THE

SHIPS OF THE FUTURE

BY

E. FAIRBURN

BEING

AN EPILOGUE

TO

THE SHIPS OF TARSHISH

By "MOHOAO."

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Robert, John and Vida Stout

N.B., SEPTEMBER, 1906.

During the seventeen years that have elapsed since "The Ships of the Future" was printed, I have made several experiments (though only on a small scale, and therefore not entirely conclusive) with the system of floats—free to move vertically as described therein—with disappointing results.

Then I read in "Pearson's Magazine" of Mr. Linden's experiments in Italy with flaps (called by him "fins") fixed at bow and stern of a boat, and their partial success. I recognised at once that Mr. Linden's method was the right one for the use of wave power for moving boats, being simple and direct.

Therefore, I wish those who read "The Ships of the Future" to regard them (all floats having been removed) as being propelled by steam power—it moving the drums, they moving the vertically-positioned paddles—non-splashing—wasting no energy—except momentarily at the turn at each end, etc., etc., or else—perhaps preferably—by the Turbine system, which I have not read enough of to understand. In connection with this request, I may state that I had written half of "The Ships of the Future" before the idea of using wave power occurred to me.

As another and independent branch of the subject, I would here state that I think that in the future that it is not impossible that unsinkable cargo ships on a large scale, moved chiefly by wind power, with rows of low masts, set at various angles, with sails made of steel, on the Venetian blind principle (thus with no "hellyings"), manned with less than one-tenth of the usual crew—in proportion to cargo—(nearly all work being done by machinery) will be used. For such ships there would be no bad weather—no trouble for officers or crews, but everything and everybody always comfortable.

E. Fairbairn
20.8.06

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THE SHIPS OF THE FUTURE.

EPILOGUE TO "THE SHIPS OF TARSHISH."

WRITTEN IN JUNE, 1889.

IN 1865 I wrote, and in the latter months of 1866 had printed, the original portion of *The Ships of Tarshish*, but did not bring it forward by way of offering it for sale until 1884, at which time, in consequence of the stir shortly before made by the launch of the *Livadia*, I offered it to the notice of the public of Auckland in conjunction with a Prologue, which I wrote at that time, by way of introduction, and had bound up with the earliest written work.

It proved by no means a success. There were about 400 copies altogether, and I think about thirty were sold. I gave away over 300 (and feel grateful, whenever I think of it, that none of those to whom I offered copies ever hurt my feelings by refusing, or suffering to appear a disinclination to accept them), and I have a few copies left in sheet form.

I sent several to England at different times, when people I knew happened to be going there from here (Auckland), and kindly consented to take charge of them and distribute them. One gentleman in particular generously undertook the bother of getting rid of about twenty of them. I saw him a few months afterwards on his return to Auckland, when he informed me that he had sent copies to several men of mark in England, though he did not mention any names; and I think it must have been owing to his kindness and taking of trouble that one day I received a biggish official-looking letter, and on opening it found it was from the Principal Librarian of the British Museum, thanking me for the "present mentioned on the other side." Turning to the "other side," I found written, *The Ships of Tarshish, by Mohoao.*

There was a shilling stamp on the letter, which fact, when I noticed it, caused the thought to come into my mind, "What a

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waste! Why, this is the full price at which I have latterly been trying to entice the public here into buying copies of it" (though each one, by-the-bye, had cost me about 2s. 9d.)

I was gratified at receiving the acknowledgment, though. It looked as though my book was worth something after all, and I stifled the suspicion which arose in my mind that had I sent a fine specimen of a *Kekereru* to the British Museum (I don't mean to the Principal Librarian, but to the proper officer) I would have received a similar courteous acknowledgment; and, therefore, I intend to send that Principal Librarian three or four copies of this "Epilogue" when it is printed, and I hereby request him beforehand, if he ever deigns to dip into it and read as far as this, not to trouble about sending an acknowledgment, and so not waste any more money on stamps.

Seeing these things then, readers will no doubt ask, "Why do you try your hand at that sort of work again?" Well, it is because in the said Prologue, from an unwillingness to increase its length, and from want of leisure at the time, I omitted many things I would have liked to have stated on the whole subject, and partly because that portion of it on which the earliest of my two previous writings treated—that is, the best form of battle ships—is a subject on which there has been since, and is, a strong and increasing interest displayed, and on that part of it which excites less interest—the best form of passenger ships—or what will be that of "The Ships of the Future," I have become possessed of some new ideas, of which I think it is a pity the public should not become sharers. At any rate, I intend to send them forth for whatever they are worth, and let them take their chance.

I do not imagine that what I am writing will have any immediate effect, but, as like many possessed with bright ideas (Dr. Austin's guests to wit) who can see at a glance the fallacy in the other fellow's craze, but know well that not a joint can be pierced in their own logical armour, I being quite sure that what I describe, or propose—or something very like it—is sure to come to pass, have a sort of hope that what I write may be the means of causing it to come to pass sooner than it otherwise would.

I said something like this in the Prologue I wrote and published in 1884, and—it may be only a coincidence, but it is just possible it may be a result—a scheme which I suggested in that Prologue has since been proposed to be carried out by a German company—that is to have a great floating national exhibition visiting in turn the different parts of the world. But I felt disappointed when I read of the size of the vessel proposed for it, as it seemed to be on a sort of twopenny-halfpenny scale, as compared with the magnificent one advocated in

the said Prologue. But everything must have a beginning, as the old saw says.

Seeing then that one of my published ideas, whether as a result—or fancied to be so only—is to be carried out, in however modified a form, the fact acts as an incentive to my bringing forward one or two new ones.

Before, however, I attempt to do this, I wish to make a few remarks on the subject of the earliest printed portion of *The Ships of Tarshish*, namely, being that of the best form for battle ships; and as that production and its said subject will be several times hereinafter alluded to, I here subjoin some extracts from it, and also furnish, together with other drawings appended hereto, a copy of the illustration given on its title page.

Page 87.—"The large iron gates were observed to commence opening outwards from the middle, as though propelled by a force behind. It was, in truth, one of the 'Ships of Tarshish,' as Mandevil called it, forcing its way out. Forth it came full armed, as the ancient goddess of war issued from the opening head of Jupiter. Polished from stem to stern, it shone like the silver moon, the profile of which, when two-thirds submerged in the watery horizon it resembled.

"The mighty vessel came out and turned slowly down the stream, and then was followed by another, its counterpart. It was about 350 feet long with a breadth of about two-thirds its length. The cross section of the part above water, its outline, formed an elliptical arch. The steepest inclination, that near the water-line, was less than 45 degrees. About 80 feet of the crown of the arch was nearly flat. The bows also sloped backward from the water's edge in the same manner as the sides. The stern was more upright. It had two cupolas, each 60 feet in diameter, and a round pilot-tower forward 15 feet in diameter. Owing to its immense breadth it appeared, from whatever side viewed, like a low circular mound crowned by fortifications. It was propelled by three screws, each with engines of 1,500 horse power. The vessel, in action, was steered entirely by means of the screws. It had a protected rudder, but this was only for use in case of damage to one of the outer screws. So much of general description must suffice for the present, one more particular will be given in its convenient place hereafter."

