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Wednesday, March 20th, 1895.

Lieut-General J. KEITH FRASER, C.M.G., Inspector-General of Cavalry,
in the Chair.

The CHAIRMAN: Ladies and gentlemen,—Mr. Berthon, Vicar of Romsey, was well known to the old Royal United Service Institution. It is more than forty years since he gave his first lecture there, and he lectured there again some seventeen or eighteen years ago, on ships' boats, for the object of saving life in case of shipwreck. I, therefore, do not think it is necessary to introduce him here, because he has lectured before this Institution before many of you, perhaps, were born. In addition to being well known on account of his duties as Vicar, I may tell you he has established a factory where employment is given to a large number of lads, and he has done an infinite amount of good. If he lectures as well as he preaches I am sure his lecture will be a most interesting one.

COLLAPSIBLE BOATS AND PONTOONS FOR MILITARY PURPOSES.

By the Rev. E. L. BERTHON.

IT is hardly a task for a civilian to attempt to point out to military men any deficiency in their appliances for the more perfect conduct of the operations of war; but there is one circumstance upon which all observers must be agreed, viz., the obstacles presented to troops of all arms by flowing streams; and though this subject has not been lost sight of, it has never before assumed the importance that it manifests at the present moment, when the fate of a campaign may depend upon a few hours gained or lost in overcoming the natural obstacles presented by rivers. So many instances of this evident fact will occur to the minds of all who are acquainted with the annals of war, that it is needless to refer to them.

My object is not to demonstrate the frequent existence of the above-mentioned obstacles, but how to overcome them in a manner that is at once practicable and effective. I think, therefore, that I shall be pardoned if, in this paper, instead of enlarging upon any of those considerations which properly belong to soldiers, I confine myself to what has been accomplished, and may be further extended by means of a system which it has pleased God to place in the hands of a civilian and a clergyman.

All readers of ancient history will remember how the armies of Xerxes and Alexander the Great crossed rivers, and I believe also the Hellespont, on rafts constructed of light frameworks of wood covered with skins; and when the Romans first visited these islands they found the natives using such frail flotations for the purpose of fishing, and to these tiny boats they gave the name of *coriacula*, because they were made of *leather* stretched over a frame of wickerwork; hence the name of *coracle* has ever since been applied to such structures, and, with very little alteration, they are still in use on the West Coast of Ireland and elsewhere. It was not, however, any of these coracles that

led to the idea of the boats and pontoons described in this paper, for they did not admit of being reduced in bulk for the purpose of transport ; nor did the thought of crossing rivers by such means occur, in the first instance, to the mind of the inventor. No, it was for saving life at sea that the principle of *collapsibility* first presented itself. It was immediately after the terrible wreck of the S.S. "Orion" on June 30, 1849, off Port Patrick, in perfectly smooth water, when more than a hundred first-class passengers were drowned for want of boats, that it fell like an inspiration upon the mind of the inventor that good and convenient *lifeboats* could be so constructed as to fold up and be stowed away in a very small space. It came in some such form as this :—

Instead of transverse ribs in a boat, make them longitudinal, and link them together at both ends, and in place of rigid planks put on segmental pieces of a strong waterproof material, so that the ribs may be made to fall down side by side with the flexible material folded between them. Moreover, it occurred almost immediately that if the ribs were made broad and flat, like thin slices of melon, a second skin might be attached to their inner edges, and the air inhaled into the cavities so formed, in the act of expansion or opening, would cause the boat to become an *insubmersible lifeboat*.

It would be a painful task now to relate the history of this invention in its early stages, and the opposition it met with both in the Royal Navy and the Mercantile Marine, although the most convincing proofs were given that boats built on this principle could compete in safety, speed, and all sea-going qualities with those of wood, and at the same time be stowed in about one-fifth of the space ; suffice it to say that such boats were built, and one of them, 30 × 10 feet, which carried 100 men, had the honour, forty-two years ago, of having the Queen and the Prince Consort on board. Nevertheless, the opposition was so strong that I was compelled to abandon the invention, and it lay buried twenty years.

In the Spring of the year 1873, I received a letter from Mr. Samuel Plimsoll, in which he told me that he remembered my work twenty years before ; and though the world was against me then, it would be ready to adopt my system now, adding that it was my duty to begin again.

Accordingly I lost no time. I hired about twelve men, built a shed a hundred feet long in my vicarage meadows, and set to work. Soon after Admiral Sir William Mends, the Director of Transports, came down to Romsey, witnessed experiments with my boats, and procured me orders for £15,000 worth for H.M. troopships, and since that all the transports carry these boats. The great success of the invention for sea-going purposes—the enormous strength and durability of the boats exceeding all expectation—led me to adapt the same principle to military purposes ; but a new departure became necessary, viz., that of building the boats in *sections*. The bipartite principle was recommended by my friend, Admiral Ryder. He wanted the principle to be adopted for the torpedo boats, 12 feet or 14 feet long. The idea immediately struck me of dividing the boats into two, and then they could go below deck. It was first applied to dinghies for the torpedo-boats, which, constructed in

two pieces, were easily carried beneath the deck; about 150 were built for our own Admiralty, and 650 for the French, besides those for many foreign navies. Here was a principle that seemed to offer immense advantages for pontoon bridges, and was favourably mentioned by General Sir Howard Douglas in his excellent work on this subject; but it was ignominiously condemned and rejected by the prejudice of another General R.E., who refused even to look at a bridge I had thrown across the Thames at Runymede, because canvas was used in its construction. Not so the officers of the Prussian Army, and after several years of exhaustive experiments that army has been equipped with 230 tripartite 22-foot pontoons, all made by me as Constructing Director of the Berthon Boat Company.

