as of sixteen, whilst with the four 1-inch plates it is only as of four. This is perfectly true as regards the punching machine, or any similar continuously exerted force; but quite erroneous with respect to a shot's impact. A punching machine of sufficient power to punch a hole in an inch plate will not only punch holes with equal facility through four, but through four hundred, if necessary; but a shot may penetrate an inch plate, and not be able to penetrate two placed one behind the other. One is a question of continued pressure on the inch, the other of impact and velocity. Solidity only would resist a large continuous pressure; but the effect of a shot's impact will be impaired by any diminution in its velocity; and the velocity may be diminished in various ways—in fact, it begins to be diminished the moment the shot leaves the muzzle of the gun.

I grant that, if these *louvre*-plates were placed under a punching machine of sufficient power, they would be penetrated much more easily than a solid plate of the same thickness, because, in the punching machine, *time* is of no account; but the time which would be required to bend these plates down is of immense importance in destroying the effect of a shot's impact, since it would cause the force of the shot to be rapidly dispersed in each direction.

Although, in the experiments which have been made against iron plates, the form of the projectile, and the metal of which it should be composed, are questions of great importance, I hold that they have engrossed an undue share of attention, and that scarcely sufficient regard has been paid to the force of propulsion. At short distances, the form of the projectile is of small importance compared with the degree of force which is employed

in its projection; thus, with a gun of a given weight, I believe it will be found to be of more importance in close action to employ a heavy charge of powder and a lighter projectile, than a heavier projectile and light charge of powder; for it must be remembered that it is the propelling force, *i. e.* the charge of powder, which drives the shot through. Now, although the charge for rifled cannon is a comparatively limited one, because, when exceeding a certain proportion, the shooting becomes wild, yet, at short distances, where great accuracy is not of so much consequence, a very heavy charge may be used with great effect. It has been proposed to increase the weight of projectiles employed against iron plates, diminishing the charge of powder. Now, were it an easy matter to penetrate *both* sides of an iron ship, this proposition would be reasonable; but, in the present state of affairs, it is altogether an erroneous idea. In support of what I have stated with regard to the effect of a shot's impact, I will quote a passage from Sir Howard Douglas's valuable work, "Naval Gunnery," page 77:—

If an oblong shot, twice the weight of a round shot of equal diameter, be fired with the same charge, the velocity of the former will be less than that of the latter, in proportion as the square root of the weight is greater; that is, the weight being as 2 to 1, the velocities will be as 1 to  $\sqrt{2}$ . But the effect of impact, measured by the volume of penetration, being as the weight of the shot and the square of its velocity, it follows that with equal charges the effect of the oblong shot will be just equal to that of a round shot of equal diameter.

From the above, therefore, it is evident that the charge of powder being constant, no additional weight in the projectile will increase the effect of its impact. The reason why the 68-pounder 95-cwt. gun has not yet been superseded in our naval service, lies in the simple fact, that a charge of 16 lb. of powder can be fired from it, and neither Sir William Armstrong nor Mr. Whitworth have been able hitherto to produce a gun capable of surpassing it on this point. With a view of beating the heaviest smooth-bores in the service upon every point, I have had a rifle gun constructed upon a principle of my own, from which a charge of 21 lb. of powder can be fired with perfect ease and safety, and with projectiles of any weight, from 120 lb. to 180 lb. or more, as may be deemed most advisable. It may, perhaps, have come to your knowledge that this gun has already been tried with very remarkable results, and a further trial is about to take place.

On the first occasion the charge was increased from 21 lb. to 28 lb. of powder, the projectiles being 175 lb. in weight. Nine rounds were fired, chiefly with a view to test the strength of the gun, and upon this, as indeed upon every other point, the result was most satisfactory. In order to try the gun (which I may here observe loads at the muzzle) to the utmost, three rounds out of the nine were fired at an elevation of  $37\frac{1}{2}^{\circ}$ ; two with 25 lb. and one with 28 lb. of powder. The range attained was very nearly six miles, and the penetration into the earth totally prevented the recovery of the shot, and could not be ascertained; the time of flight of these shot was from 37" to 40". No iron plate which has yet been placed on on a ship's side could I think resist the impact of a shot from this gun at any distance within 2,000 yards or more; and if Sir Howard Douglas's method of calculating the effect of the impact of shot be (as it doubtless is) correct, these shot would have the same force at any point

Fig. 2.

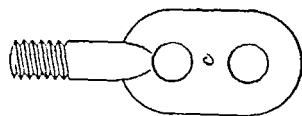


Fig. 1.

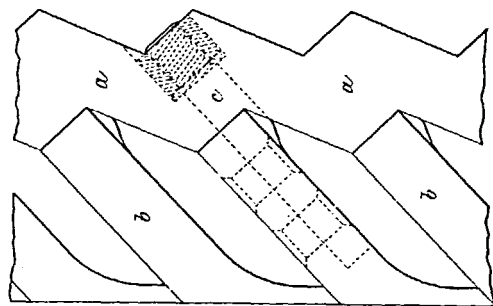


Fig. 3.