Page 95.—"At the united request of the party Mandevil gave a description of his vessels, of which the following is the substance:—Extreme length at water line, 350 feet; extreme breadth ditto, 230 feet. The outline of section in plane of water line an oval, being very much like that produced by the longitudinal bisection of a long-

shaped egg, bluntest end foremost, with a slight sharpening of the stem. Bottom flat. Greatest breadth of bottom, 220 feet. Draught of water with everything complete except coals, nine feet. Sides upright for five feet from water line downwards. The remainder of depth rounded off to meet the flat bottom. Section (vertical) of deck an elliptical arch, commencing at a foot above the water line, when without coals (consequently commencing at more or less *under* the water line when *with* coals), and having its crest 22 feet perpendicular height from base. Deck retiring at all points (stem and stern as well as sides), in an equal degree from the level of the water. About 80 feet of the crest (deck, lateral section) almost flat, no portion of the vessel above water presenting so steep an inclination as 45 degrees.

"So much for the outside shape of the vessel. Next for the construction. At a uniform distance of 4 feet from the inner surface of the outside plating of deck, bottom, and sides (except at the sharper rounded corners, where the distance was somewhat greater) was an inner skin of inch iron. Ribs of the vessel at sides and bottom of wood, 4 feet by 18 inches width, with intervals of 3 feet between each. These ribs built of three sections each 6 x 48 inches. The thickness of outside armour varied according to position. A little above and below the water-line it was 12 inches, tapering off each way as it ascended or descended. The flat bottom was half an inch thick. The arch of the deck commenced from water-line with 12 inches (thickness), tapering away for a width of 25 feet. From thence up to the commencement of the flat portion of 40 feet on each side of the middle of the crest, it averaged 2 inches; the general rule being, the steeper the inclination the thicker the plate. The nearly flat portion of 80 feet forming the crest was an inch thick. To sum up what has been already described:—

"The shape of the whole exterior—deck, sides, and bottom.

"An inner skin of a uniform thickness of one inch.

"An outer covering, of thickness varying as described.

"The ribs of wood at the sides and bottom, to which the outer and inner skins were screwed." . . .

"And, lastly, an interval of 4 feet between the inner and outer skins of deck, sides, and bottom." . . . .

Page 98.—"The interval, then, of 4 feet between the inner and outer skins is filled by steel hexagons of a least diameter of 18 inches. These hexagons are united side by side to one another, each by several screws. The four feet interval is thus something like a honeycomb. The ends of the hexagons abut on to the inner and outer skins, each individual end carefully shaped to coincide with the

rounding of their (the skins') surface. These abutting ends are secured to the plates in this manner: From the end of each hexagon, running down the middle of each of its sides, a half cylindrical hollow is indented in the making. Then the hexagons being firmly screwed together, and the sides of each opposite half hollow coinciding, a hole is produced, in which a female screw is formed." (I may here state I do not make a point of the foregoing described detail as to methods of junction, etc., written twenty-four years ago, when I was ten times more ignorant of practical mechanical detail than I even am now. Brackets used would probably have been more practical.) "All the screws used in the vessel have tapering heads accurately turned, and the corresponding holes in the plates are accurately drilled to fit them. Each screw is screwed in till it wedges itself tight. The head is then cut off flush. This sort of method stands jarring better than nuts and bolts. Besides the purpose of strengthening, this system of hexagons serves to localize and detect leaks. A thin sheet of gutta-percha being placed between the skins and abutting ends, keeps the uninjured parts watertight. On the inside a small perforation is made opposite the bottom of each hexagon for the purpose of detecting leaks. Except at the sides (where the thicknesses vary, some reaching to *three*-quarters of an inch) the steel hexagons have a uniform thickness of a quarter of an inch. In addition to this system of hexagons, which conduces so greatly to the strength and rigidity of the ship, we have in various directions steel tubular girders and braces of a large diameter."

Page 99.—"'There is one objection I have not thought worth considering—though I did consider it before commencing the enterprise—namely, the expense of these vessels. I thought what is the good of frittering away two millions on half-a-dozen inefficient vessels, when, spent on one, it may be the means of averting an evil fate from a kingdom to whom the spending of a couple of millions is like the loss of a drop out of a bucket.'"

The matter comprised in the foregoing extracts was written twenty-four years ago. I would ask any practical-minded reader, which is nearest finality—the class of battle-ship just before specified, or the latest designed British ones, as far as powers of offence and defence in coastal warfare is concerned (not to mention the class existing at the time the specification was written)?

In the Prologue before alluded to (published in 1884), I wrote the following referring to the description of battle-ships just before quoted from "The Ships of Tarshish," as compared to the British war-ships constructed since that book was printed in 1866:—

"I had the good fortune . . . to clear in one bound . . .

a great way beyond several steps which have been taken since in actual practice, the most of them composed of innumerable successive experiments and expensive *Tinkerings*, with disappointingly uncertain results. . . ."

Now the language quoted may seem very arrogant and conceited, at least as far as it alludes to my own ideas, but with regard to the latter part of the quotation and the practical results obtained after several years of experiments in producing British battle-ships I would refer to a production which lies before me, cut out from the London *Weekly Times* of March 1st, 1889, namely, a "memorial" issued by the Peace Society, entitled :

"OUTLAY CERTAIN—DEFENCE UNCERTAIN,"

and from it I extract the following phrases and sentences :—

"Over and over again John Bull (who, by the way, is one of the most timorous animals in the world), has in a fit of panic, given his Ministers *carte blanche* to impose terribly heavy taxation for an increase of armaments, and what has been the upshot? . . . .

"What have you done with the scores and hundreds of millions sterling already voted within the last ten or twelve years only? . . . Incalculable sums voted for ships and defence have been spent in almost everything but ships and defence. And of the ships built with the remnant of the money, how many have proved failures, or have had to be broken up or resold at ruinous sacrifices?

"Supposing that some scores of extra millions are spent on ships, even if the extra ships are really produced in consequence, they are likely to be obsolete and comparatively useless in ten or fifteen years. This is already the case with the great ships which have been such a terribly dear incubus to Italy.

"And further, the introduction of dynamite as an element in naval warfare is likely to render the destruction of the largest warships a very easy matter. It is a noteworthy and ominous subject."

The above are a few quotations from the Peace Society's logical and ingenuous production—logical, because if what they say is true as to inefficiency, a hundred millions should be spent right off to secure efficiency. As to the ingenuousness, that breathes in every sentence.

There are two main charges in it, one only of which, however, I want to make use of, after first merely remarking on the other (that which avers that a great part of the money has not been spent on ships at all) that the fact stated—exaggerated or not—is only a result of average human nature, and the cure will only take place when the honest breeds of men, either of their own accord, or by being kicked into it, band themselves together, and, by strict passport laws, keep out races of robbers from mixing among them. It is not a matter of

either liberal constitutions or despotism. This form of corruption is worse in "free" America (witness the Town Hall and Tammany Ring affair in New York). It is worse also in France. It is not so bad in Germany in spite of its "despotic" government, simply because there an honest breed, by strict passport laws, keeps itself from being swamped out.