More than three years ago we invited the chiefs of the Royal Engineers' Committee to see a bridge thrown over the River Test, at Romsey, formed with some of the pontoons built for Germany; the trials were perfectly successful, and a wagon, weighing five tons, was drawn across by four horses. And there the matter ended, as far as our own country is concerned, but not so in the mind of the inventor. I saw that, though the *tripartite* pontoons are considered perfect in Germany, great improvements could be made when wanted for our own Service, one of which was the substitution of *bipartite* boats for those made in three sections. Another new departure was to construct light pontoon-boats to be carried on two-wheeled carts, to accompany cavalry and horse artillery.

A third addition was that of making efficient boats so convenient and light that they could be carried on horses at any pace and over any country. I propose, therefore, to confine what I have to say to the exposition of these three developments:—

1st.—Pontoon bridges.

2nd.—Light pontoon boats on carts.

3rd.—Boats carried by horses.

1st.—A pontoon wagon on this principle carries two 24-foot pontoons in two sections, each section being 12 feet long and 5 feet wide; twelve baulks 10 feet long, twenty-four 10-foot chesses, four saddles, eight bearers, and the usual outfit of anchors, cables, oars, etc., etc., the whole well within the limits of the regulation weight. Thus:—

	lbs.
2 24-foot pontoons (four halves)	900
12 10-foot baulks	378
24 10-foot chesses	1008
4 11-foot saddles	100
4 7-foot bearers	32
8 4'5-foot stanchions	32
Anchors, cables, oars, etc.	300

2,750 lbs.

or, 1 ton 4 cwt. 2 qrs. 6 lbs.

As the time required to open and set up these pontoons in halves is only a few seconds, and they can be thrown into the water and connected afloat, it will be found that they are more convenient to handle than those in the Service. Two men can run with a half-pontoon, and carry it in halves over ground too rough to drag one of wood.

The same advantage of lightness will be found in dismantling the bridge, taking the pontoons out of the water, and re-loading them on the wagon. With regard to the anchors, it may be said that, if I double the quantity of pontoons, I must double the quantity of anchors. You will, perhaps, want more cables. The resistance, as far as the stream is concerned, will be exactly the same, whether you have it on a larger number of light pontoons, or a small number of heavy ones—the displacement will be exactly the same. In fact, it will be rather less, because my pontoons weigh less than half the others. As far as the anchoring goes, therefore, we need not consider that, though perhaps we may want more cables. When I was in Berlin about two years ago, I saw a bridge thrown across the Spree. The Germans used my pontoons the same way as they use their own. They had no anchors at all; nor did they put a rope across the river (which is one way), but they used kedges, which are very convenient indeed, and do not weigh much more than one-fourth of what the anchors weigh. I do not want to find fault with our friends the Royal Engineers, but I think some of their materials might be employed a little more economically. To make baulks from one end to the other all the same thickness is a great waste of material, and adds to the weight. My baulks are made of strong American elm, and securely fixed round the curved side. It is 6 inches in depth, instead of 7 inches. The difference of the square of 6 and 7 is considerable: one is 36 and the other 49. My baulk only weighs $31\frac{1}{2}$ lbs., but the Service baulk weighs 84 lbs. Mine will carry nearly $2\frac{1}{2}$ tons, whereas the other will carry only 1 ton 16 cwt. That is the breaking strain. I have tried it by direct test, and calculated it. There is an undoubted saving, and I commend it to the consideration of the Royal Engineers. I hope they will not consider me impertinent. This form also enables me to considerably reduce the bulk of my pontoons.

I believe, also, something may be saved in the weight of the wagon. Perhaps it will appear, at first sight, that the weight of twelve baulks (450 lbs.) has been put too low; but a little consideration will show that it is correct. The central intervals between the pontoons now in use are 15 feet, and each baulk weighs 84 lbs.; as my central intervals are only 10 feet, the scantling, or sectional area, of my baulks to bear the same weight will be only two-thirds of that of the 15-foot ones, and their length also two-thirds; so the weight of the former is $\frac{2}{3} \times \frac{2}{3}$, or $\frac{4}{9}$ of 84 lbs. But this is not all; I make my baulks *fish-bellied*, and further strengthen them by adding a skin of American elm, applied bent, and well secured to the curved under-side. It should be observed also that my system of superstructure requires no ribands, and these in the Service pontoon weigh 85 lbs. each, which I save.

As to flotation, or the displacement of the boats afloat : First, as my intervals are 10 feet against 15 feet, I have 50 per cent. more in this way only ; but, as my pontoons are 3 feet, or one-seventh longer, I have

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11·9 per cent. in addition ; so that the displacement, or sustaining power, of my bridges is 61·9 per cent. greater than that of those now in use. The 6-horse-power steam sapper can safely cross this bridge. Now, I

submit that the advantages of my system are many and various. First, each wagon carries a complete unit of bridge, consisting of *two* pontoons and *two* bays of superstructure complete; by using the whole of each (halves united) of the twelve baulks and twenty chesses, we have 20 feet of roadway, 10 feet wide, for traffic of five or six tons. But, by using the half-pontoons *separately* at 10-foot intervals, and disposing the chesses *longitudinally*, we have 40 feet of bridge, 6 feet wide, for guns and carriages up to nearly three tons. Again, each wagon comprises a raft, with platform 10 feet wide, or *two* of 6 feet; or two separate rafts with platforms 6 feet wide.

