ON

METALLIC

BOATS AND FLOATING WAGGONS

FOR

NAVAL AND MILITARY SERVICE,

WITH SOME

OBSERVATIONS ON AMERICAN LIFE-PRESERVING CARS;

BEING THE

SUBSTANCE OF A LECTURE DELIVERED AT THE UNITED SERVICE INSTITUTION, ON FRIDAY, 2ND MAY, 1856.

BY MAJOR VINCENT EYRE, F.R.G.S.,

BENGAL ARTILLERY;

AUTHOR OF "MILITARY OPERATIONS IN CABUL IN 1841 AND 1842."

LONDON:

SMITH, ELDER, AND CO., CORNHILL,

1856

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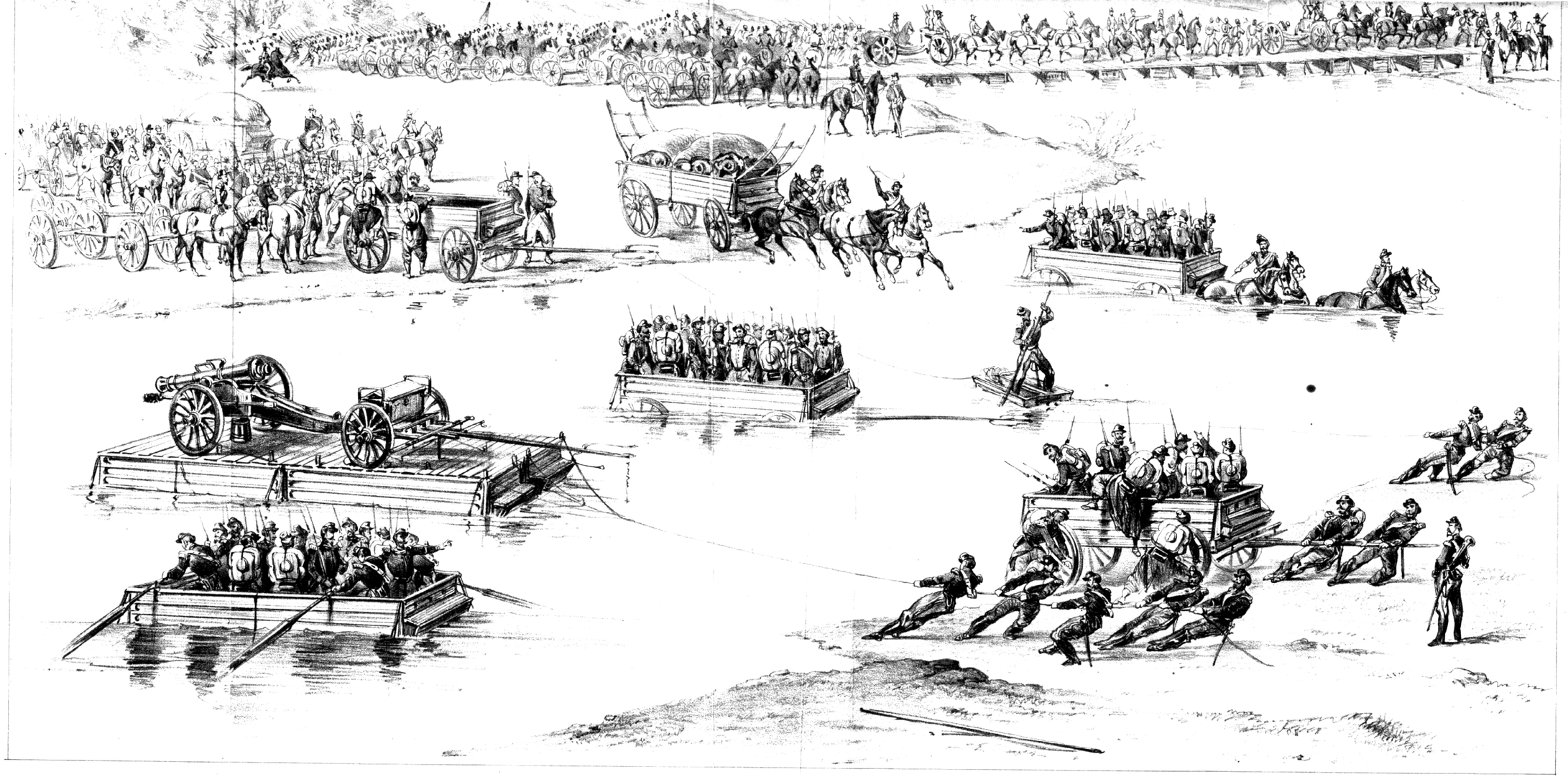

Chalvet. Zinco.

THE FRANCIS METALLIC ARMY WAGGON WITH ITS VARIOUS ADAPTATIONS TO ACTUAL SERVICE.

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CONTENTS.

NOTICE.—The inventions herein described are protected by English Patents.

PRELIMINARY OBSERVATIONS.

HAVING undertaken to draw the attention of our naval and military services to the important inventions herein described, and being encouraged by the very great interest recently evinced by many distinguished officers of the army and navy, who twice honoured my Lecture with their presence, and took an active part in the subsequent discussion, I commit my humble labours to print, in the hope that, in this more permanent form, they may prove both useful and acceptable to the members of the United Services generally, as well as to a large portion of the mercantile and shipping community of this country, whose interests are, more or less, concerned in the contents.

It is a source of some satisfaction, though of still greater *astonishment*, to me, that I should have been the first to bring to prominent notice, in this country, the admirable inventions of which I have here ventured to treat.

Till now, my occupation has not been with *boats*, except in so far as, like nearly every other inhabitant of this globe, (and like Julius Cæsar in particular!) I have occasionally been obliged to entrust my life and fortunes to their frail protection. Returning to my native land after a prolonged military service in India, chance brought me acquainted, in the course of my wanderings, with the worthy and ingenious in-

ventor of these Metallic Boats, Mr. Joseph Francis, of New York.

And here I would remark, that a great benefit has been recently conferred on the public service in India (and I, for one, feel personally grateful for the boon to "my very worthy and approved good masters" of the India House), by permitting officers on the staff to visit Europe for limited periods without forfeiting their appointments. I only wish the periods were somewhat *less* limited in duration and more frequent in recurrence! An officer who takes a proper pride and interest in his profession, will gladly avail himself of every such golden opportunity to increase his practical knowledge, and thus to render himself more efficient for the duties of his position in life; and, in devoting myself, as I have done, to the investigation of these inventions, which chance thus threw in my way, and which promise to be of the greatest advantage to the Government I serve, I considered I was performing my simple duty as a public servant of that Government.

My ingenious friend was sojourning in the French capital to recruit his health, when I became acquainted with him in July last. At that time he had no intention of visiting England; and, when urged by me to do so, he represented that he had no influential acquaintances there to introduce either himself or his inventions to the notice of those whose active co-operation would be indispensable to success, and that, therefore, an effort in that quarter would most probably be fruitless. I judged otherwise, and offered my own assistance to bring the matter to a test.

Already the result has been such as to justify my confidence. Many of our most distinguished naval officers have taken the deepest interest in the *Metallic Boats*, and in the mechanism required for their construction, and have been unanimous in expressing their admiration of the invention,

and their conviction of its immense practical utility and importance.

Military officers of first-rate experience and distinction have been equally emphatic in favour of the *Metallic Floating Waggons*, as an invaluable acquisition to a marching army on active service.

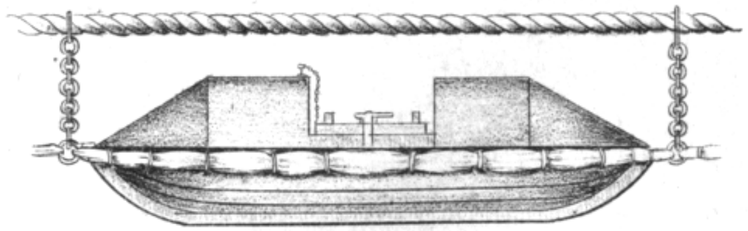
Among those who have promptly come forward to second my efforts in bringing these inventions to the notice of our public authorities, my most particular thanks are due to Lieutenant-General Sir George Pollock, G.C.B., and to Colonel Sir Frederic Abbott, C.B., of the Indian army; to Colonel Godfrey Greene, Superintendent of the Board of Works, Somerset House; to the Earl of Ellenborough, G.C.B.; and to Colonel Tulloh, Superintendent of the Royal Carriage Department at Woolwich.

I am also under great obligation to the Honourable Colonel Lindsay, M.P., Vice-President of the United Service Institution, for the laudatory terms in which he was pleased to notice my humble efforts on both occasions of my delivering the present Lecture.

VINCENT EYRE,

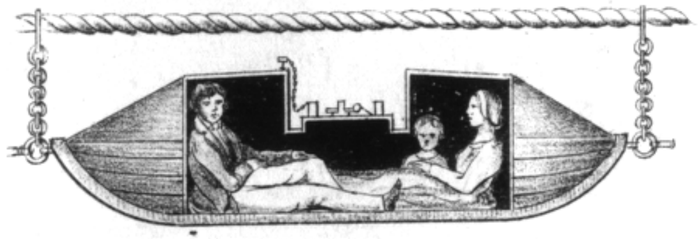
Major Bengal Artillery.

Athenæum Club,
12th May, 1856.

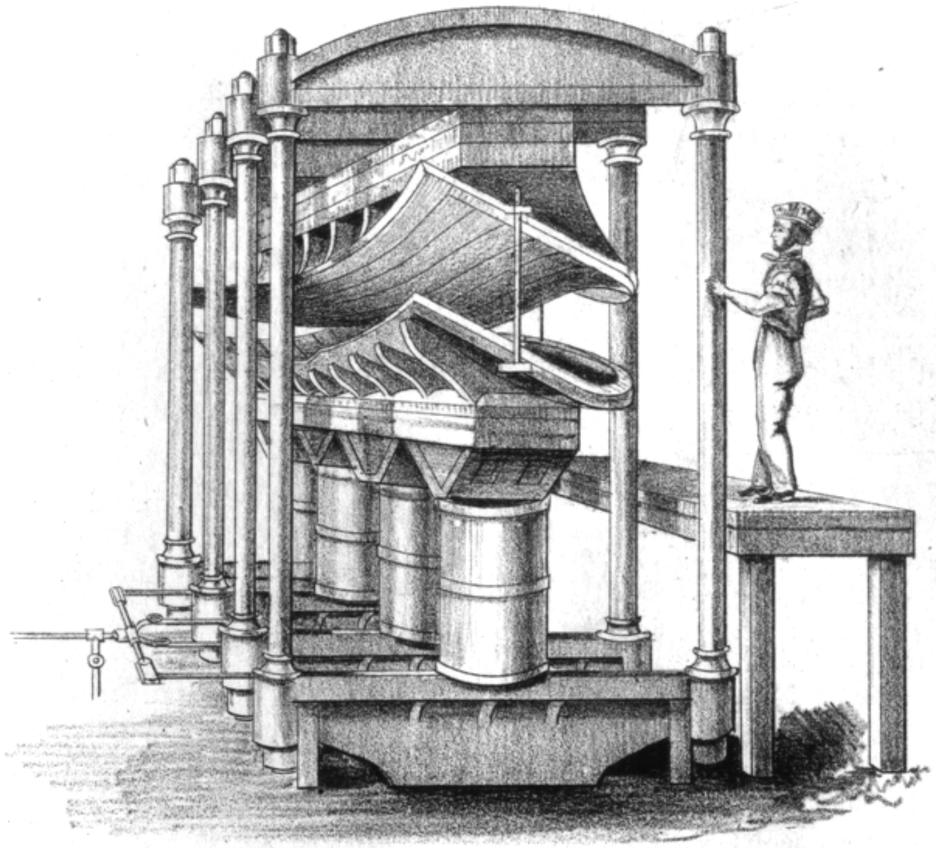


Outside View

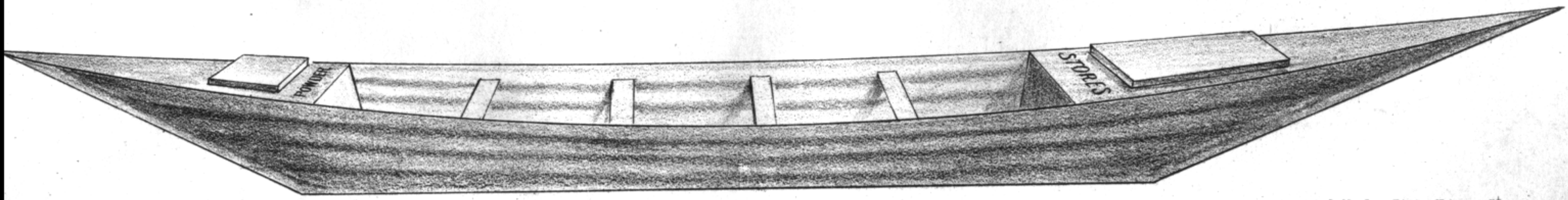
LIFE CAR.



Inside View



DIES FOR METALLIC BOATS.
Worked by the Hydraulic Press



METALLIC ARMY BATEAU

C.Chabot Zinco. Skinner St.

SUBSTANCE OF A LECTURE

ON

METALLIC BOATS, ETC.

PART I.

ON METALLIC BOATS.

1. The object of the present Lecture is to introduce to the favourable notice of our naval and military services in this country, certain remarkable inventions, heretofore unknown to or unappreciated by us; but the peculiar importance of which will, I trust, be found, after full investigation, to furnish in itself sufficient apology for my venturing to solicit the patient attention of the enlightened members of this scientific Institution, and of such of their friends as compose the present meeting, to the subjects announced for discussion.

2. It is, I believe, one of the fundamental objects of this excellent Institution, to stimulate scientific inquiry among its members, with a view not only to the instruction of our officers and soldiers, but also to the amelioration of our naval and military system generally; and at no period, perhaps, can these objects be more advantageously pursued than at the close of a campaign like that which has so recently put to

the severest of tests, not merely the personal *bravery* of our countrymen (for that has never yet been disputed), but the *practical efficiency* of our armies, when actively engaged in the difficult operations of a great and hazardous warfare, on a distant soil, and in an uncongenial climate.