Britain would have been freest of all from such corruption if she, too, by a strict passport system, could have kept herself also from being swamped out. I do not mean to say it could have been done. It is only a wistful thought.

With regard to the other fact (for unfortunately both the main charges made by the Peace Society, it cannot be denied, *are* facts, however much of a *non-sequitur* the conclusion they would wish to be drawn from them may be)—to repeat—with regard to the fact of non-efficiency of ships built and the rapidity with which they become obsolete there is no question, and if there is any comfort in the thought, Britain is not alone in this condition, but all the European navies are in a like case; and I have only quoted what I have in order to confirm that which I wrote five years ago about "innumerable successive experiments and expensive tinkerings with disappointingly uncertain results."

And so it will ever be; all money spent on warships will be wasted in a sense, unless an entirely new form of vessel is adopted. In all efforts hitherto in the construction of ironclads, the process has been very much like that of trying to squeeze a gallon of liquid into a pint measure. It has been a case of attention to and crowding in of details, accompanied with an almost total neglect of essentials and first principles.

Some of the readers of this will no doubt have seen those wonderful knives which have twenty different sorts of blades and implements in them, and if they have ever tried them, found out it would be much better to have each one in its separate form, as far as efficiency is concerned.

The unfortunate *Captain* was an example of a construction on the twenty-bladed knife principle. That ship was an attempted *omnium gatherum* of all good things. It was to have, amongst other useful adjuncts, such sail-carrying power as to be quite an economical vessel as regards coal consumption. And this heavy top weight caused her loss. *Nowadays* I believe the heresy has been begun to be mooted that carrying masts and sails at all is more expensive than using steam alone (without masts), taking one time with another—such as when steaming against a head wind has to be done, etc.—and the ground got over altogether.

This heresy was adopted in the design of *The Ships of Tarshish*.

Now, to fall back on first principles, in designing an ironclad, what are the essential qualities it should possess?

In the first place, steadiness of platform for her great guns, and room to work them in. I put this quality in the first place because the others required could not exist except by the same means with which the first has to be secured.

Secondly, Unsinkability.

In the third place Invulnerability (with reference to safety of its crew while fighting).

Now, if these three essential qualities are secured, all others are of minor importance; and possessed of these, there would be no danger of any first-class ironclad becoming obsolete. I speak now of vessels such as would be required for a channel fleet, or to blockade an enemy's coast. For cruisers, in addition to these three essential qualities, speed would be required. These will be dealt with separately at the end.

I think that no sensible person will deny what has just been advanced as to the three essential requisites. Then, if such is the case, one would think that the designers of vessels would reject everything and every old precedent, however time-hallowed, that did not secure them, and not helplessly make up their minds that they cannot be secured, and that it is a choice of alternatives whether with Messrs. Barnaby and White, to have extra thick armour on the citadel of the ship, leaving the ends, and consequently a good deal of its floating power unprotected, or whether with Sir Edward Reed, to protect the belt which secures its floating power, at the expense of a corresponding weakening of the defence of the citadel.

(Whether the merits of the controversy are quite accurately stated or not does not affect the argument.)

Then how are the three said essential requisites to be obtained? I will proceed to furnish the solution of the question proposed by one whose almost only talent is a sort of simplicity of mind, whose convictions have been strengthened, as he has grown old, by observing how much men in all things are slaves to precedent, and by remembering such cases as that of the Suez Canal, where a Balaam in the shape of the highest engineering authority of the day was brought from afar (this time not from the East but from the West) to curse, and who (unlike the other prophet) in this case *did* curse, but fortunately, as it proved, even for Great Britain herself, without effect. But to proceed:

To secure steadiness of platform it is evident there is only one way, and that is to provide sufficient size in vessels, and that the

breadth should bear a much greater proportion with respect to the length than in the orthodox style of warship. In short, the breadth should not be much less than two-thirds of the length.

In fact, without providing these requisites of sufficient size with very great breadth in proportion to length, it will be hopeless trying to produce a satisfactory result in ironclads, or a class of vessels which will not become obsolete almost before they are finished arming and manning.

Sir Edward Reed in one of his letters to the *Times* uses the following forcible language in alluding to something said by one of his critics:—

"Men may theorize and men may babble as they please about cells and cork, and coal and other more or less fanciful defences: they may labour to persuade us too, that because there is here and there a gun which can penetrate eighteen inch armour it is better to put our naval trust in steel plates too thin to give any protection at all, etc." And then Sir Edward Reed goes on to advocate the *having* of sufficient armour and "armour-belted" ships, though to my poor mind the logic of it all was not very apparent, as I thought the reason the other people did not provide the armour was because the poor ships were not able to carry it without doing without something else which was also of the first necessity. In fact, it seemed to me about six of the one to half-a-dozen of the other. But Sir Edward Reed seems to imply that you *can* squeeze a gallon of water into a pint pot somehow or another.

If it were allowable for such as I to say it (which I know it is not, and therefore will not say it—but will only imagine some ill-conditioned *Thersites* saying it), I would say, "Men may theorise and men may babble as they please about armour-belted ships, and may labour to persuade people that by transposing the positions of a number of drops in a bucket, you will be able to make it contain half-a-dozen bucketfuls extra, or that by cutting a one foot strip off the bottom of your blanket and sewing that strip on the top, you can make the article one foot longer, etc., etc., but the fact will still remain that you can't make something out of nothing, and that if you want to have effective ironclads, you must have stability and weight-carrying power, coupled with a moderate draught."

Since writing the foregoing, I have read in the *London Times* the account of the discussion on the reading of a paper by the Director of Naval Construction on the "Designs for New Battle Ships," and also that paper's leader of the 11th of April last (1889), remarking thereon. I must say that after therein reading Sir Edward Reed's condemnation of those ships, I feel inclined to apologise for having

written the lines in the immediately preceding paragraph, for from what the leader referred to states as to the one "fundamental condition" which Sir Edward Reed "regards as paramount" in battle ship construction, namely, "to keep them afloat in the face of any fire which may be brought against them," coupled with former indications as to his sentiments (such as the favourable manner in which he has written at times of Admiral Popoff's broad vessels), I begin to believe that Sir Edward Reed favours ships of the kind herein advocated; but that even he is so timid in the face of precedent that he can only venture to advocate them in an indirect way, and thus it happens that it is reserved for a Miserable *Mohoao** to rush in where an Eminent Naval Constructor fears to tread.

I like that said leader of the 11th of April last, and the logic of it. It is evidently not composed by one of the regular staff, but by a special expert. It says, "A battle ship is a compromise," from the context evidently intending the sentence to read thus: "A battle ship *must* be a compromise."

Well, in argument everything depends on the axioms and postulates admitted, and if before one is allowed to argue he must swallow the axiom, "A battle ship must be a compromise," or the postulate, "Let it be granted that, etc.," then all that these orthodox gentlemen contend for as to Armament *versus* Armour might possibly have to be granted, and also that "efficient locomotive floating targets capable of withstanding the effects of gun fire" cannot be designed so as to be at the same time "capable of inflicting as well as receiving" (attempts at) "damage."†

Now, were it not for the necessity of being obliged to admit that axiom or grant that postulate, a conceited non-expert might contend that a battle ship capable of withstanding any fire could be designed, and furthermore, that the very essential qualities required in order to be able to produce such a ship are the identical ones which would render it at the same time capable of inflicting as well as receiving damage —that is, having plenty of room for the recoil of the biggest guns. In short, *great breadth.*

But perhaps after all it is not a question of not seeing so much as willing not to see, and never minding what you do, or what money you waste so long as you are in good company. (Don't we know it, all of us, in our several small ways?)