Connected with the subject of bridge-making on this principle, there is an important consideration in making *cuts* in a bridge. I find that, owing to the particular arrangement of the baulks in the Royal Engineer Service bridge, it is necessary to provide *cut rafts* with specially constructed baulks for this purpose, and even then the process of making and restoring a cut is rather complicated.

In my system all this provision is unnecessary, and the operation can be performed with the greatest ease and expedition. Of course, every inventor sees merits in his own project; but I would simply ask if all these advantages have been combined in any other system. I would only observe that, having had long experience in building at least £200,000 worth of boats and pontoons of all shapes and sizes of canvas, I can confidently assert that this material, when coated and saturated with our flexible waterproof paint, is stronger for floating bodies, as well as more durable than wood. And here it is well to observe that all my boats and pontoons have inherent or *intrinsic buoyancy*; they are, in fact, insubmersible lifeboats, owing to the large quantity of air inhaled into the air cells in the act of opening. This also provides an additional safety in case of accident, because, should the outer skin of canvas be cut or torn, the water enters into the wounded compartment only, and scarcely affects the flotation.

Perhaps it will be said that there is nothing gained by increasing the flotation or sustaining power of a pontoon bridge beyond that of the Service form, but I would submit that the displacement of the pontoons now in our Service at 15-foot intervals—the boats themselves being of the small length of 21 feet—is not enough, in the opinion of foreign officers, to bear the weight of infantry when very closely packed by a “check.” Nor would they, at that distance—15 feet—sustain the weight of a steam sapper, which my 24-foot boats at 10-foot intervals will bear.

Time and space forbid my entering upon a minute description of the details of these bridges; the model will give some idea. But the real full-sized bridges which we have at our works at Romsey can be thrown across the river there at any time.

The second application of this principle to military purposes is that for swimming horses and ferrying guns and wagons over rivers. This, I have already observed, has been introduced into the armies of Prussia. During the last three years they have been using my tripartite boats for these purposes with perfect success, and the perfection they have reached,

not only on the part of the men, but, what is more, of the horses, is really surprising. I was told by an officer of the Imperial Pioneer Guard that he had seen a division of cavalry, 1,800 strong, cross a river in less than three hours by means of six of these pontoon-boats. The operation was performed in this way:—Eight troopers, in two lines, rode into the river

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(the bottom of which was shelving gradually to the bank), four on each side of one of the boats; they all dismounted on board, with their saddles, arms, etc. Two men at the stern then shoved the boat into the stream; the horses walked till they could no longer touch the bottom, and then, by swimming, they crossed the river, and the pontoon (now

become literally an 8-horse-power boat) travelled, without rowing, at a very good speed. Arrived at the other side, the men re-saddled, mounted again, and rode up the bank. The boat was then rowed back for another trip. Of course, it will be understood that all these horses had been practised in this manœuvre, and, possibly, German horses are more

Reproduced from a photograph by Till and Saunders.

tractable than ours ; but, I feel convinced that a very little practice would be enough to induce English horses to take to the water as readily as those of Germany ; and I submit that this exercise should be included in the training of horses for our cavalry and horse artillery.

In the Prussian Service these pontoon-boats are carried on wagons,

but such carriages are evidently unfit to follow the rapid evolutions of cavalry and horse artillery. I have, therefore, made a new arrangement for this special purpose, and it has been tried with great success at various places. I cannot say what was done at Aldershot with the light cart and boats, but I know the trials under Colonel Lord Erroll at Windsor were considered perfectly satisfactory; and I am happy to say that General Keith Fraser was kind enough to express his entire approbation of what was done under his command at Churn. This modification consists of a 24-foot boat in four sections each of 6 feet long. These are carried on a light spring-cart, side by side. When all are opened and united—the work of two or three minutes—a boat is formed 24' $\times$ 5' $\times$ 2' 6" for swimming horses. For ferrying guns, etc., a raft is made by dividing the boat in two 12-foot lengths, and skids 8 feet long are made to rest on saddles on each half-boat; two other such skids connect the raft with the shore, over which the gun and limber are wheeled on board; the shore-ends are then embarked, and the raft rowed across by men in the bows, and steered by others in the sterns; this raft will carry any weight up to three tons. It may be used very conveniently as a "pont volant" or flying bridge, and it has buoyancy for forty men or more.

The weights are as follow :—

					lbs.
Boat in four parts	..	..	..	..	500
Four skids	..	..	..	..	200
Two saddles	..	..	..	..	40
Over scotches, etc.	..	..	..	..	36
Cart	..	..	..	..	560
					1,336 lbs.

Total cart and load under 12 cwt.

With two horses this cart can accompany horse artillery anywhere, at any speed, and, should one horse be disabled, it would be an easy load for the other.

With respect to the last of the three developments of my system now produced for military purposes, I have observed that very intelligent remarks have been made lately about the possibility of carrying light boats on horses that could gallop across country and clear any object that cavalry could negotiate. Of course, the ordinary pack-horse or mule could not do this; but I think it can be accomplished in the way tried by General Keith Fraser at Churn.

Our engraving shows a very pretty, well-shaped boat carried on an extremely light saddle by a horse. This boat is 10 feet long, in two halves, 3 feet 6 inches wide, and, when collapsed, its width or thickness is about 7 inches; the weight is less than 80 lbs., but it carries four men well. The half-boats can be opened, united, and launched in one minute, and it rows very well. The weight of the saddle is 20 lbs., and it is made with four adjustable pads to fit the back of any horse. As the total weight, including the saddle, does not exceed 100 lbs., I believe a horse could keep up with cavalry in the most difficult country. The

saddle now exhibited must not be considered as fiducial. It is, in fact, only experimental; and should it not be found perfectly satisfactory, it must be possible to produce a saddle that shall be quite comfortable to a horse carrying a load less than that of a child seven years old. I know

Reproduced from a photograph by Hill and Saunders.

that General Bogle has invented a peculiar saddle, with which a horse is able, with a mountain gun, to clear a bar 4 feet high; but the nature of the load is so different that it would require a perfectly different contrivance to carry collapsible boats.