3. With increased cause for the indulgence of an honest national pride in the *former*, it is to be feared we have therewithal discovered some grounds for mortification in regard to the *latter*, arising chiefly from the stagnating influence of a forty years' peace, during which our military establishments in Europe had been suffered to sink into a state of neglect and inefficiency, calculated to excite a well-founded alarm in the minds of all who, like the late illustrious Duke of Wellington, knew from experience the difficulties and delays attendant on the reorganisation of a force for active operations, whether offensive or defensive in their nature.

4. It was recently remarked to me by an eminent shipbuilder in this city, that one great and distinctive feature wherein we differ from our Transatlantic cousins consists in this, viz., that whereas *they* delight in a thing *because* it is new; *we*, for the selfsame reason, *abhor* it. There seems to be some truth in the assertion, and perhaps the cautious conservative principle it involves may have its attendant advantages, although it is nevertheless to be feared that, in some cases, our honest John Bullish prejudices, leaning to the retention and preservation of things as they *are*, too often stand opposed to our national interests in the acceptance and adaptation of things as they *should be*, until we suddenly discover that other nations have outstripped us in the race of improvement, and that we have been content to follow laggingly behind in their footsteps, when it was in our power, and should have been our glory, to lead the way.

5. It was this national failing which, up to the commencement of the late war, operated (and I fear *still* operates) as a clog and an impediment to the improvement of our military system. *We had failed to keep pace with the times;* indulging in a too self-complacent spirit of imaginary perfection, and obstinately resisting all efforts from without to awaken us from the unhappy delusion, until the destroying angel of death again sounded aloud the fatal trump of war, and found us unprepared to meet the emergency with those means and appliances which the peculiar circumstances of the case, and the advanced state of military science in Europe, rendered indispensable, both for the preservation of the brave men who went forth to fight our battles, and for the maintenance of the honour of our arms.

6. I have alluded, *in limine*, to these somewhat sore subjects, because they serve to illustrate so freshly and so forcibly, that national antipathy to even *useful* innovations with which I cannot but feel I am now myself about to combat. WOODEN BOATS are among our most venerable institutions, and I am here this day to advocate the expediency of *abolishing them from our naval dockyards, and from our mercantile marine, henceforth and for ever!*

7. This leads me to one branch of my present subject in hand. You see before you sundry models of metallic boats, such as are now in use with the United States navy and mercantile service. These I have obtained from New York expressly for the illustration of this Lecture, and I hope, before we separate to-day, to convince all here present that boats of this description possess every possible advantage over the ordinary wooden boats at present in such universal use amongst ourselves; and that it will be for the interests of our Government, and of all private ship-owners generally, to substitute the one for the other. I appeal to sound in-

controvertible facts, and confidently challenge the most rigid scrutiny.

8. On the 7th January last (in compliance with a suggestion to that effect made by myself), their Lordships the High Commissioners of the Admiralty directed that a trial of these metallic boats should take place in the presence of Commander Bevis, R.N., who was instructed to report the results to the Admiralty. The Collins line of steam-ships, which run between Liverpool and New York, are all supplied with these boats; and on the arrival, at the former port, of the steamer "Baltic," her commander, Captain Comstock, most kindly placed his entire set of boats at our disposal, for the purpose of carrying out the intentions of the Admiralty.

9. On the deck of the ship was one of the largest boats, stowed upside down. Her dimensions were those of the largest-sized man-of-war cutter; a strong man, with a large long-handled axe, struck some twenty blows on her bottom, in one spot, with all the strength he could muster, without being able to make so much as an indentation. Every blow must have told with shattering effect on a wooden boat. One of the smallest boats was then put on shore, and rolled and tossed about on the cobble-stone pavement, with all the strength of six men; then lifted up many times on end, and suffered to fall with great violence on the stones. Some trifling indentations were produced in the sides, by the rolling process, but these a few blows from a hammer sufficed to set to rights, and it was found that no injury whatever had been done. This same boat was next launched into the water, and rowed many times against a stone pier, end on, with all the power of four men, and one to guide her; all this did not injure the boat nor cause her to leak. These boats had been in the "Baltic" ever since she was built (over five years), and will last as long as the ship, without repairs.

10. Commander Bevis witnessed these trials with undisguised astonishment and admiration, and in his report to the Admiralty he bore the fullest testimony that language could convey, as to the complete efficiency of these boats, and their superiority over those of wood. Admiral Richards, in communicating this triumphant result to Mr. Francis and myself, expressed his regret that the rules of official etiquette forbade his furnishing a copy of Commander Bevis's report, but gave us his kind and valued permission to make known its general tenor, as well as the favourable opinion of the Admiralty, as extensively as we might deem proper. Thus encouraged by so high an authority as the Naval Lord of the Admiralty, I feel a hopeful assurance that no offence will be taken in that quarter at the amount of publicity given to the matter by means of the present Lecture; since the approbation of their Lordships, composing the present Board of Admiralty, when generally known, cannot but impart a wholesome stimulus to the public mind, and go far to encourage the establishment and promote the success of any manufactory that may be set on foot in this country, for the general introduction of metallic boats into our naval and mercantile system. In connection with this subject, I will venture to mention that, immediately after the receipt of Commander Bevis's favourable report, two men-of-war boats were ordered by their Lordships for further experiment. These have now arrived in England; and it is hoped that full opportunity will be soon afforded to all those interested in the subject, to witness the trials, whenever they take place. The subject is one of national importance.

11. Meanwhile, I regret to announce that the *tortoise has again overtaken the hare!* No sooner did a report of the Liverpool experiment reach the Emperor of the French, than, with characteristic sagacity, that great man penetrated at a

glance the practical value of the invention. Forthwith Mr. Francis was summoned to Paris. The Emperor in person examined his models, and on the succeeding day was pleased to make known his sentiments in the following gratifying terms.

"Palais de Tuileries, 4 February, 1856.
"Cabinet de l'Empereur.

"Sir,

"The Emperor has witnessed with great interest, the experiments which have been made in the river Seine, with the pontoon carriage of your invention.

"His Majesty has also taken pleasure in obtaining information in detail respecting the boats of corrugated metal, which you have invented and constructed. The Emperor hopes that your invention may establish, in France, the production of a new branch of industry applicable to the public services for war and for the navy, as well as for the mercantile marine; and His Majesty has advised me to inform you that he will learn with pleasure your determination on this subject. I am happy in having to transmit to you the accompanying box, which the Emperor sends as a testimonial of his satisfaction.

"Accept the assurance of my distinguished sentiments,

"FAVE."

12. The result has been, that full arrangements have been made for establishing, on a satisfactory basis, a manufactory for the supply of metallic boats for the whole French navy, as well as for supplying the wants of the mercantile marine. It is thus that Emperors can say to this or that mountain "Be thou removed!" and the Imperial fiat is forthwith followed up by the accomplished deed. Such promptitude, it must be confessed, forms no part of our own more deliberative system; and in this respect even free Governments, with all their acknowledged advantages and cherished blessings, have sometimes their attendant drawbacks. With far greater incentives and facilities for the free exercise and full develop-

ment of thought and of genius, the system of responsible government necessarily demands more time for the previous consideration of acts whereof it must render an account to the nation; and a Napoleon can successfully solve a great national problem in less time than a Palmerston may venture to propound from his place in Parliament even so much as a small political axiom!

13. But it is time that I should proceed to describe more minutely the peculiar structure and advantages of metallic boats. And in the first place, I would remark that, although their merits have never before, as far as I am aware, been thus publicly advocated in this country, yet, so far back as 1851, they did, on one somewhat remarkable occasion, attract the attention of some of our ablest naval officers. The occasion to which I allude was one that must still be fresh in the minds of many members of this Institution, when, in consequence of the great loss of life that had occurred from time to time on our coasts, by the upsetting of life-boats, his Grace the Duke of Northumberland made his munificent offer of one hundred guineas for the best model of a life-boat which should be sent to the Admiralty Surveyor's Department, Somerset House, by the 1st of January, 1850.*

14. In reporting the general results of the inquiries into the various qualities of the boats submitted to their inspection, the Northumberland Prize Committee expressed themselves as follows:

"Hitherto all our boats have been of wood; but the testimonials in favour of metal boats are very strong. Galvanised iron (if that process prevents oxidisation, which does not yet seem to be esta-

* Of the very strong opinions that have been from time to time expressed in their favour by naval officers in the United States, I could furnish a bookfull; but it may suffice to select a few of the most valuable, which will be found in the Appendix.

blished) would be the most economical, and the corrugated form of it would give strength. But if metal boats be adopted, copper might be preferred as more durable and more tractable. The boats in which Lieutenant Lynch, of the United States Navy, descended the rapids of the river Jordan, in 1848, were of copper; and that officer reports most favourably of them. It is said that a copper boat is now supplied to every vessel in the United States Revenue Service, if not to the navy at large. The first cost of such boats might be heavy; but the material would be always of value. In metal boats, it is affirmed, that the air-tight cases could be more easily built in to the boat (if in any case such were admissible), and kept from leaking."

The Committee conclude their observations by recommending a fair and full trial of metal boats, at any convenient opportunity.

15. Five years have elapsed since that report was penned, yet a subject so full of interest to a great commercial people like ourselves has been suffered to lie dormant, until now revived by so incompetent an advocate as myself; but I trust there are some among those whom my words will reach, who possess both the will and the ability to sift the merits of this thoroughly, and, if the invention be found worthy of adoption, to give it their public and vigorous support.

16. With reference to the doubt, expressed by the Committee, as to the efficacy of the galvanising process to prevent the oxidisation of iron, it may suffice to state, that the boats examined at Liverpool by Commander Bevis, had been for five years in constant use, and exposed to the action of the elements, without repair, yet were found to have sustained no injury whatever. With a view of placing this question beyond a doubt, Mr. Francis fastened one of his galvanised iron boats to a floating buoy in New York harbour, and, attaching a heavy weight to one side, sufficient to immerse one-half the boat below the surface of the sea, he left it in that predica-

ment during six months, (half of which time she was frozen in, compactly and solidly, by the winter's ice,) at the expiration of which period it was found quite free from corrosion, and the air chambers undamaged. The galvanised iron had been procured from this country. There is, therefore, good reason to conclude that the galvanising process, when carefully performed by competent hands, is infallible, and may be securely relied on; and that, if instances to the contrary have been found, the fault must lie at the door of the manufacturer of that article.

17. Let me now invite your attention to the models of boats before you. They consist, you will observe, of thin sheets of copper (or iron), not much exceeding the thickness of a sixpence, without braces, or skeleton supports of any kind, the strength being derived entirely from the *corrugations*, or longitudinal plaitings, an application at once simple and beautiful, inasmuch as by no other known means could material so thin and frail, and therewithal so light and buoyant, be endowed with the requisite strength to answer the purposes of a really strong and serviceable sea-boat.

18. The extraordinary powers derived from corrugation are pretty generally known. Here are two plates of thin sheet iron, the one with a plain flat surface, the other with small semicircular corrugations at intervals. Let each be placed in turn between two supports, so that each end may rest on one of the supports, and it will be found, that whereas the former will sink in the middle with its own weight, the latter will scarcely yield to the combined weight of four ordinary men. Corrugated sheets of iron, as all of you must be well aware, are now very extensively employed for roofing and other purposes, in railway stations and other large public buildings; but the simple corrugations required for such purposes are effected by a rapid and easy process, differing, in some very

essential respects, from that required to give strength and stability to the graceful curved form of a boat. This can only be obtained from gradual pressure between two enormous *dies, worked* with all the force of the hydraulic piston—the greatest force, within certain limits, that is ever employed in the service of man.

19. Here is a drawing which represents the machinery employed by Mr. Francis.* It is unnecessary that I should occupy time in explaining minutely, to the present company, the peculiar machinery by means of which this mighty hydraulic power is brought to bear upon the massive dies. Let me rather draw particular attention to the dies themselves, for therein consists the great novelty of the invention which I am endeavouring to commend to your approval. The upper die, you see, is permanently fixed to the top of a frame supported by rows of iron pillars on both sides. The lower die is *movable*, and, being attached by massive iron-work to the ends of the piston-rods, it of course rises when the pistons are driven upwards by the pressure of the water; and when the two dies approach each other, the intermediate plate of metal is bent and driven into the intended shape by the force of pressure, receiving not only the corrugations which are designed to stiffen it, but also the general shaping necessary to give it the proper form for the purpose required.

20. Upon the convex die, ribs or raised surfaces are formed; and in the concave die are depressions corresponding exactly with the ribs of the convex die, or *vice versâ*. The width, concurvature, and length of these ribs, and their number and distance apart, *will be regulated according to the surplus metal resulting from the change of a plane or flat surface* (the form of the sheet before being operated upon) to the *convex* surface which the metal is caused to

* See PLATE I.

assume in forming the irregular curves in the operation, and, at the same time, to afford *strength* and stiffness wherever it is required; or, in other words, the corrugations are so arranged as to take up the surplus metal into the corrugations that would otherwise gather and wrinkle, and which is not wanted in the contour of the vessel, and form it into curved projecting surfaces to serve in place of timbers or braces.

21. It is obviously necessary that, in order to compress the metal equally in every part, these dies should fit each other in a very accurate manner, but to make them fit thus exactly, massive as they are in size and irregular in form, is a work of very great toil and difficulty. The curved and winding surfaces which form the hull of a boat, bid defiance to machinery to follow them, and it therefore becomes necessary to cut away, by manual labour with hammer and chisel, the superfluous iron, so that the whole process of fitting, smoothing, and polishing one pair of dies, is found not only laborious, but costly.

22. The efforts made by the Governments of England, France, and the United States, to manufacture boats of metal, is evidence of their conviction of their superiority over those made of wood, especially for the use of steamers. The great difficulty in construction has been to *form the metal* to the *peculiar* and *various curves* of the model of a boat. If a plain sheet of metal be hammered (or *brought up*, as the term is) to the form of the bow or stern, the metal requires to be thick to allow it, and the process of hammering requires much judgment and exactness, and a stretching of the metal more at some parts than at others, according to the fullness or leanness of the model. Thus, if the form *could* be obtained by this process, there would be a great inequality of thickness, and the *full* point, which requires the most ham-

mering, is that most exposed to wear and concussion. Supposing these efforts had been successful, the metal at the outset must be thick to bear it, and consequently heavy and costly; in addition to this, bracing is indispensable.