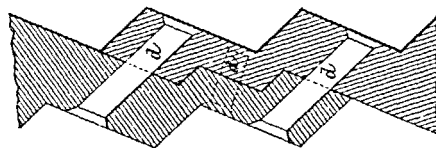
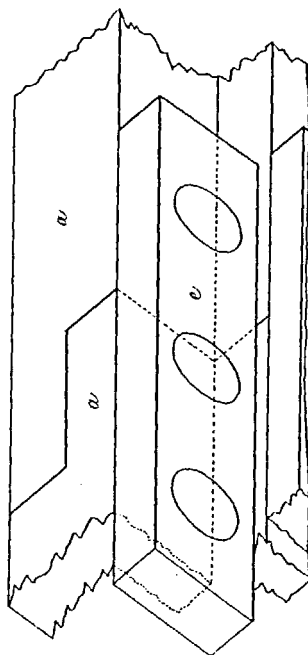


Fig. 4.



0 1 2 3 4 5 10 15 INCHES.

within that distance, as that of a 68-pound shot when it first leaves the muzzle of the gun, since the mean velocity of flight in passing over a distance of 2,150 yards was exactly 1,200 feet a second, the time of flight being 5·31 seconds. I believe it is in contemplation to arm the "Warrior" and ships of her class with thirty-six 100-pounder Armstrong guns, which are of about 4 tons each, whilst the gun I have just mentioned is of about 6 tons. Now it appears to me that twenty-four guns of this description would prove a much more efficient armament than thirty-six of the Armstrongs, which have not shown much power against iron plates. There would be besides several advantages attending such a change. One of which would be, that two portholes only would be necessary where there are now three, and that in the future construction of this class of vessel the parallel sides would require to be of less length by 90 feet, since the same intervals only (15 feet) would be required for the purpose of working the guns. Those who heard Mr. Scott Russell's most interesting lecture at the Institution of Naval Architects will both understand and appreciate this suggestion.

But to return to the subject more immediately under discussion, I would remark that I believe no sea-going vessel can carry plates of any description which shall render her sides proof against the penetration of solid shot, and therefore that these vessels should only be protected as far as may be possible, without depriving them of other and vitally important qualities, and this, I believe, may be done in a manner to prevent the penetration of incendiary and explosive projectiles of a very heavy description, by some such distribution and arrangement of the metal as that which I have now the honour to introduce to your notice.

A powerful armament and great speed are matters of the very highest importance, and not to be lightly sacrificed; in fact, an iron-cased vessel wanting these qualities would present a mere inert target to a more active and better-armed opponent; and her certain capture and destruction would be simply a question of time. A ship of war is commissioned to "burn, sink, and destroy," and not simply to save herself from being burnt, sunk, or destroyed. In conclusion, I would remark that, having no experience in ship-building, but having had great experience in the effect of shot upon various materials, I have regarded the sides of a ship in this question in the light simply of a protection against destructive missiles, that is, in what manner the greatest protection can be afforded with the employment of the smallest possible weight.

The following is an explanation of the plate:

Fig. 1 represents a transverse section of the side of an iron ship protected by the armour-plates, *aa* being the side or skin of the ship of a zigzag form; *bb* the outer or "louvre" plates; *c* is the bolt which fastens the latter on to the former. The spaces between the louvre plates may be filled with some elastic substance.

Fig. 2 gives a front view of the bolt *c*.

Fig. 3 shows the manner in which the inside plates are connected one with another in a longitudinal direction, *ddd* being the rivets, which are placed at certain intervals apart.

Fig. 4 is a front view of the vertical join, *aa* being the plates which



form the side of the vessel, and *e* the plate which is placed at the back to strengthen them at the joint. This plate is also made fast with three rows of rivets.

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In reply to various questions, Mr. Thomas stated that the gross weight involved in the proposed form would be one-fourth less than, and, according to the calculations of a well-known Iron Company, the expense about one-half (25*l.* instead of 50*l.* a-ton) the expense of the "Warrior,"—that the saving would result chiefly from all the plates being rolled at the cost of about 8*l.* a-ton, whereas the "Warrior's" plates are very expensive, especially where there is tonguing and grooving,—that repairs could be made with great facility, without disturbing any but the injured parts. The width and thickness of the armour-plates would be adapted to the size and tonnage of the vessel. It will be impossible to give a small vessel a protection equal to that of a large vessel; the effect of the shot's impact is diverted, so that the blow upon the inner plate is not felt in the direction in which the shot is moving, but at a point above it, which considerably lessens the destructive effect. The spaces between the plates may be packed or not with some elastic substance, but the packing was objected to as giving rise to the deposit of a great deal of moisture. The inside plates of iron, or skin of the ship may be flat instead of a zigzag form, but the latter offers a better resistance to shot.

The CHAIRMAN conveyed the thanks of the meeting to Mr. Thomas for his interesting and instructive paper, and the proceedings then terminated.

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