The large 22-foot tripartite pontoon now exhibited is exactly the same as those in the Prussian Army. I consider this objectionable, because it does not lend itself well to equal division for the long light bridge.

But the bow-pieces are exactly the same in size, form, and weight as those of the quadripartite boat on the cart. I know that some people unacquainted with my boats think they must be too weak to withstand collisions, but this is quite a mistake, for their peculiar construction, securing great *elasticity*, renders them far less amenable to injury than other boats.

I should like to mention this one thing. Our gear, whatever it is, guns, carriages, and everything else, have not only to do with European concerns, but very greatly with India and Africa, where rats, white ants, and other things abound. For the last twenty years we have had boats in the centre of Africa, and also in India; but the white ants and rats do not touch them. There has not been a case of rats having hurt these at all. If any officers of the Royal Engineers are here, I should be extremely pleased if they would allow me to mention the subject of materials, because the materials we use I think are superior, and at the same time very much cheaper than those used in the Service. Each of my bays, from centre to centre of the boat, is 10 feet, and the width is 10 feet, so that each one is exactly a square. This admits of the chesses being placed either way. Probably some of those gentlemen present who are particularly interested in bridge work, will kindly look at the model I am now showing, in order to see the improvements, or what I should think to be improvements, viz., the dispensing with ribands, racking, and that sort of thing, and the manner in which my baulks are put together.

The CHAIRMAN: Ladies and gentlemen,—I am sure we have all listened with the greatest interest to the remarkable lecture which has just been delivered so well and clearly by Mr. Berthon, as to make us all, even unscientific people, understand what he means, and the way in which he has carried his objects out. I hope we shall have a good discussion upon the subject, and that many who are here will speak both with regard to the scientific part which they understand better than I do, and also as to the use of the bridges and pontoons in connection with the movement of troops, and especially with regard to the movements of cavalry, because that is what appears to me to be of the greatest possible importance. You may have large pontoons for carrying an army across, but cavalry want something very light, so that it can be carried in light carts. I hope, therefore, that all those who are interested in this subject will give us their opinions.

Colonel LONSDALE HALE: I rise to open the discussion, because the suggestion to the Council that we should do ourselves the honour of asking Mr. Berthon to favour us with a lecture emanated from myself. In the old days, when we had the old Engineer pontoon trains, I was subaltern for two years, and therefore I understand something about the technicalities of the subject. Of late years, however, I have rather gone away from the technicalities of engineering, and my attention has been directed mainly to military operations both on large and small scales, and nothing has impressed itself more upon my mind with regard to military observation than the supreme importance that every army should be provided with a thoroughly effective and efficient bridging equipment, not only for large units but for very small units. Those who, like myself, have studied the movements of troops and the work off the battlefield, know that any bridge equip-

ment, to be effective, should possess mobility, portability, and, I may say, compressibility. I say mobility, in order that the bridging train may move as rapidly as possible from one point to another. I am not going to take up your time with illustrations of military history, but cases may occur where the bridging train is thirty or forty miles away from the point where the crossing is to be, and therefore there is a necessity that it should be extremely mobile; it should be portable, that it may be easily carried down from the wagons to the river bank. With regard to compressibility, by that I mean to say that the boats should be put into as small a space as possible, so that they should not be confined to the main roads, but should be able to go amongst tortuous by-ways, and even possibly across a country track. About a year ago I was asked by Mr. Berthon to go down and see his equipment. We had rather a gallery day on that occasion; but I went down subsequently with Major Dickinson, and I had the advantage of making a thorough examination of Mr. Berthon's equipment. Afterwards I went down to my own corps at Aldershot, and saw the present bridging equipment. The idea came to my mind that the time had arrived when we might have a lecture and a discussion, and a thorough comparison between the two systems, and that is the reason why this lecture has been initiated. I thought that this place was better than Chatham, because here we could get officers of the different parts of the Service. This is not an engineer's question alone—for the efficiency of one branch of the Service affects the efficiency of other branches. We have representatives of many branches here, and I hope they will tell us what they think of this bridging equipment. But as this is primarily an engineering question, I wrote to General Grant, the Inspector-General of Engineers, and asked him if he would come here, but unfortunately he is not able to do so; but he has written to Aldershot and Chatham, and we have here this afternoon experts from the Royal Engineers, and I can assure Mr. Berthon (who has been rather severe upon the engineers in his lecture) that we have quite given up the old idea, that nothing can possibly come from anywhere but Chatham. I think we have got rid of that idea, but the engineers who are here as experts will be at liberty to point out the defects they consider in Mr. Berthon's invention. They are coming with open and unprejudiced minds with regard to it, and I hope that infantry, cavalry, and artillery officers—I am pretty sure about the cavalry—will speak their minds and will not say that this is a matter for the engineers, and they have nothing to do with it and do not understand it. It does affect them most materially. If we engineers cannot provide an equipment good enough for the artillery, cavalry, and infantry, it is their business to tell us so. With regard to the cavalry, I know our Chairman has strong views on that subject, and I think no other equipment can possibly be complete which does not provide especially for the cavalry; you must have something special which shall be used for the cavalry. I do not mind speaking about cavalry, and my study of war leads me to a different conclusion upon this matter from that which the General holds. The General is quite content that the bridging equipment for cavalry shall be a cart able to carry cavalry and artillery. I am, however, quite certain that the cavalry ought to be provided with something also not on wheels, and which will enable even an officer of patrol to go across a river. Whatever equipment we give to cavalry, we should give something which can be carried, as we see in Mr. Berthon's system, on the back of a horse. I was present at the cavalry manœuvres in Berkshire this year. We got to the top of a hill not a hundred yards from the bank of the river, and as it would have been unsafe to take the cart down the hill, it had, therefore, to stop at the top. If it had been upon a packhorse, everything would have been brought down with the greatest possible ease. The only point in which I differ from the General is as to the extent to which the cavalry equipment should go. By all means have a cart, but I know the extreme difficulty of getting wheels over the country. It is all very well when you have an ordinary road, but the occasion may arise when