23. There is another method, which is by forming the side by narrow strips, like a "clinker"-built wooden boat, and riveting them together. By this process there is a great waste of metal, caused by the curving lines; much hammering is also required, causing great expense of labour; besides which, the metal must be thick, and the sides braced, or timbered, to give support.

24. By the present improved method, the whole side of a boat is formed of light or thin metal *corrugated;* these corrugations give all the requisite strength, and hold the sheet rigidly to the shape of the dies. In the first experiment a mechanical difficulty presented itself—in forming the bow with its *sharp*, *gentle*, and *bold* curves, without a gathering, or *wrinkling*, of the metal. This was overcome by a series of extensive experiments. A large set of dies was made, costing 3000 dollars; but in practice the metal would double and lap on the full curve of the top line, and wrinkle in other places. The use of this set of dies was consequently abandoned. It was found necessary to vary the depth, shape, and position of the corrugations, to prevent the gathering, or doubling, of the surplus metal in forming the bow or stern, and submit the metal, in forming to shape with corrugations, to a pressure of 800 tons.

25. It should be stated that by this process cast-iron dies are made as large as a full-sized boat, with the corrugation on the upper, or convex die, and corresponding depressions of the lower, or concave die. So that a sheet of metal placed between is *forced to the shape*, as the dies come *together*, and the corrugation, being *formed while it is in that shape*,

holds it RIGIDLY and FIRMLY THERE; and so effectually is this accomplished, that the shell, or outward surface of a boat, when put together, will hold its shape and withstand hard service without thwarts or braces of any kind inside. No frames or timbers of any kind are required, as the strength is attained by the *corrugations*, and these corrugations *add nothing* to *the weight* of the structure; for the strength is put into the boat by the *peculiar formation* of the sheet. The stiffness, or strength, of the sheet is increased by the boldness, form, and depth of the *corrugations;* so that, as these are increased, the thickness of the metal can be *decreased*, still retaining the *strength*.

26. The strength was fully demonstrated at the Cherbourg Dockyard, in France, a few weeks since, by 45 discharges of heavy ordnance under the bottom of a 30-feet common steam-ship's boat, purchased by the French navy department for the purpose; which fully settled the point of its being *unnecessary* to *lower* this *kind* of *metal* boat from the ship's quarter in *discharging cannon*.

27. To more fully test this principle of construction, Mr. Francis offered to make a boat with the metal *one-half* the thickness, and bolder corrugations, and take the risk of a discharge of 100 heavy cannon; but the department was satisfied. It should be understood that the very severe experiments made at Havre and at Cherbourg by the French Government were not demanded by the latter, as their scientific engineers were satisfied without any such tests; but they were carried out at the request of the inventor, so that the principles of construction might be practically demonstrated.

28. Thus, then, by this process we have a light and strong metal boat—the advantages of which are understood by all nautical and practical men. And it may be added, that, if

the weight of metal in a boat is reduced one-half, by *producing the strength in the sheet itself*, instead of adding timbers or frames to impart it, the *cost* is proportionately *reduced.* Moreover, if a heavy boat in the water strikes an object, such as a wreck or a rock, the concussion, if severe, causes injury, if not destruction; whereas, a light boat *rebounds*, and consequently is not injured. This has been fully demonstrated in the United States Exploring Expedition to the Dead Sea—the unfortunate explosion at Hurl Gate by Professor Maillefert—the boarding of wrecks at sea, and by the Government surf-wrecking boats on the entire coast of the United States.

29. The Hurl Gate explosion, in the vicinity of New York,* was sufficiently remarkable in its consequences to set at rest this question of strength for ever. In blasting some large rocks which impeded the navigation of the East River, by means of the galvanic spark communicated to 150 lbs. of powder below the surface, by some unaccountable mistake, the wrong mine exploded within three feet of the boat's stern, wherein the Professor was seated with his brother-in-law. The boat, with its occupants, was forthwith hurled up in the air, and fell at a distance of 150 feet. No lives were lost, and the only damage done to the boat was that the air chamber at one end was torn out, and the end of the boat bent up, thus forming a shield, protecting the persons in her from the force of the explosion. A wooden boat, which lay adjoining the metal one, was shattered to a thousand atoms, and the two men in her dreadfully mangled and killed.

30. In fact, the superiority of metallic boats, whether of iron or of copper, made in the manner I have described, over those of any other construction, is growing every year

* See Appendix B.

more and more apparent. To sum up their good qualities briefly: they are more light—more strong—more lasting—more easily managed—require less repair. They are fire-proof—worm-proof—water-proof. They will not corrode or rot—are always tight and ready for service in every climate. They can never become water-soaked; or, when hung to the davits for six months, or a year, they are ready for lowering into the water. The concussion of cannon has no effect upon them. The stroke of a shot that would disable a wooden boat, would only perforate an iron one, and a perforation, when made, can be easily repaired, by simply beating back the protruding parts with a hammer. Of their capability of resisting other kinds of shocks, ample testimony is borne by Lieut. Lynch, U. S. N., in the public report of his voyage down the river Jordan, and exploration of the Dead Sea, in 1848. The navigation of this stream involved no ordinary peril, and the boats were subjected to the severest possible tests and trials. They were impelled against rocks; they were dragged over shoals; they were swept down cataracts and cascades. One solitary wooden boat, which started with them, soon went to pieces, and was abandoned; but the metallic boats survived through the whole, and finally floated tranquilly in the heavy waters of the Dead Sea, in nearly as good condition as when they first left the dies. *

31. Another most valuable, though quite unintentional, testimony has, within the last few days, been borne to the vital importance of supplying indestructible metallic boats to our navy, by no less an authority than Admiral Sir Edmund Lyons, in the course of his evidence before the Crimean Court of Inquiry on the 20th April. It appears that Colonel Tulloch had expressed an opinion that the carpenters of the fleet might have been made available for constructing some

* See Appendix C.

sort of shelter for the horses of the Cavalry; and, in order to combat this idea, Sir Edmund expressed himself as follows:—

"As a proof of the suddenness with which the gale came on, I may mention that the second in command, and some of the captains of the fleet, having come on board of my ship, were obliged to remain on board for several days and nights. Now, under these circumstances (he adds), it must be apparent to everybody, that the *boats* of *the fleet*, upon which the supplies of the army were dependent, must have been constantly getting out of repair, and that, *therefore*, all the carpenters of the fleet were required on board."

32. I confidently appeal to all here present, whether more convincing testimony could possibly have been adduced in favour of that which I have been now advocating? After the instances I have already brought forward of the wonderful strength and durability of metallic boats, even under much more trying circumstances than those described by Sir Edmund Lyons, is it not abundantly evident to common sense, that, had the boats of our fleet in the Black Sea been formed of that material, the carpenters would have been saved the labour of perpetual repairs, and their valuable services might have been applied in the manner suggested by Colonel Tulloch, with the best possible results to our suffering forces on shore?

33. It would be easy to multiply proofs of the efficiency of these boats; but I have probably said enough to satisfy my hearers that I am advocating no mere ingenious theoretical novelty, but an invention of real, solid, practical utility, which has already stood the test of years in America, which has been eagerly received in France, and which we may reasonably hope to be very generally adopted in this country, both by our war and mercantile marine.*

* See Appendix D.

PART II.

ON MILITARY FLOATING METALLIC WAGGONS.

34. I WILL now pass on to another branch of the present Lecture, scarcely less important in a *military*, than I trust I have already proved the former to be in a *naval* point of view; and as such it may, therefore, be considered as falling more within my legitimate scope, as a member of the military profession.

35. The safe and easy transit of armies across swollen streams and unfordable rivers, has been acknowledged by all military writers to be one of the most formidable difficulties in war; hence it may be fairly assumed that whatever tends to facilitate that operation by the simplest and readiest means, is justly entitled to a most attentive consideration, and I unhesitatingly point to the models now before you, as offering the very best practical solution of the problem that has yet been produced; and I am happy to find myself supported in that opinion by several most distinguished officers of the army, who, from their very great practical experience in such matters, are entitled to speak with authority upon them. Some of those to whom I allude are here present this day, and having themselves had ocular demonstration of the capabilities of the invention, will perhaps be kind enough, at the conclusion of the Lecture, to favour this meeting with their views, since any remarks from such a source cannot fail to be valuable.

36. Here is a model representing a military metallic road waggon, of the pattern now in use with the United States army; the part comprising the body being made, as you will readily perceive, on the same principle as the metallic boat just described. But to go into a minute detail of the construction might be tedious. It may suffice briefly to state that the bodies, being composed of the same corrugated metal as the boats already described, partake of the same durable and indestructible qualities; and whereas an ordinary military waggon, such as those at present in use with our army, is useful only for the purposes of land carriage, the metallic waggon unites in itself, either singly or by combination, the qualities of an ammunition or store carriage, a *pontoon*, a *row-boat*, a *raft for the heaviest artillery*, and, finally, a *bridge* for crossing the whole *matériel* of an army over deep and otherwise impassable rivers. These various qualities have been well exemplified in the lithographic drawing on the wall.* The nearest figure of all represents the waggon body set free from the running gear, and used as an ordinary boat. Next to that floats a large raft, composed of four waggon bodies united compactly together, and covered over by a platform, on which rests securely an ordinary field gun. This is a simple and most invaluable mode of applying the invention, for the movements of troops are often impeded by the difficulty attendant on the rapid transfer of artillery from bank to bank, on reaching an unfordable stream; but guns accompanied by waggons of this description, are in a position to solve that difficulty for themselves with the greatest ease and rapidity. We next perceive a complete waggon filled with troops, drawn across the stream by some soldiers stationed on the opposite bank. These men are supposed to have established a communication, in the first place, by means of

* See PLATE 2.

small canoes, formed of two feeding troughs united together, and conveying a man with a rope. Next, beyond, are some waggons drawn by horses, and filled with troops and baggage; on reaching the bank of the river, the horses plunge boldly in, drawing behind them their precious freight, without any delay being incurred to unload or to secure the baggage from wet. The metallic body is perfectly water-tight, and the opposite bank is reached without any damage being incurred. Last of all, in the distance, we see an excellent *pontoon bridge* formed by a number of these waggon bodies arranged side by side, and covered over with planks in the ordinary mode. By this means a whole army may pass from bank to bank in a very few hours, without being encumbered with a lumbering pontoon train, or delayed while boats are collected from distant points. On the dry bank we perceive the running gear of the waggons divested of their bodies, while the latter are serving the purpose of pontoons. This completes the picture, which was very recently drawn by an artist in Paris, by desire of the Emperor Napoleon. For transport across the seas, these metallic waggon bodies, being made in two pieces, admit of being packed closely together, one within the other, thus economising space.

37. On turning my attention to this subject in July last, so convinced was I of the very great practical utility of the invention, and of its great importance in a military point of view, that I determined to bring it to the notice of the India House and the War Office authorities, as soon as practicable after my arrival in England; and I went so far as to indulge a hope that, if approved by the War Office, it might yet be applied to some immediate use during the war we were then waging with Russia.

38. With this view I obtained a full-sized waggon from the

manufactory in New York, and, soon after its arrival, in September last, it was subjected to some highly interesting experiments, in the presence of two most distinguished officers of the Bengal Army, Lieut.-Gen. Sir G. Pollock and Colonel Sir Frederic Abbott, the scene of operations being a piece of ornamental water, called the "Black Sea of Wandsworth." My reasons for requesting the presence of these two officers in particular, must be obvious to all those at all conversant with the recent military history of British India. In 1842, Sir George Pollock, being called upon to avenge our losses and disasters in Affghanistan, traversed and re-traversed, with a large army, the country of the Punjab, or land of the five great rivers, each varying from 300 to 500 yards in width. Throughout these difficult operations Sir Frederic Abbott was his chief engineer, and superintended the crossing of our troops, with all their munitions of war, over these great and formidable rivers, and the same able and scientific officer was subsequently called upon, in 1846, to construct the celebrated bridge of boats across the Sutlej River, for the invasion of the Punjab by Lords Hardinge and Gough, during which he partook in the glory of our arms in the great Seikh campaign. These two officers were, therefore, peculiarly well qualified to appreciate such an invention as that which I laid before them, and Sir George Pollock's first remark to me, after witnessing the experiments, was, "How invaluable such waggons as these would have been to me in the Punjab!"* It is unnecessary that I should, at present, enter into the de-

* Sir G. Pollock was present at the first delivery of this Lecture, and on the 7th May ensuing addressed to Major Eyre the following valuable testimony:—"If I could have had the benefit of Mr. Francis's carts when I crossed the five rivers of the Punjab, the soldiers would have been saved some days' hard labour. I was detained a day or two at each river, whereas, with his carriages, I could have crossed each river in three or four hours without difficulty, and without fatiguing the troops."—Signed, GEORGE POLLOCK.

tails of these experiments, as I shall shortly have occasion to read the Official Report of Colonel Tulloh, Superintendent Royal Carriage Department at Woolwich, on some precisely similar trials subsequently made by him, by order of the War partment. Suffice it to say, that, by the two distinguished officers just named, it was fully tested and approved, and pronounced by them to supply what had long been the desideratum in India, viz. a really efficient substitute for the cumbrous and expensive pontoons in present use, besides being applicable to a variety of other useful purposes, to some of which I will presently advert. I would not have it supposed, however, that I mean hereby to *find fault* with, or undervalue the admirable pontoons in present use with the British army. The distinguished names of *Blanchard* and *Pasley* are sufficient guarantee for the practical value of their inventions in this line; and circumstances may frequently arise, both in peace and war, where their pontoons would, perhaps, have the preference over all others. Still, I would have all marching armies as *independent* as possible of all such extraneous assistance. The more means a general can muster wherewith to facilitate the movements and operations of his army, the more boldly can he look danger in the face by day, and the more comfortably can he repose from his fatigues and anxieties by night.