Then again there would be the fearful expense. One such vessel might cost three millions. Still finality is a *desideratum*, and such vessels, though high priced, would never be obsolete, but would

* *Anglice*—Wild man of the woods.—*Savage.*
† See Appendix, Sec. No. 4.

always be fit to take a position in a line of battle—while if some *other* party built even only one—all these fine, orthodox ironclads would represent the value of so much old iron; unsuitable for cruisers, and not daring to show their noses in coastal warfare.

My summing up is that I am sure the Peace Society people are right when they hint that these new vessels will be obsolete before the last in the programme is completed.

At the same time I think it very probable that these battle ships in their performance will fully realise the programme which our naval constructors have set before themselves to carry out, which, as I understand it, is this: after closely watching our next strongest neighbours to secure a certain percentage of strength beyond that of those neighbours, and to top ~~any~~ by a little any improvement they may be supposed to have hit upon.

This may be taking a comfortable, but not a very lofty stand, nor is it a policy of a sort to excite much enthusiasm, when we consider that our exemplars, by whose doings that policy is regulated, have not the slightest fear of either our power or will to invade them, and that we have to do ocean police duty for the whole world, including ourselves, and that the last-named is an obligation we cannot, without being mean, evade, and that the great expenditure required for the purpose does not *all* come out of the pockets of the much-quoted British taxpayer, but part is contributed by various outsiders in the shape of cheap raw material and supplies.

After the foregoing rather long discussion, we will proceed to the second hereinbefore propounded essential quality required in a battle ship, namely, Unsinkability.

To secure unsinkability, what we have to do is to fall back on old-fashioned simplicity in planning and construction.

Before proceeding, I will quote a passage from *Xenophon*, whose clear and simple style, with its sweetness and light, one turns to as a refreshing change from modern "leading articles" couched in "Middle-class Macaulayese."

It is taken from the "Retreat of the Ten Thousand," which brilliant operation (the actors therein being chiefly Lacedæmonians, consequently of Danite or Israelite descent) was therefore performed, I am proud to think, by men of the same stock as our own, or the British race. The quotation is as follows:—

"The generals and captains assembled were in great perplexity, for on one side of them were exceeding high mountains, and on the other a river so deep that when they sounded it with their pikes, the ends of them did not even appear above the water. While they were in this perplexity, a certain Rhodian came to them and said,

'Gentlemen, I will undertake to carry over four thousand heavy armed men at a time if you will supply me with what I want, and give me a talent for my pains. Being asked what he wanted, 'I shall want,' says he, 'two thousand leather bags. I see here great numbers of sheep, goats, oxen, and asses; if these are flayed, and their skins blown, we may easily pass the river with them. I shall also want the girths belonging to the sumpter horses. With these, adds he, 'I will fasten the bags one to another, and hanging stones to them, let them down into the water instead of anchors, then tie up the bags at both ends, and when they are upon the water, lay facines upon them, and cover them with earth. I will make you presently sensible, continues he, 'that you cannot sink, for every bag will bear up two men, and the fascines and the earth will keep them from slipping.'

"The generals hearing this thought the invention ingenious, but impossible to be put in practice; there being great numbers of horse on the other side of the river to oppose their passage, and these would at once break all their measures."

The foregoing gives a hint of how unsinkability is to be secured in the construction of a vessel, namely, by using a great number of small cells for the purpose of providing floating power, or, on the principle, so to speak, of not carrying all one's eggs in one basket.

These cells should be numerous enough—not *half-a-dozen*—which number, not long ago, was thought sufficient for any vessel—nor half-a-score, nor a score, nor even ten score, but as least as many as can be placed in position, not more than five or six feet square across, and, for battle ships at least, of the hexagonal form. The necessity of having these cells sufficiently numerous is another reason why vessels should be flat-bottomed and very broad. These cells should reach from the vessel's bottom to about two feet above the water line thereof, when loaded.

In my description of *The Ships of Tarshish*, or war ships, in the earliest written portion of the work, and hereinbefore quoted, I provided cells only eighteen inches in diameter, which, of course, as far as that feature went, would have provided for a still greater margin of unsinkability, but then I only provided for these bottom cells (in common with those in sides and arched decking), being only four feet in depth, that is, as filling a space between double skins four feet apart. This was a mistake, as I freely acknowledge now, when laying of mines and discharging by electricity has become more of a science. The cells in a vessel's bottom should be of length enough to reach sufficiently above the water-line, so that if by chance a hole should be blown out in that bottom, no water would be able to rush into more than the damaged cells.

This is the way in which absolute unsinkability could be secured. If cells six feet across would not secure it, then cells three feet across would, and if not then (I am treating now of warships), then by having ones of still smaller diameter, of course having thinner steel plates for smaller cells.

I may be excused for alluding to the fact that I was the first writer to propose having a very great number of cells in a ship's bottom. When the *Ships of Tarshish* was written (twenty-four years ago) about half-a-dozen watertight compartments were considered to be sufficient. A short time ago I read of a projected steamer which was to be provided with over a thousand cells in her bottom.

I proceed now to the consideration of the third-mentioned requisite for a battle-ship, namely, Invulnerability. This also, as well as unsinkability, cannot be secured without very great breadth and consequent weight-carrying power, and provision thereby of room for placing all armour at a favourable angle for receiving the impact of projectiles; for invulnerability is as much to be secured by a slanting surface being presented to receive such impact as by thickness of armour, and room for slanting sides could not be got in a narrow vessel, nor (any more) floating power to carry a sufficient thickness of armour. Therefore a first-class ironclad *must* be of very great breadth. It must also be of a sufficient size to supply a floating power that will carry armour with a sufficient margin of thickness, and to be broad enough to be steady in rough weather.

Judging from the performance of the *Livadia* when crossing the Bay of Biscay in a heavy gale, as recorded by Sir Edward Reed in a letter to the *London Times*, I think the dimensions chosen by me in my *Ships of Tarshish* (*i.e.*, 350 feet long by 230 broad) the very smallest with which a first-class ironclad should be built, as the *Livadia* (230 feet long by 153 broad) evidently, as proved by the damage she sustained on the occasion mentioned, was not powerful enough to encounter ocean waves.

I have hinted at the commencement of this that since printing the two previous portions of the *Ships of Tarshish* I have somewhat modified my ideas expressed therein as to the best form for passenger ships, and perhaps for some classes of fighting ships, such as swift ocean cruisers, either first-class powerful ones or second-class less powerful. I may state shortly at present, explaining more fully afterwards, that the modification is in connection with two important points, one of which could not be taken advantage of in ships of the *Livadia* pattern, whatever other advantages ships of that pattern might possess. These two points are, first, utilising a form of propeller (not my own invention I may state, but which nevertheless

I hink would not be safe to use except with vessels of the great size which I advocate), which form of propeller, owing to the advantageous angle at which it moves through the water nearly all the time that it is in it, would produce a greater amount of speed out of the same horse-power than any other; and secondly, *the being able to make use of the power to be got out of the rise and fall of ocean waves.*

I will more fully explain these two points when I come to the second portion of this paper, which deals with the probable form and size of the passenger ships of the more or less distant future.