you cannot use your wheels. You, therefore, ought to have an equipment which can, when necessary, be taken on a packhorse. I will not detain you longer than to express the regret I feel that we have not here this afternoon the device for crossing rivers which Mr. Berthon saw, and, which was shown at the Berkshire manœuvres by Captain Rimington, of the Inniskillen Dragoons, who, I am glad to say, is present. If the General will not have his pack-saddle, at all events we can fall back upon our ordinary corn sacks. The system is eight corn sacks, a little bit strengthened and waterproof, and filled with hay or anything else. They are then tied together, and if you have a lancer regiment you can use the lances and so make a super-structure of that kind. These sacks, filled with hay, carried five adults safely. I hope that we shall very soon have in the Museum an example of Captain Rimington's system.

Major DICKINSON: I have listened with great interest to Mr. Berthon's admirable lecture. I have to thank him not only for the pleasure I have had to-day, but for his courtesy and kindness to me at Romsey on the occasion which Colonel Lonsdale Hale has referred to. I make these remarks with some diffidence, because I quite recognise the fact, not only that there are many officers here who are more capable to speak on the subject than I, but that Mr. Berthon has considered and devoted his skill and time to this very subject for more years than I, perhaps, number in my whole life. I can only trust that the remarks I may make will have the effect of eliciting the opinions of the lecturer and of others which are more valuable than my own. The lecturer has divided his subject into three heads. First, pontoon bridges. By pontoons, I imagine that he means to refer to the pontoon train of an army corps. Perhaps I may be allowed to make a few remarks on this head, as it is the head with which I have more practical acquaintance than any other. What I have to say will relate principally to that point. We use, as Mr. Berthon knows, in the Service 15-foot intervals from the centre of one pontoon to the centre of the other, whereas the lecturer advocates the use of 10-foot intervals from the centre of one pontoon to the centre of the other. He claims for that short interval three advantages, namely, that his baulks are lighter from the fact that they are shorter, that material for one raft can be carried on one wagon, and that the sustaining power of the pontoon is greater in proportion to a fixed length of bridge. Something, however, I think, can be said on the other side. By shortening the intervals we get a waterway, in the system advocated by Mr. Berthon, which is no greater than the width of his pontoon. The width of his pontoon is 5 feet, and the width of the waterway between the pontoons 5 feet. He has referred to the fact that the strain on the cables is proportional to the displacement. That I have no doubt is the case as regards current, but I think he forgets the fact that when there is a strong wind blowing the effect on the cables is very much increased, and, undoubtedly, with his pontoons, at the closer interval he puts them, he will suffer in that way. Certainly, the holding power of his anchors and the number of his cables must not be less than ours are at present.¹ I think they would have to be more. This one disadvantage, I think, is inherent to placing the pontoons closer together. Another point, which I think very important, is that, undoubtedly, our 15-foot baulk is a very useful article. Spans frequently have to be bridged of less than 15 feet in width. That can be done with a single bay in a few minutes. The gaps that have to be bridged of less than 10 feet are of much rarer occurrence. Further, the 15-foot baulk is extremely useful in spar bridging, trestle bridging, suspension bridging, and all sorts of bridging, other than pontoons. The 10-foot, fish-bellied baulk, which the lecturer has shown us, would be certainly very much less useful. To sacrifice our 15-foot baulk would, I think, be sacrificing a great deal. With regard to flotation,

¹ The Prussian six-fluke grappels hold quite as well as heavy anchors, with less than a quarter of the weight, besides stowing in a very small space.—E. L. B.