39. That great military authority, Sir Howard Douglas, has devoted a valuable volume to the subject of military bridges, and the passage of rivers in military operations. In reference to the difficulties that frequently beset our armies in the East, his observations seem to me so applicable to the matter now under discussion, that I am tempted to quote one or two passages. He says,

"Provision for the passage of rivers, in the earlier operations of

are nearer to resources that may be made available. But when, having crossed many rivers which may have become fordable, the passage of others which are unfordable is to be undertaken, near or in the presence of an enemy, the operation will entirely depend upon the state of the bridge equipment which the army may have brought with it, or upon the means which may be found on the rivers in the seat of the operation. *Upon the latter it is never safe to depend.* An army relying entirely upon these is *never safe*, and *ought not to be successful.* Whatever be its qualities and its force, the operations in which it is engaged will depend mainly upon material means; and there can be no more discreditable cause of failure, on the one hand, and no more obvious means of producing it, on the other, than for an army to trust to such contingencies."

Every one must admit the force of these observations, and it must be equally obvious, that an army, well supplied with floating metallic waggons, might boldly pursue its onward career, through such countries as Sir Howard Douglas describes, however frequently intersected by deep streams, without being checked or discouraged by any such disastrous results as are here so emphatically and so faithfully pointed out.

40. As the most hopeful channel, whereby to create an interest in this matter among the War Office authorities, I first addressed myself to the Earl of Ellenborough, whose experience in war enabled him at once to perceive, at a single glance (as the Emperor Napoleon has since done), the importance of the invention. His Lordship lost no time in communicating the contents of my note to Lord Panmure, and the result was, that Colonel Tulloh, the able and energetic Superintendent of the Carriage Department at Woolwich, was directed to place himself in communication with Mr. Francis, with a view to making a trial of his waggon. To save him the delay attendant on procuring one from New York, I made mine over to him. On the 30th December, it was subjected to a variety of experiments at Woolwich, and I am happy to

have it in my power to make known the successful result in Colonel Tulloh's own words.

"War Department, Pall Mall,
"1st January, 1856.

"Sir,

"Agreeably to your request, I have the commands of the Secretary of State for War, to transmit to you the inclosed 'Copy,' of a Report from the Superintendent, Royal Carriage Department, dated 12th ultimo, upon your Patent Corrugated Metallic Waggon.

"I am,
"Sir,
"Your most obedient Servant,
[Signed] "J. Wood.

"Joseph Francis, Esq.
"Care of Major Vincent Eyre,
"Athenæum Club,
"Pall Mall."

[copy.]

"Royal Carriage Office,
"12th December, 1855.

"Sir,

"In compliance with the order from Lord Panmure, dated the 13th August, 1855, and your Minute of the 17th August, 1855, upon my letter of the 16th of the same month, ordering me to carry my recommendation for the purchase of Francis' Patent Corrugated Metallic Waggon into effect, and when obtained, to give my opinion, &c.,

"I have the honour to report, that I lost no time in writing to the parties in New York; and a few days since I received the waggon in question, with which, on Friday, the 13th ultimo, an experiment was made in the presence of Mr. Francis, the patentee.

"It was first placed in the water, with the whole of its running gear attached, including the pole; the weight was 17 cwt. 0 qrs. 4 lbs. Sixteen men then got in, and their weight amounted to 25 cwt.; this brought the waggon down to about a foot from the top. Attempts were then made to upset it in the water by the whole of these men bearing down, first on one side, and then on the other; but without effect. The upper edge of the waggon could not be brought

below the water. The same experiment was tried with only six men in it, and with the same result. The next trial was with the body alone, the running gear being detached and allowed to sink in the water; attempts were again made to upset it without effect. It was then loaded with planks, and two men, weighing in all 34 cwt.; but neither in this case could any rolling bring the upper edge under water. Four of the bodies connected together form an excellent raft, capable of supporting any heavy ordnance of the service; and by keeping the running gear attached, they can be run in and out of the water with great facility. The weight of the waggon body alone is 5 cwt. 0 qrs. 7 lbs.; with its wheels, &c., complete, 17 cwt. 0 qrs. 4 lbs., being rather more than that of our old Flanders waggon. There are many circumstances in which a waggon body of this description could be found very useful; and by making some alterations in its construction, as stated by Mr. Francis, it could be made to pack up in sections, in a small compass, on shipboard. Any damage done to the corrugated iron can be easily repaired. The running gear possesses no advantages over our own; it is similar in construction to the American Lumber Waggon, but much heavier. The feeding trough can be fixed on the pole, for feeding. Two of them connected together form a small boat, capable of conveying one person across a stream in order to make a communication with the opposite side, which might be found useful. *I am, therefore, of opinion, that the invention might prove valuable to the service; and I beg to recommend it strongly to the attention of the Minister of War;* for, with the improvements which are capable of being made by reducing its weight and rendering it portable, I have no doubt this material, from the peculiar form of the corrugations affording such great strength, might be made highly useful for carts and waggons, as well as pontoons.

* * * * * *

"I have the honour to be,
"Sir,
"Your most obedient Servant,
[Signed] "ALEX. T. TULLOH, Col. R.A.
"Supt. R.C.D."

41. There the matter has since rested. The Minister for War probably felt averse to the introduction into our mili-

tary service of any extensive change in the field equipment of an army at that critical period; although it can scarcely be doubted that waggons of this description would have been considered by our Generals in the Crimea a valuable acquisition, to replace the wooden conveyances originally sent out, and which had soon become unserviceable, from the very severe nature of the service they encountered.

42. The emphatic approval of an officer so eminently qualified as Colonel Tulloh to form a sound practical judgment on a matter so entirely within his own province, could scarcely have failed, under ordinary circumstances, to settle the question at once. The time has passed since the self-reproach of Medea could be fairly applicable to our War Department—"Video meliora—*proboque*—deteriora sequor." It is to be hoped that a new and more spirit-stirring motto now distinguishes their banner and animates their counsels—"Excelsior."

43. Meanwhile, Mr. Francis has found some substantial consolation in that summons from the Emperor Napoleon to which I have already alluded, and which has resulted in the prompt establishment of a large manufactory in Paris, by the Emperor's express desire, and under his own immediate patronage, for the supply of metallic bodies of all shapes and sizes to meet the various requirements of the French service.

44. The practical results of the use of these waggons* in the United States army, for upwards of a year, has led to further orders to supply the wants of the service, and an entire substitution of metallic for wooden waggons is gradually taking place. To General Davis, the American Secretary at War, much credit is due for putting the invention to the test in the United States army, and thus deciding on its merits.

* See Appendix E.

45. The account of the exhibition in the river Seine at Paris, before the Emperor, on the 2nd of February, as published in the *Moniteur*,* officially, has drawn the attention of the heads of two other powerful Governments of Europe to the subject, with whom the inventor is now in communication. I am also happy to have it in my power to state, that, owing to the favourable representations of Sir G. Pollock and Sir F. Abbott, the East India Company have determined to give the waggons a trial in each of their presidencies in India. Sir F. Abbott has suggested a modification of the form of the metallic bodies, whereby each would form a demi-pontoon, and might be fitted on the common country bullock carts and employed to carry the commissariat supplies of marching armies on service. When required, they might be easily formed into floating rafts, or temporary bridges.

46. Each body would, in this case, be divided into two compartments, as shown in the model; and two bodies being united end to end, the two central compartments would be filled up with closely packed bags of dry fodder (whereof an abundant supply invariably accompanies an Indian army). This would form a sufficiently substantial roadway, when covered over with such brushwood as the country might afford, and which is almost everywhere obtainable, and by these simple expedients, would be saved the trouble and expense of conveying the heavy and cumbersome equipment usually considered indispensable for an ordinary pontoon bridge.

47. The small model, now in my hand,† is a flat-bottomed bateau, much used in the United States for lake and river service, both with land troops and with marines. Each bateau contains two water-tight compartments, one for powder, the other for stores; and, in such services as our Indian troops have been recently exposed to in Burmah, during the late war,

* See Appendix F.

† See PLATE 1.

such bateaux might have been turned to excellent account. I am informed they elicited the marked approval of the Emperor of the French.

48. Having thus cursorily introduced to your notice this invention, which bids fair to become an important feature in modern warfare, I leave it to the consideration of abler men, in the full belief that, as its merits have been already recognised by the scientific officers at Woolwich, it cannot fail to be brought, sooner or later, into general use. It is merely a question of *time*. Meanwhile, the earnest and unhesitating way in which it has been already adopted by the French Emperor, affords sufficient guarantee for its intrinsic worth, to such as might otherwise harbour a doubt on the subject.

49. To those who guide and control the affairs of our Indian empire, I would suggest, as a matter well worthy of their early consideration, the very great saving that might be effected in our army and ordnance Commissariat departments, by the *substitution of corrugated galvanised iron, or copper, for wood, wherever practicable.* It will be found to defy alike the destructive effects of fire, heat, wet, dry-rot, and insects. Year by year, *our timber forests are dwindling away*, and it becomes more and more difficult to obtain well-seasoned wood for the various requirements of Government. Here is a never-failing and enduring *substitute*. In India it would be most desirable to abolish altogether the use of wood in the bodies of our ammunition waggons and store carts, in the roofs and doors of our public sheds, as well as in our sea and river boats; and I feel satisfied, that the saving thus effected from year to year, throughout the three presidencies, would very soon be evidenced in a very remarkable manner in our annual financial statements.

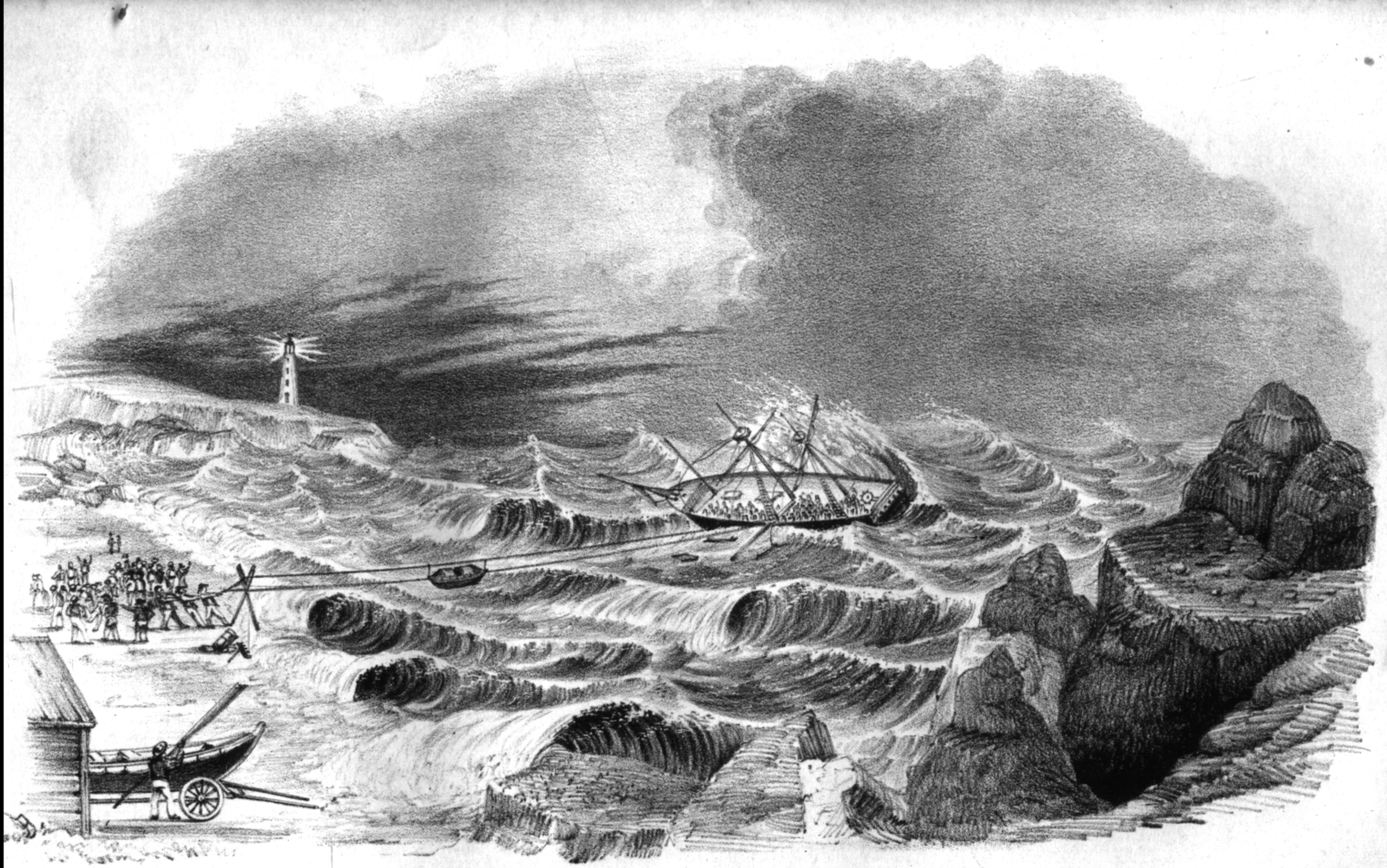
PART III.

ON AMERICAN LIFE-PRESERVING METALLIC CARS.

50. My preceding observations have been made chiefly with the view of introducing to notice an improved material for our naval and military services, in peace and war. I have now to crave your attention to another subject, closely connected with the foregoing, but with a higher and nobler purpose, which cannot fail to enlist your generous sympathy, and secure your hearty approval, inasmuch as it relates to the *preservation of human life* from those perils and disasters to which the inhabitants of our sea-girt island are perpetually exposed. You will observe that I have called in the aid of the fine arts to illustrate this portion of my Lecture.

51. In describing metallic boats, I purposely abstained from enlarging much on their qualities as "life-boats," since it may be thought, not without reason, that we are already well supplied with many admirable contrivances of that nature; some of which have, I believe, very recently formed the subject of a Lecture in this very room. At present, therefore, I will simply remark, that the "Francis Life-Boat" has been extensively adopted by the American Government,* which has passed a law, compelling every passenger-ship to be provided with a certain proportion of these boats; and has also stationed them along the whole line of sea and lake coasts, where they have been instrumental in saving many hundreds, I might almost say thousands, of lives annually.