The second of these two points could not be taken advantage of in ships of the *Livadia* pattern, though I think these latter, owing to their shallow draught of water and the enormous strength of build possible in connection with them above that in connection with those of any other form, would be the best for coast defence, or for forming the main portion of a fleet in blockading an enemy's coast.

It would be better, however, on account of the exposed position of screws and their consequent liability to suffer damage, that in place of them the propelling agent should be paddles of the kind more fully described hereafter, and shortly now as worked in connection with bands, passing over drums fitted in three or four openings parallel with one another, constructed in the middle part of the vessel, the blades of the paddles to project just beyond the vessel's flat bottom, and the whole to be provided with means for being thrown out of gear, so as the paddles should lie flat when passing over shallow ground, at which times the auxiliary propelling power, through ejection of water, as next described, might be used till the shallow part is passed over. For while the paddles are so thrown out of gear on account of shallow water, or in case of damage to them by mines, a subsidiary slow propelling power might be provided by having, say, three large tubes parallel to one another extending from stem to stern, each end opening near the level of the ship's bottom and rising (for purpose of being protected) in the middle; the whole provided with powerful pumping apparatus.

There is a great chaos of opinions on the subject of war-ships. You come across some people who say, "The opinion of the best authorities now is that ironclads are utterly useless—what are really wanted now are cruisers, the swiftest afloat that can be built, each carrying one powerful gun that will throw further than any guns carried by an average ironclad, which by her superior speed could choose her own distance and disable the ironclad, etc." Something after the fashion of the *Pirate* in Marryatt's novel of that name. All very fine if you have no coast to defend or blockade.

Again, you hear it said that torpedoes and dynamite guns are going

to revolutionise everything—and that trying to secure defence against such things is hopeless. If it were so it would not matter much for countries like France, Germany, and Russia, which have large standing armies; or America, which could soon raise a big army; but it would be a poor look-out for England. For my own part, I have never been much a believer in torpedoes or dynamite guns—and think that in actual warfare, they will, perhaps, be found to prove more dangerous to the users of them than to the enemy, and that the vessels of the nations which employ them will require to have chiefly *Curtiuses* for their crews. An exception might be in naval warfare on rivers.

My own opinion is that a vessel with a sufficient number of hexagonal cells (say, ones of three feet diameter as a maximum number or minimum diameter) in her bottom, reaching two or three feet above the water line, might pass over dynamite mines, and unless in actual contact with such mines, or if there was any space occupied by water between that mine and the ship's bottom, that the water thrown up would escape in the direction of least resistance, and that direction would be in radii all round the vessel, which latter might be heaved up a foot or two, then subside below water level to the same extent, and, after a few oscillations, settle to rest; but that would be all. If the bottom were in actual contact with the mine (a most unlikely thing) a few cells might be crushed in, but no disablement take place.

As for the deck of an ironclad (or rather all the surface above water) with the exception of a conning tower, and one or two cupolas, that should present a perfectly clean appearance like the glacis of a fort, allowing no foothold or cover to boarders. Not those fearful and wonderful labyrinths of adjuncts which are to be seen on warships of the present style, and which seem to invite a hailstorm of splinters.

With regard to cupolas, if in pairs, their centres should be respectively on alternate sides of middle line of vessel sufficiently far to allow of the big gun in each being trained fore and aft if required (not on middle line as shown in the *Ships of Tarshish*, which showing was an oversight—the worse that the form of construction gives plenty room for the eccentricity).

I will now turn to describe a different class of vessels and to a more peaceful and pleasurable subject, which is to propound the probable approximate form and size of the passenger ships of the future, and after having done so I will return for a short time and give my idea of the best form for swift ocean cruisers, which (as to some of them at least) in the method of being propelled, would resemble such passenger ships.

THE MERCANTILE NAVY OF THE FUTURE.

In the Prologue to the *Ships of Tarshish*, written and published in 1884, is the following prognostication :—

"I think that the dimensions of the passenger-carrying ocean-going ships of the future will be something like 500 feet wide by 750 feet long, etc." . . . "I take 500 feet to be the least extent required to secure nearly an equilibrium in the heaviest gales. This is with reference to the width of ocean waves, with reference to which I am sorry to confess I have *no data*. The vessel's breadth should be double that of the wave or nearly so." Again :—"These vessels would be of the *Livadia* or Ships of Tarshish fashion."

I have since changed my mind as to the above-named shape being likely to be that of the mercantile ships of the future, on account of an important point having occurred to me; which point is, as before mentioned, *the utilising the power to be got out of the rise and fall of ocean waves*, and in conjunction with so doing, having a form of propeller (already mentioned), which while being more effective than any employed hitherto, could also perhaps be used more advantageously in connection with the same form of construction, as would be required in order to utilize the said wave power.

But if I am wrong in my estimate of the practicability of utilising that power, then the *Livadia* form of vessel would after all be the best, because of its greater strength and shallower draught.

Also, I have since found, from reading, that ocean waves are much broader than I thought, the extreme breadth being about 500 feet. And as mankind, I am certain, will never be satisfied with anything short of finality in the matter of equilibrium without a break at sea, therefore the ships of the ultimate future will be about 1,000 feet broad by any length not less in extent than the breadth, but exceeding it *ad libitum*.

I may state here that I do not profess to go into small details of construction, but only give a general outline in my written description, and the same is the case with the drawings which are furnished herewith. At the same time, I have thought the thing out sufficiently to know that what I suggest *could* be done.

I would propose then to have nine vessels placed side by side, with a total breadth of 1,000 feet from outside to outside of the two outer vessels. Each pair of vessels to have a 30 feet wide opening between them (this dimension being equal to what perhaps their draught would be). Each of the two outside vessels to be 135 feet broad, and each of the seven intermediate ones to be 70 feet broad. Let

the said openings between reach upwards to 30 feet above the water level, or 60 feet from the bottom of the vessel. With regard to length, the mean of that of all the vessels would be 1,000 feet, but varying as to individuals—the middle vessel being 1,250 feet long, and the outer sides of each outer vessel being 750 feet long, the line touching the bow ends of each of the intermediate vessels (also those of the other two) forming a uniform slope between, and meeting the corresponding line drawn from the opposite side in a right angle.

Above the 60 feet level (measured from the bottom) would be the cargo carrying and habitable portion of the vessel, and the construction of which would be designed so as to form a secure and perfectly rigid connection of the vessels one with another.

There are drawings attached at end of this paper which illustrate this general description. In these also, as in the written description, there is no pretence of giving exact details, as nothing but sufficient experiment would settle the many questions that would arise in connection therewith.

To propel the united vessels there would be paddles attached to bands passing over drums, placed at suitable distances apart, say two or three hundred feet. No more length should be taken than found of actual advantage, in order to leave room for the other adjuncts hereinafter described for obtaining auxiliary driving power from the action of the waves. (This form of propelling is adopted from one of the numbers of the *Marine Engineer* of about four years ago.)