the lecturer says that, by placing the pontoons closer together, the relative displacement for a given length of bridge is increased. No doubt that is the case; but if you have sufficient flotation in pontoons at 15-foot intervals, is there any object in placing them closer together? For these reasons I have not been convinced that the balance of advantages lies with the shorter interval between the pontoons. I have no doubt it is known to most officers here that our present service bipartite pontoon enables us to make a bridge of the ordinary width of roadway, 10 feet, or it enables us to make a double length of bridge with a narrow roadway. I think we should gather, from what the lecturer says on the subject, that his equipment only has that advantage. We can with our present equipment, if we are prepared to sacrifice a portion of the width of the bridge, double the length of the bridge. We further have, with our equipment, some small advantages which I do not think can be claimed by Mr. Berthon. We can make a boat of any length. Our bipartite pontoon consists of two portions, one of which has a bow end to it, and the other has not, but has two square ends. By means of inserting the necessary number of square ends we can make a boat of any length we like, and make a bridge 10, 20, and 30 feet wide, or any multiple of ten. Further, we can make long rafts by inserting the necessary number of square ends. By using one square end to every bow end we can make transport rafts of four sections, which is a very great advantage where you have to move pontoons along a waterway.¹ I do not know that with a roadway wider than 10 feet one would be likely to use them for bridging, but they come in very useful in the case of pierheads and things of that sort. The lecturer has spoken of the process of making cuts in service pontoons, and of its being a very complicated affair. If I could show it to him I could convince him that that is not the case. I think we have gathered from what he said that the cut raft was a special raft. That is not the case at all; the cut raft is precisely the same as any other raft in the bridge. The only speciality connected with the cut raft is its connection with the standing part of the bridge. That connection is simple. We can make cuts without it, but we use it for the sake of rapidity and simplicity. We must remember that on service the ordinary bridge train is liable to very rough usage indeed. The number of sappers in a pontoon troop, on a war establishment, is small. The pontoons will constantly have to be handled by men who are not very much accustomed to their use. They will have to be hauled up on rocky, stony beaches, and at a time when it will be very difficult to get at them to repair them. I think it must be admitted that our Service pontoon will take a great deal of scratching and knocking about before you make a hole in it. The question is: Will canvas pontoons stand as rough usage as ours will? I cannot think that they will.² The outer skin is no doubt a protection against the sinking of the boat, but if the outer skin be perforated it will let water in between the outer and inner skin, and if it is the case, as the lecturer pointed out to us, that it will not entirely fill the space between the two, a very large portion will be filled, and the compartment filled will run from one end of the boat to the other. Will not then the boat become waterlogged? [MR. BERTHON: No.] On the other side the lecturer has claimed advantages as regards weight. I think it amounts to this. I am considering now the bridge for carrying the ordinary loads such as it would be necessary to carry on service. Every 20 feet of bridge of collapsible boats, the lecturer has told us, weighs 1 ton 4 cwt. 2 qrs. 6 lbs. Every 15 feet of Service

¹ If the pontoons on the wagons are made like those on the light cart, viz., with two bow sections, and two with both ends square, a boat on *one* wagon can be made either 12, 24, 36, or 48 feet long. Whereas on the R.E. system it takes *two* wagons to make a boat 42 feet long.—E. L. B.

² The canvas pontoons have *keels* and rubbing pieces on their bilges. They are never injured by dragging over shingly beaches; besides being so light, when a pontoon is divided in two it is easily carried by two men.—E. L. B.

bridge weighs 1 ton 1 qr. 6 lbs., that is to say, practically 15 feet of our bridge weighs as much as 20 feet of the collapsible bridge. In connection with that I should like to mention the fact that the item which the lecturer describes as anchors, cables, etc., in our case weighs 382 lbs., whereas he has only allowed 300 lbs., that is to say, he has omitted something which we consider necessary—whether it be weight of anchors or not, I do not know. I should like to ask Mr. Berthon if his boat would take the ground well if grounded. The Service pontoon will take the ground very well, provided it be not very rough. No one would think of grounding a pontoon if the ground was not fairly smooth, such as the ground in a tidal river. I believe that our pontoon acts very well when it has to be grounded under ordinary circumstances. So much for the first division of Mr. Berthon's subject. With regard to his second division, pontoon boats on carts for the cavalry division acting independently, I am sorry to say that I am not in a position to give any definite opinion. I have seen them, by Mr. Berthon's kindness, at his own works, but I have never seen them actually at work, and I have never had the handling of them myself, although I should very much like to do so. For that reason I am not in a position to express any opinion upon them at all. I can realise the fact that the problem of finding the best equipment for cavalry purposes and for the purposes of a pontoon train of an army corps is rather a different one, because the importance of mobility as compared with durability is very much greater. With regard to the swimming of horses, of course, any boat will do for that. With the Service pontoon we have walked our horses into the water, and swum across in the same way as Mr. Berthon has described. I should like to ask if it is not a fact that these truss-beams which I see on the light equipment which has been exhibited do not interfere with the rocking of the boat, so that if there was rough water, would not that increase the danger of the water coming into the boat?

ADMIRAL SAUMAREZ: I think I was the first naval officer, when First Lieutenant of the "Sampson" in 1852, who had trials of one of Mr. Berthon's collapsible boats, and I was enabled to hoist it between the ship's side and our cutters at the davits with oars and sail. I tried the boat in a good breeze, and drove her on purpose on a rock to test her. I need hardly tell you that it caused great rents, but it did not disable the boat in any way. The boat was perfectly safe, and after we had patched her up again she was just as ready for work as before. The lifeboats we have now in the Channel Islands are those of Mr. Berthon's. I am sorry they are not more generally in use than they are. I know no better contrivance than Mr. Berthon's collapsible boats for saving life at sea.

The CHAIRMAN: Is there any cavalry officer here who will give us his opinion on this subject? I am afraid General Wilkinson is not here now; if he had been I should have asked him to say a few words about the necessities for cavalry crossing rivers. Mr. Berthon was kind enough to lend one of his boats to the Royal Horse Guards, at Windsor. One of the officers who carried out the experiments of crossing the Thames is here, and I am sure we should be very glad if he would be kind enough to tell us how it was done, and what they thought of Mr. Berthon's boat.