* See Appendix G.



The LIFE CAR saving the Passengers and Crew of the SHIP AYRSHIRE in Jan^{y} 1850.

52. Associated with these life-boats, on the same coast, is another most admirable invention, whereof I have been so fortunate as to secure a fine model—the first, I believe, ever exhibited in this country. I allude to the "LIFE-CAR," which I find noticed, for the first time, in the January number of the "Life-Boat Institutions Journal," in an article on the "Life-Saving Benevolent Association of New York."* After enumerating the services rendered to the cause of humanity by the said Association, the writer proceeds to remark as follows:—

"It will be observed that two-thirds of the persons saved, as above quoted, viz. 1000 out of 1500, have been so through the instrumentality of a life-car, drawn through the surf by lines, after a communication has been effected with the stranded ship by means of the mortar and rocket apparatus; to us a striking circumstance, as, in this country, a much greater number of persons are saved by life-boats than by the mortar and rocket apparatus; indeed, we are not aware of any instance where so great a number as even 100 persons have, on any one occasion, been rescued by means of the apparatus on our own coasts.

"Judging from the descriptions given of the life-car in use in America, we conceive *it must be of a superior character to anything of the kind in use in this country.* It is said to convey ordinarily four or five persons, perfectly dry and unexposed, through the heaviest surf, and to have brought, from the wreck of the 'Chauncey Jerome, Jun.,' as many as six children and one woman at a time. At the wreck of the 'Ayrshire,' it is stated, that 'every soul —men, women, children, and infants—came through the surf, during that cold snow-storm, dry and comfortable.'"

53. The picture on the wall† (which is derived from an authentic source) represents the interesting event here al-

* In the article above quoted the invention of the life-car is erroneously attributed to Captain Ottinger, U. S. Revenue Marine; but the real inventor was Mr. Joseph Francis, the patentee, whose claims have been fully recognised by the United States Government.

† See PLATE 3.

luded to. It was in the middle of January, and during a terrific snow-storm, that the ship "Ayrshire" (here represented), with about 200 passengers, was driven upon the shore of New Jersey by the storm, and there lay stranded; the sea beating over her, and a surf so heavy rolling in as made it impossible for any boat to reach her. Providentially a life-boat station was within hail, and the life-car apparatus was expeditiously brought out. The very first shot from the mortar carried the line direct across the wreck; it was caught up by the crew, and the hawser hauled off. The car was then attached, and in a short time every one of the 200 passengers was safely drawn through the foaming surges, and landed on the shore. Fortunately the station was near at hand, otherwise many of those saved from drowning must have perished from the cold; but, as it was, all were landed "dry and comfortable," and at once found shelter in the station-house, where they had the benefit of a fire, and of such other small comforts as the liberality of the Government provides.

54. The life-car is, in fact, a description of *boat*,* formed of copper or iron, and closed over by a convex deck, with a sort of door or hatchway through it, by which the passengers to be conveyed in it to the shore are admitted. The car will hold from four to five persons; when the passengers are put in, the door, or cover, is shut down and bolted to its place, and the car is then drawn to the land, suspended by rings from a hawser, which has been previously stretched from the ship to the shore.

55. It may be readily imagined that the alternative offered of being temporarily entombed alive within this small dark and gloomy receptacle for the purpose of being drawn through a raging surf in which no boat could possibly sur-

* See PLATE 1.

vive, may seem, at first sight, but very little less terrible to timid minds than than of abiding on the wreck; but the emergencies of the case are generally such as to afford but small time for hesitation or delay, and a very few minutes usually suffice to release the terrified, but now grateful, inmates from their prison of hope. Being subject in its passage to the shore, to the most frightful shocks and concussions from the force of the breakers, every precaution has been taken to impart the requisite strength to the car, and such improvements as experience suggested have from time to time been made, both in the outward form and the inward accommodation. As at first made, the passengers could only be stowed in a recumbent position, which rendered them almost powerless; but the form is now changed, so as to admit of a sitting posture; which, while it greatly facilitates ingress and egress for the passengers, adds considerably to their comfort and safety.

56. The car, as may be seen by the picture* (or model), is suspended from the hawser, by means of short chains attached to the end of it. These terminate in rings above, which ride upon the hawser; thus allowing the car to traverse to and fro from the vessel to the shore. The car is drawn along by means of lines attached to the two ends of it, one of which passes to the ship, and the other to the shore. By means of these lines, the empty car is first drawn out to the wreck, by the passengers and crew, and then, when loaded, it is drawn back to the land by the people assembled there. But many American ships are now provided with a life-car on board. I myself saw one, stowed snugly away under one of the boats of the Collins steamer "Baltic," quite unsuspected by the passengers.

57. It is impossible to do justice to a subject of so much

* See PLATE 1.

importance at the fag end of a Lecture like this; much more might be said, with advantage, both in regard to the life-car and the life-boat, but time at present fails. I can, therefore, only express, in conclusion, my own thanks, and those of Mr. Francis, to the Committee of this Institution, for having thus afforded me an opportunity of bringing prominently to public notice, the several inventions which have formed the subject of this Lecture, and, should time permit, I shall be glad if, from among the many competent gentlemen here assembled, any of them will have the kindness to favour the meeting with such observations as may occur to their minds as appropriate to the occasion.

On completion of the Lecture, Colonel Sir Frederic Abbott* rose to explain an adaptation of Mr. Francis' waggon to the military requisitions of India. He had been asked, some months back, by Major Eyre, to witness some experiments on Wandsworth Common with a new army waggon. At Wandsworth, he found a waggon like that represented by the model on the table; some horses were brought from a farm, some labourers from a brick-field hard by. The waggon was drawn to a sheet of water, dragged in until it floated with its running gear; the latter was then detached by removing two pins; the body was used as a boat, and loaded with men, who endeavoured vainly to upset it. It was then floated to its running gear, and re-attached, when the whole was drawn on shore. The speaker said, that he saw at once the value of such a waggon in aid of military movements. He saw that such waggons could

* Sir Frederic has entered more fully into the subject in a letter to my address received since these sheets went to press, and which will be found a few pages further on.—V. E.

be used, not only as ferry-boats, but as bridges; that their extreme simplicity and facility of management rendered them available in the most unskilled hands. On being asked whether he considered these waggons as adapted for Indian campaigns, he objected to their size, which rendered them unmanageable for bullock draught, and he proposed to reduce them to such dimensions as would place them on a par with ordinary country carts, such as run on one pair of wheels, and are drawn by one pair of bullocks. Each revised waggon body would be a sort of trough of corrugated iron, 9 feet long at top, 6 feet long at bottom, $3\frac{1}{2}$ feet wide, and $2\frac{1}{2}$ or 3 feet deep. Two of these united lengthwise, would form a boat. The boats, moored side by side, in close contact across a river, and having their centres filled with brushwood, or bags of chaff, would form a bridge capable of sustaining the heaviest traffic. He had constructed bridges over the wide and rapid rivers of India, using the frail native open boats by way of pontoons; and glad, indeed, would he have been, had he baggage waggons which he could have turned to such useful account. Sir Frederic Abbott would say nothing disrespectful of pontoons, especially in the presence of the father of pontooniers, the gallant Sir Charles Pasley. Pontoons were useful and necessary in Europe, where streams were perennial, and generally of a moderate breadth, and where powerful horses were used for draught. In British India the case was different. Campaigns were made, almost invariably, in the dry season, when all the smaller streams had disappeared, and the only obstacles remaining were the large rivers fed by the melting of mountain snows. These were of formidable dimensions; seldom affording passage of less than 200 or 300 yards, generally much wider. For such rivers, a pontoon train of European pattern required so vast an establishment of draught

added so much to the *impedimenta* (already overwhelming) of an Indian army, that a general would ordinarily take the chance of finding boats on the rivers, rather than be burthened with such an encumbrance. Consequently, the largest pontoon* train ever carried with an Eastern army consisted of 14 rafts, or 28 canoes (of Pasley's pattern); and this being good for only 90 yards of bridge, was utterly insufficient for the passage of the smallest of rivers usually met with.

On analysing the parts of an European pontoon train, it would be seen, that, of the aggregate weight, the canoes, or boats, formed one-fifth, or thereabouts; the remaining four-fifths being due to beams (balks), planks (or chesses), and the massive cars, or waggons. If, therefore, any means could be devised by which the roadway and cars could be dispensed with, little objection would remain against the boats. Sir F. Abbott contended that by his proposed adaptation of Francis' iron bodies, he had supplied those means. These modified bodies would be fitted as commissariat carts, of which vast numbers accompany every Indian army, which, to avoid oppression of the inhabitants, carries all its stores complete. The additional weight would be small.† The bridges might be formed by the camp followers under the direction of a few officers and overseers, native or European. The speaker concluded by recommending Mr. Francis' invention most heartily to the notice and consideration of military men.

General Sir Charles Pasley, R.E., in reply, stated that he highly approved of the boats, but he doubted whether, under certain circumstances, the waggons could be safely used to support a bridge. He proceeded to describe, at great length,

* Carried with the army of the Punjab in 1849.

† There need be no additional weight whatever, since the iron body can be made *lighter* than a wooden one of the same dimensions.—V. E.

his own experiments with various kinds of pontoons, and his conviction that pontoons should be decked over, not open, as these waggons were.

Colonel Portlock, R.E., remarked that a discussion of the relative merits of the pontoons of Sir Charles Pasley and of General Blanshard seemed foreign to the object of the Lecture, and he would therefore endeavour to bring it back to its proper course.

As a covering for the roofs of buildings, metal plates, or sheets, have been long in use, and those acquainted with British North America will doubtless remember not only public buildings covered with sheet iron, but the steeples of the churches covered with tin, and brilliantly reflecting the sun's rays.

This mode of covering, however, requires a strong wooden support in beams and rafters, and has only lately become more general by the fortunate thought of corrugating the iron, an invention which has rendered framework unnecessary in many cases; an arch of corrugated iron supporting itself. In a similar manner, metal boats have been long in use; and, to go no further back than Macaulay's last volumes will take the inquiry, it appears that William III. had a large number of tin boats prepared for the passage of the Boyne.

Here, again, however, the full advantage cannot be gained by the use of simple sheets of metal alone, and it is evident that the corrugating principle would also be equally beneficial, if applied to boats, as in buildings; but, for a moment, let it be considered what that principle is. By corrugating the iron, the flexible plate is rendered rigid as the surface is bent, so as to form longitudinally a series of parallel girders or beams, and transversely a series of arches; but it is also evident that by thus rendering the plate rigid, the difficulty

of adjusting it to a curved, or varying surface, is greatly increased; and, without doubt, that difficulty would have prevented its use in the construction of boats, had not Mr. Francis surmounted it by his ingenuity.

He determined to give the rigidity due to corrugation, and the form of the boat itself, by one simultaneous operation, and for that purpose he prepared *dies* of the form of the boat, with grooves on their surface, corresponding to the intended corrugations, and the plain sheets being placed in the dies, and subjected to the powerful pressure of a hydraulic press, were at once corrugated and shaped.

This very ingenious contrivance was not, however, even then quite perfect, as Mr. Francis soon found that the same breadth of metal being required to be adjusted to different spaces, the surfaces were *wrinkled*, or overlapped over the lesser spaces; but this difficulty he quickly overcame by adjusting the guage of the corrugation to the position of the plate, and thus, as it were, not only swallowing up the superfluous metal, but giving more strength to the parts requiring it.

It is not surprising, then, that the results proved satisfactory, and that Mr. Francis most fully carried out his object of producing the admirable ship boats, of which the models are before us.

The application of the same material to the construction of military waggons has been equally successful, and he would only therefore, for a moment, dwell on the secondary application of these waggons as boats, or pontoons.

It has been alleged that they would not have the advantages of air-tight boat pontoons, such as those of Sir Charles Pasley, or of close cylindrical pontoons, such as those of General Blanshard, in the passage of very rapid streams; but it is not considered that Mr. Francis intends to deny that

under some circumstances, it may be necessary to adopt such pontoons as those of Pasley or Blanshard, but simply to put forward the very natural and simple application of his own waggons as boats or pontoons under ordinary circumstances.

Every one knows that open boats have been used successfully on the Rhine and other great rivers as the substructure of bridges, and though it is not intended to compare ordinary pontoons, or even Mr. Francis' waggons, with such vessels as the Rhine Bridge Boats, it cannot, Colonel Portlock conceives, be doubted that an able engineer would readily produce such a combination of these waggons as would render them perfectly secure and stable for supporting any bridge and any weight required for military purposes; and if so, can there be a doubt of the great importance of having a number of such waggons *always* available with an army for such a passage; and yet not, in the meantime, dragging their long bodies *uselessly* along, as the pontoons of the *present* construction do; but fulfilling at every moment an useful and important function?

Considering, as he does, that it ought to be received as a military axiom, that everything with an army should be capable of as wide an application as possible, Colonel Portlock enforced the peculiar value in this respect of Mr. Francis' waggon; which, like the canoe of the North American Indian, could be turned over, and being partly supported at one side, would become a valuable and effective shelter. Had such waggons been in the Crimea, they could have been readily applied to such a purpose, and, let it be added, that there can be little doubt that corrugated iron might have been brought into use before Sebastopol for the construction of huts, similar to the long hunter's hut of America, or the Algerine hut of the French, without difficulty. It is, indeed, curious

escape notice at the time of most need; but so it is—for, whilst our engineers and our military departments were planning wooden huts, heavy in material and difficult in construction, had they but thought of abandoning wood for iron, they might have had prepared, without loss of time, any number of corrugated plates of galvanised iron, light enough to have rendered their carriage easy and practicable, and yet strong enough to have enabled them, when put together, without wooden framing, and without nails, to have stood firm, in the shape of a long triangular hut, or tent.