As in very rough weather the paddles working in the trough between the waves might be liable to race, it would be prudent, perhaps, to work each of the alternate sets in conjunction with the other.

The remainder of the space between the vessels, fore and aft, not taken up by the drums and paddles described (these being supposed to be placed amidships) would be taken up by large, so-called driving coffers, these to be as broad as would fill up the space between the vessels, after leaving sufficient room for them to work up and down, by about 43 to 46 feet long (according to thickness of dividing walls, hereinafter mentioned, though the bottoms might underlap these in an L form, to increase buoyancy) by a depth of say 24 feet, or as much deeper as experiment would prove could be allowed, after providing for extreme range of play. Between each pair of coffers, for purposes of strengthening connection, there might be dividing walls across from 5 to 10 feet thick, to reach as low down as they could without killing the action of the waves. These coffers would be attached to the vessels each by (say) 10 dovetail pistons, working on their three exposed sides against roller bearings (so as to be free

to move up and down with little friction), there being two such pistons working in each dividing wall, and three in each of opposite sides of vessels, the middle one of each triple set, last named, being provided with a rack for driving a pinion.

The form of the proposed superstructure is shown in the drawings, without any pretensions to its not being capable of great improvement being made on it, because, as implied before in this paper, only general principles are insisted on, all mechanical and other details being omitted.

The proposed superstructure consists, first, of a decked-in portion at the bow, as shown. The deck rising from the water-line at an elevation angle of 30 degrees (measured on the square from the sloping lines each side of the bow) till it meets the 60-feet level, and ending in a bulwark rising a little above that level as shown.

With respect to the remainder of the superstructure, or that part of it lying aft of the just described bow portion, commencing at the 60-feet level, there is first a bulwark from (say) 18 to 20 feet high all round the margin of the deck (at said 60-feet level); then rising from that deck are four stories, receding one behind the other (as to their roofs) at a uniform slope of 30 degrees. There is a gangway all round the base of each story about 26 feet broad—or equal to the co-tangent of 30 degrees multiplied into 15 feet, that being the height of each story. Then a large flat space, upon which is a central circular hall and tower.

These tiers or stories are intersected by openings or streets thirty feet wide running across the vessel from side to side, and the walls of these openings, as well as those of the different divisions of the whole superstructure, would be designed so as to secure the strongest possible system of trussing, in order to bind the whole of the upper and lower works together.

In the drawings nothing is shown on this large flat space (except the central hall and tower), but on it might be erected houses of the ordinary kind with streets between, and squares, with gardens; and this would form the passengers' living portion of the vessel, the tiers below being devoted to cargo.

The sixty feet vertical extent of these tiers above the deck would probably supply sufficient depth of trussing to secure a solid connection between the vessels, but the structures and street walls above might be designed so as to add still further strength.

In the drawing of the end elevation and cross section, the dotted line shows the probable form of ocean waves at their highest and broadest, and the action—as influenced by the rise and fall of these waves—of the large iron coffers or boxes placed free to move in a

verticle direction (as before described) between the vessels, is shown, these iron coffers being supposed to be weighted to near the same weight as that of a volume of water equal to that of the said coffers.

I imagine, however, on reflection, that the so weighting of these coffers, or anything near like it, would not be advisable, and have come to the conclusion that the proper course for finding out to what extent they should be weighted would be to determine by experiment the point at which the force of the up-stroke of the pistons produced by buoyancy would be balanced by that of the down-stroke produced by gravity.

According to the drawings there would be in the whole system of united vessels, 104 of these coffers, and I have made a rough (rule-of-thumb) calculation of their average driving power. I give the result of it with diffidence, for the following stated reasons :—First, I have never before had any practical experience with the sort of calculation involved, and have had to read up for it; secondly, I have had to guess at one of the elements used in the calculation, it being a thing that could be determined only by actual trial; and thirdly, the result which came out seemed to be too good to be true. I having, as shown in the beginning of this paper, looked upon the power to be obtained as only an auxiliary one to the extent of perhaps one third, certainly not more than one-half. It is as follows :—

First, I guessed that the proper weight for the coffers would be that of one-third of their volume in sea water. Next, I assumed that the average stroke with the pistons one with another, and one time with another, would be five feet, that is, assuming them to exert force both up and down; and that this double stroke would occur every ten seconds, or five seconds for each way, that being the received period of an ocean wave.

The answer is a total of 129,000 horse-power (about), which I can scarcely believe, as it seems, as I observed before, too good to be true. However, I let it go. Experts will soon set it right. It is, however, just possible, on the other hand, that the power might be even greater than the above given one; for I have allowed a good deal of margin (in taking $2\frac{1}{2}$ feet above and below mean sea level) of deduction from the average rise and fall of ocean waves—for losses caused by shelter, eddy waves, reluctance of coffers in answering to the call of waves readily, and consequent meetings on return journey, etc.

How much the shelter, caused by outer parts of the vessel, might kill the action of the waves, lessening their rise and fall, would be one of the matters for experiment: but still there would, no doubt, be a considerable amount of vertical motion of the water still going on in spaces between the vessels.

This utilising of the power to be got out of the rise and fall of ocean waves could only be carried out in connection with vessels, and those of the enormous breadth described, and in no other conceivable juxtaposition.

A day may come when most of the manufactories of the world shall be established out in the middle of the ocean, when, as speed would be no object, a greater number of the driving coffers could be used in proportion to space available—less being devoted to the use of the paddles, which would only be required to slowly shift the position of the manufactory according to the time of the year. What healthy lives the operatives would lead! No risk of typhoid fever!

I have said nothing as to steering apparatus or funnels, nor shown anything relating to them in the drawings, as these are matters of detail. But there can be no doubt that all the kinds of ships herein suggested could be steered much more easily than those at present the fashion.

Reverting now (as stated would be done a few pages back), for a short space, to the subject of war-ships, a swift cruiser might be constructed as a triple vessel say about 500 feet long and about 180 feet wide, with fifteen to twenty feet wide openings between, and propelled with paddles as described, by steam alone. I say a *triple* vessel for I think a twin vessel would not allow of a sufficient height to afford a strong enough union without being top heavy.

A powerful ironclad swift cruiser might be made of four or five fold vessels, say 500 to 600 feet long, and 250 to 300 feet wide, and in which the power to be got from the rise and fall of ocean waves might be utilised, and so save steam while slowly cruising in the track of vessels. All the machinery for propelling such a vessel would be entirely out of reach of possible harm, and the cells next to the outer skin (as indeed could be done in the case of all the battle ships herein proposed) could be filled with coal, giving additional thickness of armour, and in this case without risk of causing top-heaviness. To create elasticity, the cells next exterior, in coast defence ironclads, might be filled with sawdust chemically rendered non-inflammable and hydraulically compressed.

And now I will resume the subject of passenger and cargo ships and make some general remarks on it.