Captain FERGUSON, R.H.G.: All I can say on the subject is that none of us—except, perhaps, Lord Crichton—knew anything at all about the boat, which was sent down to us by Mr. Berthon. A squadron was told off to use it, and in a few days, after a little practice, they could get the boat into the water in about a minute. The first boat we had was only a two-jointed one, with two pointed ends. The horses, of course, at first knew nothing about it, and at starting it was a matter of a good deal of pulling. After a time, however, it answered very well. On one occasion I remember a horse being very bad, and when it got about half way up to its withers in the water it began to plunge a great deal, and in doing so put one of its feet not only through the outside skin, but scratched a hole in the

inside skin. All that was done was that someone put a handkerchief over the hole in the inside skin, and the boat went on all right with another thirty or forty horses. Our feet were a trifle wet, but beyond that there was no harm done at all. After that Mr. Berthon kindly sent us a larger boat, which certainly, for our purpose, answered very much better. The boat Mr. Berthon sent, I think, was a similar boat to that used by the Germans. There were two ends and a middle piece, and that we found, for our purpose, was a great deal better, because we had more power for rowing if the horses were not going kind. You want to have considerable storage-power, which, in a smaller boat, we do not get. With a larger boat we may have more men rowing, and the boat could be pulled round much easier. With that boat we were able to take six, and occasionally even eight, horses at a time over the river. The boat, I think, could not possibly have worked better.

Major RAWSON R.E. : I have been asked to say a few words on this subject, and, in doing so, permit me to say that I am extremely pleased to see Mr. Berthon here this afternoon looking as well as he is. I wish more Englishmen would come to our assistance as he has done with inventions of this sort. It is, indeed, a great pleasure to have Mr. Berthon's boat brought prominently before us once again. He has alluded to some work of the R.E. Committee, and it is from that point of view that I approach the subject this afternoon, because I know what the Committee have been and are doing. I am sure he will not mind my saying that, from his remarks, you might be led to think that the Committee have not been considering Mr. Berthon's boat in the way that they ought. Mr. Berthon, in his paper, says, "The trials (before the Committee) were perfectly successful, and a wagon, weighing five tons, was drawn across by four horses, and there the matter ended, so far as our own country is concerned." The matter, I hope, is not ended by any means. The Committee for a great number of years have had their eye on this boat. As early as 1876 they began experimenting with it; and they are at the present moment getting from Mr. Berthon boats to carry on trials in connection with cavalry operations; so that, as far as the trials he referred to are concerned, I hope they are very far from ended. I should like to get some opinion from Mr. Berthon on the question of repairs. He does not touch upon that in his address. One knows from experience in Canada that the boats there—not the dug-out canoes, but the birch-bark canoes—are repaired very rapidly; and I presume there must be some system of repairing these boats very rapidly. If Mr. Berthon would kindly give us some information upon that head, we should all be very much pleased. I notice that the latest boat which he mentions, a boat 10 feet long, in two halves, and 3 feet 6 inches wide when collapsed, weighs about 80 lbs., and he seems to have made very little alteration upon the boat he originally put forward in 1876. That was a 9-foot boat, and when closed 2 feet 3 inches deep, 6 inches in width, and weighing about 80 lbs. At that time the R.E. Committee put before him this suggestion: "Can you produce us a shorter boat which can be carried on a pack-saddle?" Apparently, Mr. Berthon did not see his way to doing that at the time, but the boat he now brings before us is 10-foot long (a foot longer than the other one) and 3 feet 6 inches deep, instead of 2 feet 3 inches, and its width 7 inches, instead of 6 inches. There is, you will see, very little alteration there; but it is in the wrong direction.¹ The Committee, I know, went on with his 14-foot duplex boats, as he called them in 1881, and they went on with a 12-foot, 20-foot, and 22-foot boat—in fact, they carried on a great many experiments with his boats, so I may say that the matter was not lost sight of during all these years,

¹ The boats supplied to the Royal Engineers many years ago were 9 feet long and 4 feet 3 inches wide. They weighed about 140 lbs., and when collapsed they were 10 inches thick.—E. L. B.

and is, I know, not being lost sight of now. He has also touched on the question of his superstructure in comparison with ours. Major Dickinson showed us that our baulks are really jacks-of-all-trades. You cannot have a baulk of a particular pattern which is not useful all round. I think that is really the reason for retaining the rectangular baulk; but, in addition to that, is Mr. Berthon quite satisfied that his fish-bellied baulk is a good baulk when he has not got a level roadway? You are liable to have your boats tilted in many ways, and you may get strains which will bear on his fish-bellied baulk in an unsatisfactory way, and in consequence a rectangular baulk will probably come off rather the best. I notice in the superstructure of the raft for ferrying guns, shown in a previous plate, a model of which he puts before us, that he has added in the model a strong rectangular frame on the shore end. It is necessary to add that, because in running a gun on from the shore, unless you have something to keep the baulks from being at different levels, you get an unequal distribution; you get either the bow end or the stern end a little down, and you get the gun tilted over, which may cause the boat to capsize. I have no doubt that the rectangular frame must be added for that purpose. Notwithstanding what I have said I am exceedingly glad to see Mr. Berthon here, and that the question of his collapsible boats for certain cavalry and horse artillery purposes has been brought prominently before us.¹

Sir ARTHUR GRANT: The question of Mr. Berthon's boats taking the ground has been raised. Perhaps I may be allowed to say that I saw one of them take the ground once on a hard, gravelly bottom, with a large number of men and heavy weights, representing guns, in her, and she received no harm whatever.