In fact, Colonel Portlock said, there is so much of practical ingenuity in Mr. Francis' plan, that he sincerely hoped that the British Government, however habitually cautious it may be in admitting great military changes, would follow the example at once of the democratic Government of the United States and of the despotic Government of Napoleon III., by adopting into its navy and army both the boats and the waggons of Mr. Francis; and further, that it would give him the opportunity of applying his ingenuity and his material to other military purposes.

Mr. Francis explained, in answer to a question from the Secretary, that the thwarts were moveable and could be slid in and out of their places, so that *nests* of boats could be formed, one stowed within the other. The Hon. Colonel Lindsay, in conclusion, expressed his conviction that the subject was one of great importance, and it was also highly important to hold meetings of this kind, where officers could give each other the benefit of the experience they had acquired. We were now again at peace, but he believed that the professional interests of the service would not be neglected as they formerly were. In future it was intended that every division of the army should be accompanied by artillery, and by its own commissariat, waggon train, and means of supply.

It would be well to try these waggons in our camps. We must ascertain that they are good waggons; and if so, it would be a great advantage to be able to use them also in crossing rivers. He thought that their great portability and the small space they occupied was a great advantage; under certain circumstances they might also be used to form huts or temporary shelter. He felt that the present meeting and the services at large were highly indebted to Major Eyre, for the clear, lucid, and forcible manner in which he had brought these inventions before their notice.

From Col. Sir Frederic Abbott, C.B. (late Bengal Engineers), Lieut.-Governor of the East India Military College at Addiscombe, Surrey.

My dear Eyre,—

It was matter for regret, that after your valuable and interesting Lecture, no naval officer* took up the subject of Francis' beautiful iron boats, which the facts brought forward by you would prove to be the most useful, most safe, most enduring, and therefore the most economical of all boats yet invented. I well remember the day when traversing the ocean field in a ship which had been battered almost to pieces by a hurricane off Madagascar; when, all hands at the pumps, we were running down for refuge to that oceanic Cave of Adullam, Port Louis, Isle of France; every moment expecting to hear the rough voice of the carpenter proclaim, as he sounded the well, that the leak was gaining on the pumps. I remember the anxious scrutiny made of the clumsy wooden launch, our only stay; and I remember vividly

* Although no naval officer took part in the discussion, yet many expressed privately their approval of the boats; among whom I may be pardoned for mentioning Admiral Sir G. Sartorius, who has testified the greatest possible

the startling assurance of my old friend "Chips," who, in the whisper of a sea-horse, assured me, that, even if we succeeded in launching that huge commodity of timber into the sea, she would not float an hour! so thoroughly had her thousand seams been opened by the vertical rays of a tropical sun. I should have enjoyed greater peace of mind for ten days following, had we been equipped with Francis' corrugated iron boats.

I much regretted, too, that my gallant friend and master, Sir Charles Pasley, addressed the meeting under an impression that Francis' metallic waggons were to be applied to the formation of a pontoon train. This would be, indeed, to retrograde in military arts. No engineer of the present day would venture to exchange the open bateau for the decked canoe of Pasley, or the close cylinder of Blanshard; but when Sir Charles Pasley denies their utility as *substitutes* in absence of a regular train; and when he denies the practicability of constructing a bridge at all with such flat-bottomed vessels as Francis' waggons, or my adaptation of the same; and an experienced officer like Colonel Tremenheere of the Bengal Engineers endorsed the same opinion,—I feel myself called upon to say a few words to show, that I have not been misleading you by a vain theory.

On the great rivers of the Punjab, it is the common practice of the country to construct bridges of that most fragile of ferry-boats, the "*Chuppoo*," which is a flat tray of two planks stitched together with pieces of hard wood, shaped like a truncated triangle. The sides are mere gunwales of inch plank, with three or four slight battens to keep them in place. When leisure serves, and the bridge is to be permanent, wooden trestles are placed on the floors, rising a few inches above the gunwales; short balks are laid from trestle to trestle; these are crossed by odd pieces of jungle wood; a

coating of earth or stable litter completes the roadway. If the bridge is impromptu and temporary, the boats are moored as before, the centres are filled with brushwood rising above the gunwales, stable litter crowns all. Over such bridges, elephants, the most suspicious of brutes, walk across with little hesitation, dragging after them in harness our heavy siege guns. Camels, those unwieldy beasts, whose utility as carriers is greatly qualified by the difficulty of forcing them over obstacles and dangers, walk across such bridges with much *sang froid.**

Compare, now, these structures with the bridge of English pontoons which was thrown across the Thames at Runnymede, in 1852, for the Chobham force. This bridge was so lively in the water, so alarming to animals unaccustomed to *expedients*, that the cavalry got over with difficulty, and not without danger. The first 9-pound field-gun that attempted to cross in team, was precipitated into the river, with loss of its two wheel-horses; the others swam ashore.

I happened to be standing at the bridge head, anxious to see the experiment, and I do not hesitate in affirming that the accident was owing to the want of stability in the pontoons, and the want of hold in the bare planks of the roadway. The wheel-horses slid all fours, and could not respond to the guiding rein; they were pushed into the river by the gun, which followed, and the four trace-horses were dragged in backwards. This bridge was formed of Blanshard's cylindrical pontoons, which, while they afford great facilities of handling, are about the most unstable of any. Pasley's canoe-shaped and decked pontoons are far superior in the latter respect; yet Sir Charles Pasley himself told us, at your Lecture, that in some Indian campaign (I did not hear

* The open bays of the regular pontoon bridge are one great cause of alarm to animals. When boats are in close order, the way looks firm and solid.

which), horses were so alarmed at his bridge, that an artillery officer, unable to persuade his animals to take the bridge in cold blood, retired his troop, gun by gun, about 100 yards back, and then dashed at it, full speed. Such a proceeding was doubtless reprehensible, as this officer compromised the safety of the bridge, and with it the safety, perhaps, of the army. He should have unyoked his teams, by which he would not have lost many minutes. In Sir H. Douglas' work on Military Bridges, 3rd Edition, p. 175, occurs the following anecdote, regarding the passage of the Sutlej, in 1846 :—"The next morning, at three A.M., the work was renewed, and by half-past nine, the whole roadway having been made with tamarisk brushwood,* and a considerable portion of it with earth also, the bridge was opened for the passage of the guns and cavalry of Sir Harry Smith's division, the greater part of his infantry having been ferried over already. The Commander-in-Chief arrived also, and crossed that afternoon. During the intervals between the passage of troops, the pressure of camels, carts, ponies, doolees, camp followers, and even elephants (the passage of which, by the bridge, had been absolutely forbidden), towards the head of the bridge, was beyond the conception of those who have not seen the *impedimenta* of an Indian army. Nothing but the whip of a stalwart provost-marshal, and the volunteer assistance afforded him from the highest to the lowest ranks in the army, availed to keep the bridge from utter annihilation. *This* pressure continued, with scarcely any visible diminution, for four days." Now, had this been a pontoon bridge of European pattern, which horses were afraid to cross, our baggage would have been left behind.

In 1838, Major G. Thompson, C.B., of Bengal Engineers,

* Laid over planks and beams.

the "Hero of Ghuznee," constructed a bridge of *flat*-bottomed boats over the Indus at Bukkur. An account of this great military engineering feat will be found in the tenth volume of the "Professional Papers of the Royal Engineers." In 1843, the Engineers constructed two bridges of such boats on the Sutlej, near Ferozepoor, for the return of the united forces of Pollock and Nott from Cabul. Major A. Cunningham, Captain A. Crommelin, and many other engineers, have constructed such bridges on every river of the Punjab. Colonel Tremenheere says they will not stand against a "fresh" of the river. This is only on account of imperfect mooring. The native system is to anchor every fourth or fifth boat. This is to ensure destruction of the bridge under a "fresh." But the holding ground of most Indian rivers, where not rocky, is excellent: the great difficulty experienced is in recovering the anchors. In the Report of the Chief Engineer of the Punjab (Colonel Robert Napier) for 1854, he says of the bridge of flat-bottomed boats on the Ravee, "During the present year (a season of very unusual floods), the bridge has been maintained the whole time; but twelve boats in addition to those estimated, sixty-two boats in all, have been found necessary." And he adds in a foot-note, "Since writing this, the communication across the bridge has been stopped for a day by a high flood turning the east flank of the bridge; *but the moorings remained firm.*" Those who have seen Indian rivers at flood, under the influence of tropical rains, will understand the value of such testimony. The objections suggested by the gallant officer may, therefore, be considered as completely answered.

Sir Charles Pasley despises *flat* boats, because they are unmanageable in currents. This objection is quite fallacious in regard to rivers of moderate depth, such as those of the Indian plains. In rivers with ten or fifteen feet of water

and intersected with shoals, the flat-bottomed boat is the most manageable of all, even in the fiercest currents. In such rivers ferry-boats are managed entirely by the pole.

At the passage of the Sutlej, in February, 1846, it was necessary to throw across the river Grey's Division to cover our bridging operations. Fourteen pontoon rafts, of Pasley's pattern, were used. Each raft took from our limited *personnel* seven sappers (we had only two companies). Each raft took at a trip about 25 infantry; and as the canoes drew some 18 inches of water, and the river was full of shoals, the work proceeded tediously, hopelessly, until we got three or four "chuppoos" from the land-locked basin. Each chuppoo, worked by two men with long poles, carried over at each trip a whole company of infantry, or a field-gun, with its four horses and its detachment of gunners; and drawing then only a few inches, it poled straight across, and performed two trips to one of the pontoon rafts.—*Vide* Douglas, Military Bridges, 3rd Edit. p. 167, and Professional Papers of the Royal Engineers, vol. x. p. 182.

Mr. Francis' floating waggon would be just as manageable as these "chuppoos."

I will quote one more passage from Sir H. Douglas' Military Bridges (vol. x. p. 83), in illustration of the manageableness of flat boats in currents.

"Immediately after the victory gained by the British army over the Sikhs at Goojerat, February 21, 1849, the Commander-in-Chief, Lord Gough, detached a large force, under General Sir Walter Gilbert, to pursue the enemy; and as the Sikhs in retreating had burned all the boats by which they crossed the Jhelum, Lord Gough dispatched, in aid of the General, the pontoon train under Lieutenant Crommelin. Before the train arrived, the train had crossed the river, about eight miles above the town of Jhelum, by fording the five

nearly parallel channels above the place at which their united streams form the main river; and Lieutenant Crommelin received orders to form the bridge at Jhelum, in order to convey over the river a detachment under Brigadier Macleod, with all the heavy guns and stores. The river at Jhelum being above 400 yards wide,* could only have been passed by using the pontoons as rafts, and this would have required a longer time than could be afforded; but on reconnoitring the river, which had been swollen by the rains,† Lieutenant Crommelin ascertained that only one of the fords by which the division had crossed was impassable; and at this place, where the branch was 100 yards wide, he proposed to construct the bridge. The spot was some distance below a rapid, and the banks, which were perpendicular, were three feet high.

"The pontoons, which were of copper, and constructed on Sir Charles Pasley's pattern, were sufficient in number to form fourteen rafts, and these united would stretch across the stream. The rafts were formed at Jhelum, and tracked up the river to the proposed spot, a distance of about 14 miles; and the landing-places being completed, the rafts were ranged along the bank. A row-boat, which was brought up with the train, was found very convenient during the formation of the bridge.

"The first raft being well secured to the landing-place, two others dropped into their places without difficulty, and were made fast to stakes driven into the bank, as well as anchored. The anchor of the fourth raft would not hold, and the raft dropped far down the stream, notwithstanding the exertions of five sappers to row it up. An unsuccessful effort was then made to form a bridge by booming out the standing

* This at the dryest season.

† Rain must have fallen after the passages of Gilbert's light troops and

portion, and adding other rafts from the shore. One additional raft was fixed in this manner, but, in attempting to add a fifth, the strength of the current rendered it impossible to keep it steady in its position. The remaining rafts were then allowed to drop below the bridge, and an effort was made, partly by hauling and partly by rowing, to bring them up against the stream; and in this manner two more rafts were added to the four already fixed. The bridge was now commenced from the opposite bank, and five rafts were there fixed. The night then closed with a part of the bridge projecting from each bank, and with a gap in the middle. A large flat-bottomed native boat was then obtained, and, being repaired, was moored above the bridge by means of two cradles filled with stones, to serve as anchors. Guided by strong cables made of jungle grass, the boat was then allowed to descend the stream into its position between the two parts of the bridge, where it was secured by guide-ropes: the bridge was then rapidly completed by hauling two more rafts into position, one on each side of the native boat. The part of the roadway which was over the boat was supported on trestles, resting on its bottom.

"The pontoons were much out of repair, and leaked considerably; but it is presumed that, under such circumstances, the 'Pasley' pontoons were more manageable than cylindrical ones would have been. During the passage of the heavy ammunition carts, the platform of the bridge was occasionally under water: the camels also, in passing, caused great undulations and leakage of the pontoons."

Thus we see the much-despised flat boat coming to the assistance of the European pontoon, in a rapid.

With regard to pontoon trains for British India, it hardly becomes an old engineer to discourage their formation. Colonel Tremenheere assures me there is good hope of

emergency. I rejoice to hear this. There will, I presume, be but one train for that Presidency. This will be, doubtless, located in some central spot,—at Roorkhee, probably, the head quarters of the sapper corps. Let us suppose it to be there, exercising the sappers on the holy waters of Gungajee,* which Sir Proby Cautley has so unceremoniously diverted into utility by his noble canal. Let us suppose it there, with its hundred and fifty cars, and its thousand bullocks; and let us suppose the Peshawur force suddenly called to the field to suppress some formidable disturbance. On the right of Peshawur is the Cabul River; in its rear, the Indus; the pontoon train is 400 miles distant, or something like a month's march. Many other divisions of the army of this great Presidency are similarly situated: none can be considered as efficient without the means of crossing rivers of magnitude, and, if we adhere rigidly to the European system, each division must have a full train, involving an expense which the most ardent admirers of pontoons would hardly venture to press upon Government. Now if each division of the army were supplied with the modified demi-waggon of France's corrugated iron, the troops could take the field at a moment's notice—no river could stop them; they would require no experienced or trained pontooniers to escort them; any camp followers could put the waggon bodies into bridges; and being used as commissariat store carts, they would add little to the *impedimenta*. In piping times of peace, these iron troughs or waggon bodies would lie in the commissariat yards, giving trouble to no one, yet always ready for employment.