I have often thought, when musing over the subject, how I would like to stir up the minds of thoughtful men (apart from those whose vested interests, or professional instincts of habit would naturally bias them against the subject), to realise to its utmost what a beneficent gift this great ocean which covers two-thirds of the earth's surface really is. To make them perceive how that by properly utilising its

qualities and the conditions which prevail over its domain, the whole face and state of the world might be changed exceedingly for the better; and this by the same means, that is having suitable ships as would render what is now looked upon, often, with terror or dread into a source of pleasurable excitement, a spectacle of grandeur, accompanied by a sense of perfect security and comfort; such as the contemplation of the effects of a hurricane at sea from the balcony or tower of one of the ships of the future, as they might be, and certainly *will* be sooner or later under conditions of greater safety than would exist in the same latitudes anywhere on shore in similar weather.

Then when "the sea was mountains rolling," *truly*, and not in humorous irony or professional optimism, *Barney Bunting* might, after "turning his quid," say to *Billy Bowling*, "Lord help them, how I pities all unhappy folks on shore now."

Consider this great expanse! what it really is. The equivalent of a network of millions of miles of ways a thousand times better than railways, each line able to supply free of cost perhaps a great portion, or perhaps all, of the locomotive power required in using it. We spend millions of pounds on land; we run ourselves into debt in order to make a few tens of thousands of miles of roads, continually costing further large sums for maintenance. The ocean ways, on the other hand, cost nothing for either construction or maintenance.

I know some will ridicule this as a great discovery of what everyone knows already, and of what has been acted on for ages. But what I contend for is that less than one-tenth part of the inherent potentialities have been made use of.

We see some countries thickly populated, men crowded thickly together, with all the evils resulting from such crowding. We see other countries with good lands, in a better climate often than that of the thickly populated countries, thinly inhabited. We see under this condition of things products wasted in one place which would be gladly utilised in another.

There is nothing which would tend to equalise the conditions subsisting between all the countries of the earth more than the taking advantage, to their fullest extent, of the possibilities afforded by the ocean for locomotion.

With vessels on the scale described, cargoes of thousands of fat cattle and sheep could be conveyed in four or five weeks from one side of the world to the other, and landed in as good condition as when embarked.

Emigrants in thousands could easily be carried to fill the waste places of the earth, and while on the voyage be more comfortably

housed and treated than they ever were before in their lives—not as now, subjected to all sorts of miseries and degradations.

I have no doubt but that to some a good deal of what I write will appear ridiculous. But to the more thoughtful readers I would further suggest the following considerations :—

Civilization, education, and wealth are rapidly spreading and increasing all over the earth.

The Eastern Question, which for hundreds of years has kept the heart of Asia locked up, will be solved before another generation has passed away.

The African questions will also be solved within the same period, and the whole of that Dark Continent opened out.

Each of these circumstances, in addition to many other important ones not mentioned, will lead to the to and fro locomotion of millions.

Hundreds will require to travel by sea as well as by land where units do now.

To meet this altered condition of things increased facilities will have to be given either in the direction of more numerous vessels, or larger ones.

Now, can there be any doubt as to which of these alternatives should be chosen? Everyone knows with what shrinking—and justly too—a sea voyage is looked upon by most people, that is by those who are not seasoned to that form of travel, and those in delicate health.

The shrinking is both on account of the real great dangers to be encountered—dangers from fire, collisions and storms, and also on account of the great discomfort to be endured during the whole of a voyage, especially in the matter of sleeping arrangements.

Unless it is impossible from the nature of things, it is as certain as that the sun is shining from the heavens on some place every day, that at some future time men will be able to travel in vessels absolutely safe from the risk of foundering, and free from any motion conducive to sea-sickness, and with sleeping-rooms as comfortable as (if not more so than) the average of those in good hotels on shore.

Freedom from sea-sickness is only to be got by having vessels of very great breadth, and absolute safety from the risk of foundering, is only to be got also by having vessels of very great breadth, because such safety can only be secured by having a great number of cells in the ship's bottom, and room for that great number can only be obtained by having that bottom broad.

Because cells of a description to secure almost absolute immunity from the risk of foundering could not be used in connection with the ordinarily shaped vessels—narrow in proportion to their length—for

the reason that it is necessary in order to secure such immunity that the upper ends of such cells should be a sufficient distance above the water line. Then above the tops of these cells there should be sufficient height of superstructure to provide for cargo and living room. To provide this sufficient height in a narrow vessel would make it top heavy, and liable to roll heavily, not to say, capsize.

Therefore the quality to secure freedom from sea-sickness is also the quality to secure immunity from the risk of foundering.

Then why not have vessels constructed of a very great breadth, and with a superstructure erected on a floating system of a great number of cells, side by side, and strongly joined together—cells so small in diameter that it would require a great number of them to be damaged before the general buoyancy would be appreciably affected?

Even in the case of collisions there would be no danger of foundering, and no danger to life, except to those happening to be in or near the parts coming in contact. But with the altered conditions which would arise with electric lights carried three or four hundred feet high, risk of collision would be almost nil.

I do not mean to say that vessels of the extreme size (passenger ships), shown in the drawings, should be made at the first start, only that such is the size—this relates to breadth—which will reach to finality, and where the spirit of progress might be supposed to rest satisfied. As to length, that given is only the supposed *minimum* required to secure finality.

Yet even now, if all existing British lines could be consolidated, such ships would pay, and such consolidation (with such ships) would mean the wiping out of every other line on the face of the ocean. Not, however, that I believe in such things except as national affairs carried out with due regard to justice to everyone.

What grand permanent international exhibitions could be carried out with such vessels!

To resume. I think, however, that 250 feet would be the least breadth required to secure immunity from the risk of foundering or capsizing, along with a considerable degree of (though not perfect) immunity from liability to sea-sickness. Such vessels might be built, either as triple vessels joined together, with spaces between for working long lines of paddles on bands passing over drums; or they might be of the *Livadia* class, but driven with the same kind of paddles fixed in openings left in the vessel's bottom. This last would be the strongest class, and the shallowest in draught.

I do not for one moment under-estimate the difficulties which are in the way of introducing the class of vessels here advocated, as there can be no doubt that the obstacles in such way would be enormous.

APPENDIX.