Believe me, my dear Eyre, yours, &c.,

ADDISCOMBE HOUSE, 23rd May, 1856. F. ABBOTT.

* The familiar name by which the river Ganges is designated by the Hindoos.

APPENDIX A.

GENERAL OBSERVATIONS ON THE MANUFACTURE OF METALLIC BOATS AND WAGGONS.

1. THE dies employed for stamping metal boats and waggons are *durable* in a very high degree, and become more perfect by use; so that age, instead of impairing, actually *enhances their value*.

2. The tendency of wood to decay renders it unadvisable to construct a large supply of wooden boats or waggons for anticipated demands; whereas, by reason of the imperishable nature of galvanised metal, we are enabled to prepare, of both articles, a supply in advance for future wants, and to store them in so compact a manner as greatly to economise space; since the component parts may be stowed away in separate piles, ready to be put together, or may be transported to distant places for that purpose, and there suffered to lie for years in deposit, without any fear of deterioration.

3. While the *wooden* boat or waggon deteriorates by disuse or age, the metallic body actually *improves*, because the paint upon it becomes harder by exposure to the weather, and thus contributes more perfectly to its protection.

4. The average duration of a wooden boat falls short of six years, and in that period its repairs amount to one-third, or more, of its original cost; hence, in eighteen years a ship will require three suits of wooden boats, subject to the inconvenience and danger of leakage, and other obvious drawbacks;

whereas a metallic boat will last *as long as the ship itself*, besides being exempt from the trouble and expense of frequent repairs.

5. A blow that would *break* and *disable* a wooden boat or waggon, would only bruise or indent the metal one, without impairing efficiency.

6. Metal boats are not affected by the heaviest discharges of cannon while hanging at the davits. This was practically tested on a recent occasion at Cherbourg, by order of the French Government.

7. Metal boats and waggons, as already stated in the body of the Lecture, are *fire-proof, water-proof, worm-proof, do not corrode or rot*, and possess every other advantage in point of durability and strength over those of wood.

8. One set of machinery will furnish material for at least *forty boats per diem.*

9. All the boats for the navy and public service generally, might be made by *one set of machinery*, with *one establishment;* whereby an immense annual saving to Government might be at once effected.

10. Corrugated metal boats will be found admirably adapted for *canal* purposes; drawing less water than the wooden and iron boats in present use; and therefore allowing a larger space for *freight;* thus increasing the *profit.*

11. The advantages of manufacture in England over that of the United States are very great; as the price of labour is less; and the galvanised iron being made here, can be obtained at greater advantage, as required; more perfect, and in longer sheets, which decreases the labour. The cost of iron in the United States per lb. is from $4\frac{1}{2}d.$ to $5\frac{1}{2}d.$; in England, from $3d.$ to $3\frac{3}{4}d.$

12. The manufacture of these boats has been in progress about eight years, passing through a series of experiments to

perfect it, at a great expense. Like iron-ship building, the manufacture has been simplified and perfected by perseverance in experiment and practice.

13. The metallic boats furnished to the United States' Government eight years since, and those of the Charlestown and New York line of steamers, are now in as good condition as when built, without having had any repairs. Those on the deck of the "Collins" steamer, after being exposed to heat and wet and lying near the smoke-pipe five years, are reported by Commander Bevis, R.N., to the Admiralty to be "perfect as ever."

14. All metallic boats are LIFE-BOATS; the air chambers increase the strength, and add very little to the weight of the boat; as the shell of the boat forms the principal part of the chamber. By these means a sufficient number of cubic feet is obtained at the ends, where the room is useless for other purposes; so that, unless a powerful life-boat is needed, more of the valuable space in the body of the boat is encumbered, and the chambers are protected from injury. Wooden boats, as life-boats, require their chambers to be formed entire, and resting on the timbers or frames; thus much valuable room is lost.

TO REPAIR "METALLIC BOATS."

This is a simple operation, for if by repeated bending back or forth the bottom is cracked or broken, place a piece of wood over the inside, and nail through from the outside, having first put paint or flannel between.

A piece of common sheet-iron or tin may be applied to a hole punched through a boat. A nail sharpened answers for a punch, and common nails for rivets. If bruised or bent by concussion, apply a common hammer or mallet to knock it to

place. Such temporary means to repair may be resorted to at sea, or where machines are not at hand.

Any common sheet-iron or tin worker can repair as well as the manufacturer of the boat. Metal boats can be placed in the *hottest* place, as by exposure to heat for months or years the paint becomes hard and durable.

APPENDIX B.

Professor Maillefert's account of the Explosion referred to at page 14.

Astoria, April 19th, 1852.

E. MERIAM, Esq., Brooklyn.

Dear Sir,—Since the fatal accident that took place at Hurl Gate, on the 26th ult., this is the first time that I am able to use my sight, so providentially recovered, and I cannot make a more appropriate use of it than by stating to you the following fact:—

In the beginning of February last, you wrote me that Mr. Joseph Francis, the inventor of the Metallic Life-boat, wished to have the life-boat used by me sent to him, for the purpose of repairing it; but I wrote you in reply that I could not spare the boat even for a single day, fully appreciating its value and great superiority over wooden boats, and moreover, it did not want any repairs, notwithstanding the rough usage to which it had been subjected for seven months past; it was quite providential that I insisted on keeping it, as, scarcely a month after, this same boat saved my life in two distinct ways.

First, in protecting me from the immediate effect of the explosion, as the end of the boat, instead of flying into small fragments in every direction, as did my wooden boat, only bent up and acted as a shield, behind which I was protected to a certain extent. Secondly, it saved me from drowning, in the manner following: When the charge exploded, which was only three feet distant from the stern of the life-boat, and about seven feet from myself, the boat, together with me and my brother-in-law, were sent to a distance of 135 feet, and I sunk to the bottom, where I remained senseless for three or four minutes, according to the statements of all the bystanders; on

recovering, and after incredible struggles, having only the use of one arm, I came to the surface, and was greatly relieved to perceive some twelve yards off my faithful life-boat floating, with my brother-in-law supported by it. After sinking and rising once more, I succeeded in getting hold of the boat, which floated so light that ten or twelve persons could have been supported by it; no other object was seen floating in any direction but very small fragments of the wooden boat, too small to be of any service as life-buoys.

It is a fact truly worthy of public notice, that the boat was not supplied with any extra buoyant power, such as corks, India-rubber buoys, &c., but was purely and simply supported by its own metallic air-chamber.

This goes far to show to what hardships these admirable boats can be subjected.

They may be knocked about upon rocks, or twisted out of shape, or bent up by superhuman power, yet in despite of all they will float, and be the means of saving lives, as in my case.

In conclusion, I have to state that my firm conviction is, that had my poor unfortunate men been in one of these metallic boats, *instead of a wooden one*, some of them would have been saved, as they were *mutilated by the fragments of wood*; for instance, Capt. Southard, who stood no closer to the exploding charge than myself, was struck in the side by a fragment of his wooden boat, while I was protected by the iron sides of the life-boat.

(Signed) B. MAILLEFERT.

APPENDIX C.

From the Report of the Secretary of the Navy to the Congress of the United States, being portions of a Report made by Lieut. W. F. Lynch, U. S. N., of an Exploration of the Dead Sea.

U. S. Store-ship "Supply," November, 1848.

To the Hon. J. Y. MASON,

Sec. U. S. N., Washington, D. C.

I have the honour to report that, in obedience to your order of September 30th, 1847, I assumed the command of this ship on the 2nd day of October following.

By your special order I obtained *two of Francis' Metallic Life-boats*, and while the ship was being equipped, procured the various articles deemed necessary for the successful result of the contemplated attempt to descend the Jordan, and explore the Dead Sea.

On the afternoon of March 31st, 1847, we succeeded in landing the boats and all our effects. The next day we transported them to the banks of the river Belus, near Acre, where we pitched our tents that evening.

* * * * * * *

Our route was over high mountain ridges, and through deep and seemingly impassable gorges; but we succeeded, and on the 8th launched the boats upon the placid waters of the Lake Tiberias.

For the purpose of economy in the transportation of stores, I purchased a (wooden) frame boat, the only one of any kind on the lake.

On Monday, April 10th, at 2.30 P.M., we started. After leaving the lake, we passed the village of Semakh on the left, and soon came to the ruins of a bridge of the same name. The fragments of the bridge entirely obstructed the channel, except a narrow place towards the left bank, where the pent-up water found an issue, and ran in a sluice among the scattering masses of stone. After reconnoitring the rapid, we shot down the sluice,—the *leading boat was whirled against a rock*, where she hung for a few moments, but was got off without damage.

Tuesday, April 11th.—We started at 8.40 P.M., the current at first two knots per hour, but increasing as we advanced, until we came to where the river, for more than 300 yards, was one foaming rapid, a number of fishing weirs, and the ruins of another ancient bridge, obstructing the passage. After five hours' severe labour, we got the boats through,—the *metallic ones without injury*, but the wooden frame one so battered and strained that she sunk shortly after, and we were obliged to abandon her. *Had our other boats been of wood, they would have shared the same fate. A blow that only indents a metallic boat, would fracture a wooden one.*

Shortly after leaving the last ruined bridge, we descended a cascade, at an angle of 60 degrees, at the rate of 12 knots, and immediately after, down a shoal rapid, *where we struck and hung for a few moments upon a rock.* We have to-day descended one cascade and seven rapids,—three large, and four small ones.

Wednesday, April 12th.—At daybreak examined the whirlpool

and rapids. Descended the first rapid, and at 11.5 shot through the whirlpool, and *down a desperate-looking cascade of eleven feet.* At 12 we stopped to rest, and at 12.45 started again, — and at 1 P.M. completed the descent of the third rapid since morning. Near sunset, we descended the most frightful rapid we had yet encountered, and, after passing down two others, arrived, at 6.30 P.M., at Jir Mejami (a bridge of the place of meeting), and shooting through the main arch, descended about two hundred yards of the shallow rapid, when, it becoming too dark to proceed, we hauled to the right bank and made fast for the night.

We to-day descended two cascades, and six rapids, four large and two small ones. The current has been rarely less than four, and sometimes, down the rapids, as much as twelve knots per hour.

Thursday, April 13th.—*Succeeded in getting the boats safely down the rapids uninjured, save a few indentations in their bilge.* As we would this day approach the Lower Ghor, which is traversed by hostile tribes, to be prepared, I mounted our heavy blunderbuss on the bow of the leading boat.

At 10.40, *descending an ugly, brawling, shelving rapid, she struck on a rock just beneath the surface of the water, and broaching, broadside on, was thrown upon her bilge*—taking in a great quantity of water; but all hands jumping overboard, her combined strength and buoyancy carried her safely over, though for some minutes we feared she would go to pieces.

The river to-day varied from five to six knots velocity of current; we descended twelve rapids, three of them formidable ones.

Friday, April 14th.—The boats, this morning, had little need of oars to propel them, the current carrying them down at the rate of four knots per hour. The width of the river has varied from seventy yards, and two knots current, to thirty yards, with six knots current. *We struck three times upon sunken rocks to-day,* and *the last time nearly lost the leading boat.*

* * * * * * *

It gratifies me to state that the boats are in almost as good a condition as when we received them.

FROM CAPT. W. F. LYNCH.

March 19th, 1849.

If in any way I can serve you by making known the excellent qualities of your Metallic Life-boats, I feel bound to do so, *for with*

no other kind of boat, however strongly constructed, could the descent of the Jordan have been accomplished, and the expedition must have been unsuccessful without them.

To Joseph Francis, Esq.

FROM JOSEPH C. THOMAS, ESQ.

Extract of a Letter from Joseph C. Thomas, one of the Dead Sea Expedition, March 19th, 1849.

Being one of the party attached to the "Dead Sea Expedition," under Lieut. Lynch, I would state, that but for the Metallic Life-boats we never could have accomplished the descent of the river Jordan. *No other kind of boat could have bounded over rocks and down such deep and dangerous rapids. To these boats we owe our lives*, for, had they failed, *as did the one wooden boat* we had, we must have been thrown on the shore, and been murdered by the hostile Arabs, and the whole expedition have failed.

Joseph Francis, Esq.

APPENDIX D.

The following testimonials in favour of Metallic Boats are selected from a vast number, which have been placed at my disposal, as illustrative of the various points particularly alluded to in my Lecture.

FROM EDWARD K. COLLINS, ESQ.

(No. 1.) New York, Aug. 4th, 1850.

I have provided Francis' Metallic boats for the "Collins Line of Liverpool Steamships," as from my own experience they are far superior to any others in point of *Economy*, *Durability*, *and Safety*.

I should think no other kind of boat could be relied on for spare boats for passengers when steamboats are destroyed by fire. They are fire-proof, and are not affected by the heat.

EDWARD K. COLLINS.

From Capt. Thos. Brownell, U. S. Navy.

(No. 2.) 11th September, 1848.

These boats are always ready for use at a moment's warning, in any climate, and such as would render a wooden boat entirely useless. They can be used at sea, and lives saved, where wooden boats could not live, even if in a floating condition. The boats I have in use I have put to very severe tests.

From Report of the Judges on Naval Architecture.

(No. 3.)

The Galvanised Iron Life-boats have superior advantages over all others, for the following reasons:

First.—Their endurance under severe trial, it being almost impossible to meet with sufficient injury to disable them from sustaining their complement of persons for any length of time in case of *storm*, *wreck*, or *fire*.

Secondly.—Their extreme tightness, united with great strength.

Thirdly.—Their inability to become nail sick, worm-eaten, or leaky from exposure to the sun, however long they may be out of water.

Fourthly.—These life-boats may be used at sea to preserve life when nothing else can live, or for the daily use of the ship, *being always in readiness for either service.*

Circular.

(No. 4.) Treasury Department, March 8th, 1851.

Sir,—It having been determined by the Department to substitute in future Francis' Metallic Boats for the wooden boats now in use for revenue purposes, no further repairs will be sanctioned on such boats. When the boat at your port is deemed unfit for further use, without repairs, you will so advise the Department, giving the length, breadth, and depth of said boat, when her place will be supplied with the Metallic Boat above referred to.