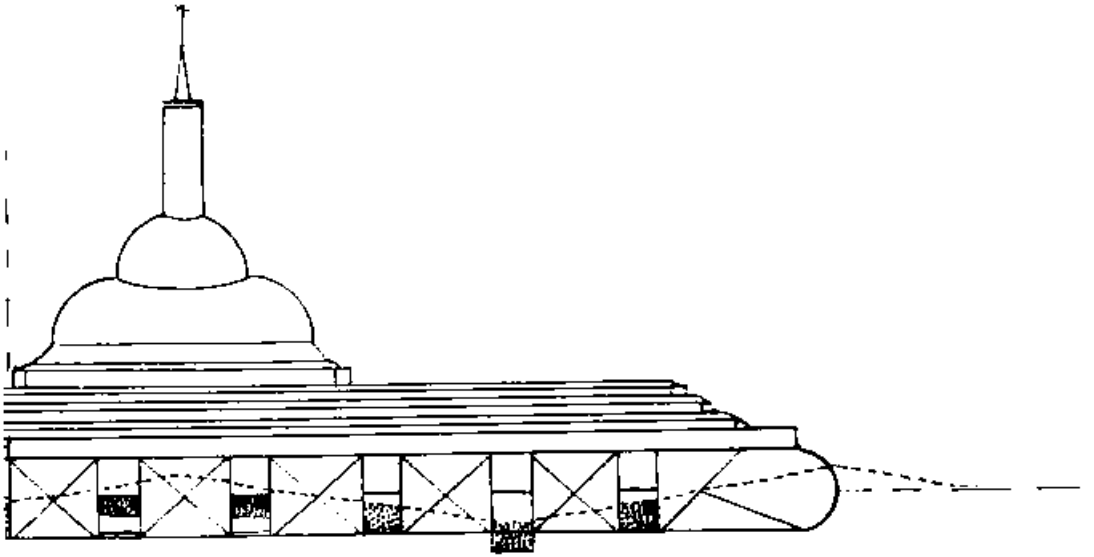
(1.) The establishment of the "Ships of the Future" would increase the importance of all first-rate harbours, that is those with room to manœuvre in, and good breadth of entrance channels, though very great depth would not be required, as their draught would be scarcely equal to that of some of the vessels of the present time. I believe though that such ships might, with a flowing tide, be safely allowed to ground on ocean beaches (those with a shore deepening suddenly and free from rocks) when the wind was off the land, and receive cargo there by means of suspension bridges, rigged quickly from plant carried on the vessel.

(2.) In the case of canals such as the Suez, and Panama to be, there would be a difficulty with these broad vessels. But perhaps the possibility, if not probability, will be that by and by, in place of canals at these places (perhaps at Nicaragua in preference to the latter-named one), or supplementary thereto, there will be railways of over one thousand feet in breadth, made with a hundred or more parallel rails, on which these flat bottomed ships could ride from one ocean to another. These railways, though of such great breadth, would perhaps not cost much more than canals of the ordinary width.

One weak point seems to be that when going before the wind, wave power would be reduced. In going against the wind it would be increased. It would follow from this that the at present adopted principle of choosing ocean routes between such places as England and Australasia should be reversed; going southwards by the Horn and returning northwards by the Cape.

(3.) It is very possible that the result I have brought out as to amount of horse-power may be proved by experts to be fallacious. Still even if it were so, as to the large amount quoted, *prima facie*, there *must* be a good amount of *auxiliary* power, at least, to be got from the method proposed; and even if the whole thing as to utilising the said power were a delusion practically—though delayed thereby, the establishment of the class of vessels proposed would be certain sooner or later to be accomplished. Of course strong steam power, in any case, would require to be always available, when wanted for smooth water and harbour service, unless there was surplus wave power which could be stored for the purpose of using at such times.

(4.) I would state that since finishing the composition and fair copy of this paper, I have read the *Times'* leading article of May 2 last (1889) on "Imperial Defence" with greatly satisfactory appreciation, and think it more than makes up for all the defaults of that of the 11th of April preceding alluded to. There appears not a point in it to be taken exception to, but on the contrary it is a most concise and lucid statement of the true conditions of the subject, comprising everything to be considered in dealing with it.



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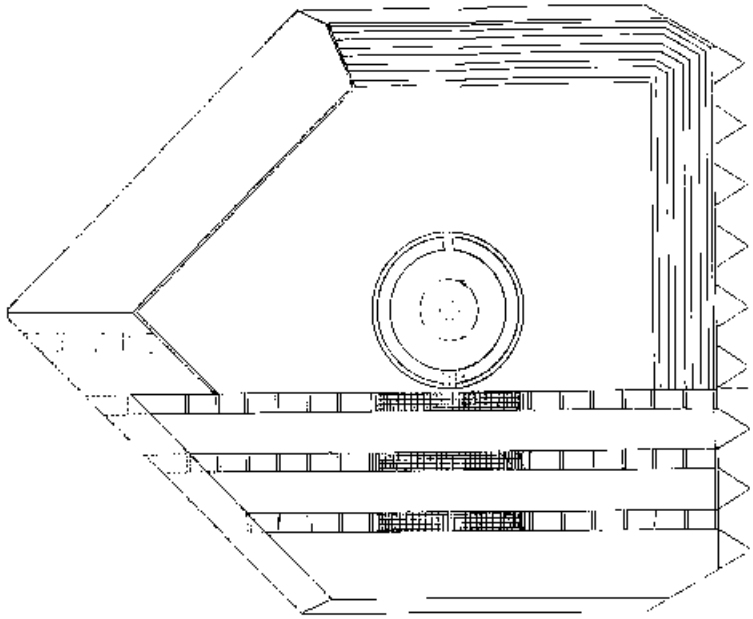
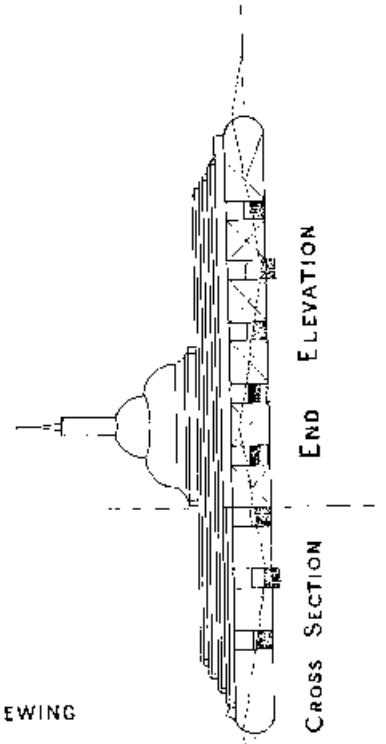


SECTION

At 60 Ft. from Bottom



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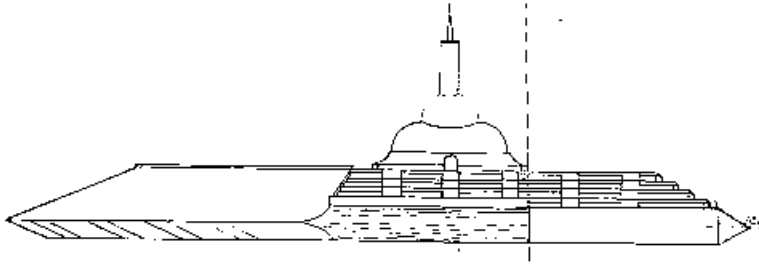
CROSS SECTION

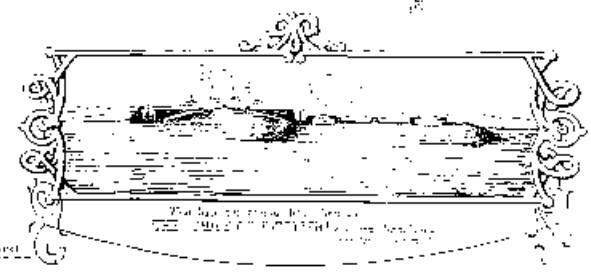
DRAWINGS SHEWING

"THE SHIPS OF THE FUTURE"

SCALE 200 FT TO AN INCH.



SIDE ELEVATION SECTION



THE SHIPS OF TARSHISH

BEING A COPY OF THE DRAWING GIVEN ON THE COVER OF THE BOOK OF THAT NAME PRINTED IN OCT. 1866.

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