Very respectfully, your obdt. servant,

Thomas Corwin,

Secretary of the Treasury.

To Collectors of the Customs,
and Captains of the Revenue Cutters.

FROM CAPT. C. STODDART,

Of the U. S. Mail Steamship "Crescent City."

(No. 5.) September 30th, 1848.

I have just received the Galvanized Iron Boat which I sent you for repairs. She was crushed as she hung on the davits, by another ship coming in collision—and she now appears as good as when I purchased her. Had she been of wood, she would have been entirely ruined and beyond repair; whereas, being of metal, she was repaired in six hours at an expense of only five dollars, and made as good as new. I feel constrained to say, that the metal boats are far superior to wood, because they are always ready for use, are not affected by the heat of the sun or burning of a vessel, and are capable, far beyond boats of wood, of resisting the action of the waves, and if jammed, too, as mine was, can be repaired at trivial expense, when a wooden one, in like circumstances, would have to be replaced by a new one.

FROM CAPT. G. W. FLOYD.

(No. 6.) U. S. Mail Steamship "Washington,"
New York, Sept. 13th, 1850.

The Metallic Boats furnished by you for the United States Steamship "Washington," when she was built, are as good as new, and have needed no repairs. I consider the Metallic Boats superior in every respect, as they are always tight and ready for sea. In case of wreck or burning of a vessel, a tight and fire-proof boat is of vital importance, and at such times they are appreciated.

From my own experience, I can say that the Metallic Boats have the requisites of safety and durability.

GEORGE W. FLOYD, Commander.

FROM CAPT. J. COMSTOCK.

(No. 7.) New York, Aug. 26th, 1850.

I am fully of opinion that your Metallic Life-boats are invaluable to all sea-going vessels. Their great strength and buoyancy renders them available when the ordinary wooden boats would be of no service, and their lightness will allow of their being carried on shipboard, where other boats could not be put. In case of fire no other boat of course is its equal; and on the score of humanity, I hope all passenger-carrying vessels will be by law compelled to carry as many

of your boats as is consistent with room or space available for such purposes. When landing on rough beaches they will be available; other boats would be dashed to atoms.

Jos. J. Comstock, Steamer "Baltic."

Charles V. Morris, U. S. N.

(No. 8.) Washington, August, 1852.

I have been in possession of three of "Francis' Metallic Life-boats," for a length of time, and have tested them in the severest manner. They are fire-proof—worm-proof—will not corrode or rot—always tight and ready for service in every climate, and when hung to the "davits" six months or a year, they are then ready for lowering in the water. The concussion of cannon has no effect upon them. They are superior to wooden boats in every sense—more buoyant—more economical—and cannot become water-soaked.

Charles V. Morris, U. S. N.

Capt. W. L. Hudson, U. S. N.

(No. 9.)

You refer me in your letter, to the *dingy* of the "Porpoise," as having been *thirty-nine months in continual use* in the China Seas, and having returned somewhat worn, but requiring only slight repairs to fit her for another cruise. I had with me in the "Vincennes," on her recent cruise, one of your Metallic dingies, which, during a cruise of *three years*, did most of the drudgery of the ship, and was used nearly as much as all the rest of the ship's boats put together. She is now at this yard, ready for another cruise, and was, with the exception of some few hours' labour on her woodwork, as good as new. We kept her well painted, and had no occasion to repair or patch her ironwork during the cruise.

My copper quarter boat that you furnished, was lost from the quarter in a gale of wind off Cape Horn. We saw her borne from the ship, buoyant as a swan on the billows, as far as the eye could trace her.

W. L. Hudson, Com. U. S. N.

Navy Yard, New York, Jan. 24, 1853.

APPENDIX E.

Office of the Quarter-Master General U. S. Army.
Washington, D. C., April 30, 1855.

DEAR SIR,—Having informed me that you intend visiting Europe, for the purpose of introducing your Manufactures of Corrugated Galvanised Iron, it is my wish that you may have my opinion in regard to them, hoping that it may be of some service to you.

Of the Metallic Life-boats and Barges, it is only necessary to remark that their reputation is so well established, and their usefulness so fully conceded by all in this country who have had an opportunity of testing them, that nothing I can state can add to it. I shall, therefore, confine my remarks to the Waggon-body, which has been made under the direction of the Secretary of War for army purposes.

It was very desirable in this country to have a waggon body that might be used in case of necessity as a boat or pontoon in crossing the numerous rivers and streams in our widely extended country west of the Mississippi River; while it would at the same time answer all the ordinary purposes of transportation, thereby saving expense to the public, by dispensing with pontoons, which could only be applied to the one purpose.

In this, I am happy to be able to state that you have been entirely successful, and that after repeated experiments and tests in the presence of the Secretary of War and members of the Senate and House of Representatives of the United States, the Quarter-Master General and other officers of the army, it has been adopted into our service, and is now being used on our frontiers in the Indian country.

The weight of the metallic body is not greater than that of the wooden one, and it being capable of sustaining the running gear (wheels, &c. &c.), in addition to a moderate load in crossing streams, is a desideratum which will suggest itself to all, and especially to military men.

In case of necessity, the body can be detached from the carriage and used as a boat, and by connecting four or six of them, with a plank covering, a boat can be made of them by which the heaviest pieces of artillery used in the field can be safely conveyed across a river. They can also be used in the construction of a military bridge.

From the test I have personally superintended and seen applied to it, I have full confidence in the improvement, and I cheerfully recommend it as being far superior to anything of the kind which has been used in our service, and hope that you may be successful in introducing it into other countries, where it may be found necessary for either public or private uses.

With the best wishes for your health, and a speedy and safe return to our country and your home, I remain, dear Sir,

Very respectfully your friend and obedient servant,

(Signed) CHARLES THOMAS, Lieut.-Colonel,
Deputy Quarter-Master General U. S. Army.

Joseph Francis, Esq., New York.

Hotel du Rhin, Paris, July 11th, 1855.

At the request of Mr. Francis, I have examined the letter of Colonel Charles Thomas, Deputy Quarter-Master General U. S. Army, of which this is a copy, and certify it to be a genuine document.

I have been on duty in the Quarter-Master General's Office, and know well the signature of Colonel Charles Thomas.

It gives me pleasure further to confirm all that Colonel Thomas has said of Mr. Francis' Pontoon Waggon, which, after several severe tests, has been adopted in our service, and I gladly recommend Mr. Francis and his invention to the attention of such military men as he may present it to for examination.

(Signed) HENRY WAYNE, Major U. S. Army.

Legation of the United States, Paris, July 11th, 1855.

I certify that the signature of Henry C. Wayne to the Certificate attached to the letter of Colonel Charles Thomas, Quarter-Master General of the U. S. Army, to which I annex this note, is genuine; that Major Wayne is an officer of the said Army, of merit, and that full faith and credit are due to his statements and opinions.

(Signed) T. Y. MASON.

Extract from a Letter from General Harvey, U. S. Army, to Joseph Francis, dated Fort Pierc, M. Y., Oct. 26th, 1855.

I am very much in favour of your Metallic Waggon bodies, and urged the Quarter-Master General to let me have a number for my

expedition against the Sioux Indians, and my experience satisfies me they are the best we can have."

Letter from Colonel C. Thomas, Deputy Quarter-Master General U. S. Army.

Quarter-Master General's Office, Washington, Jan. 26th, 1856.

SIR,—I have to inform you that the Secretary of War has sanctioned the purchase of fifty more of the Metallic Waggon bodies. You are requested to have part of them finished—say twenty-five—with as little delay as will ensure their being made in the best manner. The remainder can be finished at your earliest convenience.

(Signed) CHARLES THOMAS,
Deputy Quarter-Master General.

From Colonel T. S. Jonah, Quarter-Master General, U. S. Army.

Washington, Feb. 8th, 1856.

SIR,—I wish you to have made, with as little delay as possible, for the use of the Department, eight six-oared Metallic Barges, with their equipment of oars and life-boats. Also twenty Metallic Bateaux, with oars and paddles, similar to those made at your establishment about a year since (Life-boat principle).

(Signed) THOMAS S. JONAH, Quarter-Master General.

APPENDIX F.

FROM THE "MONITEUR."

L'Empereur, accompagné du ministre de la guerre, d'un aide de camp et d'un officier d'ordonnance, s'est rendu, le 2 février, sur les bords de la Seine, près de l'Ecole militaire, pour être témoin des expériences faites en vue de démontrer les qualités d'un chariot militaire, de métal cannelé, que M. Francis, de New-York, avait construit pour le présenter à Sa Majesté.

M. Francis commença par donner des renseignements sur son mode de construction et sur les procédés employés pour donner une grande force à un métal très-mince et très-léger, et en fournit la preuve en frappant la caisse de toutes ses forces, à coups redoublés

et au même point, avec un gros marteau à long manche. Il fit ensuite lancer le chariot, avec tout son train, dans l'eau, où il flotta comme un bateau ; les hommes qui y étaient embarqués, au nombre de seize, se portèrent en masse sur les côtés sans pouvoir, malgré tous leurs efforts, faire arriver les bords au niveau de l'eau. Le chariot fut après cela dirigé sur le courant de la rivière, afin de montrer qu'une forte charge pourrait, par ce moyen, être transportée d'une rive à l'autre sans qu'il fût besoin d'ôter les roues : de sorte qu'un train de ces chariots pourrait continuer à suivre sa route sans retard.

Ensuite, le train ayant été détaché, on fit manœuvrer la caisse séparément, comme un bateau à rames.

Ces expériences obtinrent l'approbation de Sa Majesté, qui eut la bonté d'appeler deux fois M. Francis, et de le féliciter sur son succés.

L'Empereur se fit donner par M. Francis des renseignements détaillés sur ses bateaux métalliques, qui ont acquis une grande célébrité, et dont des modèles étaient sur les lieux. Après un examen circonstancié qui dura plus d'une heure, Sa Majesté témoigna l'intérêt qu'elle prenait à ces inventions, comme étant une amélioration importante pour le service de l'armée et de la marine.

En même temps, M. Francis informa Sa Majesté de nouvelles officielles reçues de l'armée des Etats-Unis, rendant compte d'une expédition de 1,500 milles sur de très-mauvaises routes, expédition pendant laquelle ses chariots avaient traversé des rivières, flottant avec leurs charges d'une rive à l'autre, sans qu'aucun cours d'eau eût pu en arrêter la marche.

APPENDIX G.

Navy Department, Bureau of Construction, Equipment, &c.
July 19th, 1850.

Sir,—Having been informed that Congress was about adopting measures for the prevention of the great loss of life which sometimes occurs from steamboat disasters on our waters, I take the liberty of expressing my opinion, founded on the various trials to which Metallic Boats (furnished with air-chambers) have been exposed, that they afford the best means of safety to the lives of persons exposed, either by the foundering of a vessel, or destruction by fire.

A cutter so fitted, 26 feet in length, furnished to the United States frigate "Savanna," was reported to this Bureau by the commanding officer, New York, to be capable of sustaining inside from 25 to 30 men, when filled with water.

The great advantage they possess over boats built of wood, is, that they are fire-proof, and are not liable to leak when exposed to the action of the sun, *or to be smashed when coming in contact with a ship's side, or even rocks.*

Those used by Lieut. Lynch in descending the rapids of Jordan, although they received violent concussions in striking rocks, *did not leak a drop*,—the indentations thus produced were removed by a common hand-hammer.

Had the unfortunate "Griffith," on Lake Erie, been supplied with two of these boats, 30 feet long, and of suitable width, many if not all her passengers could have been saved.

Many vessels of the navy have been furnished with one for the purpose of crossing dangerous bars, landing in a heavy surf, or lowering at sea in the event of a man falling overboard; for such purpose I consider them superior to any others heretofore used in the navy or mercantile marine.

Very respectfully, your obedient servant,
(Signed) CHARLES W. SKINNER.

Hon. Daniel S. Dickenson, U. S. Senator,
Washington City, D. C.

ORDERS FROM ENGLAND FOR BOATS.

A gratifying proof that the merits of Metallic Boats are beginning to be appreciated in England, may be derived from the fact (only made known to me since these sheets went to press), that the owners of the "Cunard" line of steamers, from Liverpool to New York, have just ordered a complete set of Metallic Boats for that splendid new steam-ship the "Persia."

THE AMERICAN STEAMBOAT LAW.

AN ACT

To amend an Act entitled "An Act to provide for the better security of the Lives of Passengers on board of Vessels propelled in whole or in part by Steam, and for other purposes."

SEC. 4. *And be it further enacted*, that every such vessel carrying passengers shall have at least two good and suitable boats, supplied with oars, in good condition at all times for service, *one of which boats shall be a life-boat made of metal, fire-proof*, and in all respects a good, substantial, safe sea-boat capable of sustaining, inside and outside, fifty persons, with life-lines attached to the gunwale at suitable distances. And every such vessel of more than *five hundred tons*, and not exceeding *eight hundred tons measurement*, shall *have three life-boats*; and every such vessel of *more than eight hundred tons*, and not exceeding *fifteen hundred tons* measurement, shall have *four life-boats*; and every such vessel of more than fifteen hundred tons measurement shall have *six life-boats*; all of which boats shall be well furnished with oars and other necessary apparatus: *Provided, however*, the inspectors are hereby authorised to exempt steamers navigating rivers only from the obligation to carry of the life-boats herein provided for more than one, the same being of suitable dimensions, made of metal, and furnished with all necessary apparatus for use and safety; such steamers having other suitable provisions for the preservation of life in case of fire or other disaster.

Memorandum of the different Gauges of Metal used in the Manufacture of Boats and Waggons.

No. 16. Weighs 2¼ lbs. per superficial foot, used for man-of-war cutters and the heaviest waggons.

No. 18. Weighs 2 lbs. per superficial foot, used for ordinary waggons and boats.

Nos. 20 and 21. Weighs about 1½ lbs. per superficial foot, used for the lighter boats and waggons.

Woodfall and Kinder, Printers, Angel Court, Skinner Street, London.