Colonel CAVE: I do not think that we have heard anything of the relative cost of the orthodox system of the Royal Engineers as compared with Mr. Berthon's system. Another point which I do not think has been very much dwelt upon, and which I should like to hear more about, is the compactibility of the thing. That must be an enormous advantage over the huge things which are used in the orthodox train. I fancy I remember seeing guy ropes to be used when going down certain declivities, which I think must be exceedingly difficult to manipulate. [Major DICKINSON: They are never used.] In my opinion compressibility and compactibility are the greatest advantages in this system, and about these we have heard very little. Another point raised by Major Dickinson, I think, has scarcely been fully considered, he spoke of rough usage and the different advantages of the two systems in rough usage. Now it seems to me that—especially bearing in mind how he tells us they very often have to use what we may call unskilled labour—the infantry and troops who may be hard by to assist, what is most likely to happen under these circumstances is, that the boats will be let fall. I cannot help thinking that if a wooden boat falls, it is far more likely to sustain injury than one of these canvas boats; and, therefore, looking at durability from this point of view, surely there is in Mr. Berthon's system a decided advantage and not disadvantage. Another point of comparison, but one which I did not quite catch, had reference to the relative amount of floatability of the one system compared with the weight. In a ton of this material I should imagine that there would be a great deal more floatability than in a ton of other material. That is a point of comparison about which I should like to hear Mr. Berthon's and Major Dickinson's opinions.

Major-General TULLOCH: I have had something to do with the use of this boat for troop service at sea, and I must say the satisfaction one always feels when one sees these Berthon boats on board ship is very great. In the Indian troopships in former days we had nothing but very large pontoons, so big that if any accident

¹ The little rectangular frame is no part of the equipment, it merely represents (in the model) the shore from which the bridge starts. The chasses hooked into the side baulks keep the whole properly together.—E. L. B.

happened it was patent to everyone that they could not be got out. Nevertheless, they were turned to a useful account—they were made receptacles for potatoes, and during long voyages they were found extremely useful for that purpose. In both private ships and on board Government ships it has always been an immense satisfaction to look over the side and see three or four of these large Berthon boats stowed away. On board large passenger ships I have often looked at the number of boats and calculated how many people it would be possible to save in case of accident, and I have come to the conclusion that in many cases we should have come to very great grief indeed. In coming home on the last occasion it was with very great satisfaction that I saw these very large Berthon boats made use of by the P. and O. Company. I never had the pleasure of meeting Mr. Berthon before, but I am exceedingly pleased in now having seen the man who has done so much for the benefit of the people who have to go to sea.

Mr. JAMES : As a rival of Mr. Berthon, I may say that I had one of his boats for five years. Major Dickinson was asking as to the durability of the canvas. The durability of the canvas was proved to me when I saw Mr. Berthon's boat, because I used to keep the one I had on a very rough shore, where there was broken glass and piles. I used to leave the boat there continually, and I had it for four or five years, and it never got a hole through it. The convenience of a canvas boat struck me so much that I designed one myself, only it had a single skin. As Captain Fergusson has said, if you have got a hole in it you can easily stop it up with a pocket-handkerchief, and that, perhaps, is simpler than having a double skin.

Rev. E. L. BERTHON, in reply, said :—I should like to make one or two remarks upon what Major Dickinson so kindly said. With reference to the advantages of my boats, I do not think he mentioned two. With respect to the bridge, we can make a bridge 40 feet long, and the light bridge will carry the heaviest field gun or anything up to three tons. That is one thing. Another thing is with reference to the rafts. I not only have a very heavy raft that will carry six tons or more on one wagon, but I can make it into two separate rafts, which will carry a wagon ; or, by having a 6-foot roadway, I can carry two sets of military carriages, guns, and other things. That is an advantage which I have with my system. Then there is the question of making holes in these boats. I grant that if you took a knife, or any sharp thing, you could make a hole in the canvas boat more easily than in a wooden boat. Captain Fergusson has told us of a horse having kicked his foot through one of these boats. What would have occurred if the boat had been made of wood? The horse would have kicked a hole through it. Would any boat stand the kick of a horse? Then there is the question of holes being made in the boat owing to its going on the rocks. Hundreds and hundreds of times we have driven these boats against rocks, pier-heads, and shingle beaches, and almost all things, without any danger. A little while ago we had a letter from a gentleman in Australia who said that he had one of these boats. He was anchored some distance from shore—I think it was not far from Sydney—and he did not take the boat on board. It came on to blow very hard during the night, the painter broke, and the boat drifted ashore on to a rock and thumped about all night long. When the gale ceased they thought they would go and pick up the pieces which were left. They found, however, that the boat was just as good as it was before. There was not the slightest injury. If it had been a wooden boat the timbers would have been shaken out of her, but as it was there were no sharp points to the rocks, and there was no hole made through the canvas. That was owing to the elasticity ; but had it been a wooden boat, and the timbers struck against the rock, of course she would have gone to pieces. I once knocked a hole through a door with one of these models. At Port Elizabeth I once threw one of these boats off the deck of a ship—I threw it right over the taffrail on the water, and it was not hurt in the slightest—the boat

was 20 feet long. You could not do that sort of thing with a wooden boat. With respect to repairs, they, I may say, are extremely easily made. One speaker has mentioned a point under the shore end of the superstructure, that it wants something on the shore to keep the ends in the right position. That, however, is not the case. I can show you a pair of my chesses and you will see that each of the chesses is provided with a claw which goes into the side of the baulk. There are no ribands. I should like the officers of the Royal Engineers to see this and say what they think of it. It does away with racking, and we get a very neat contrivance without it. The whole thing is all kept together. I should like to mention the question of materials. Some twelve or fourteen years ago we had to make some slight superstructures for the R.E. Committee. They insisted upon their being made of Kauri pine. We replied that Kauri pine was not in the market and that it would be extremely dear to have it sent over. Thereupon they sent me a very choice piece of Kauri pine, and we had the things made. One day one of our foremen came to me and said, "Look at this stuff, sir." I said, "It does not look very good." So we had a bar made, and then took up the first piece of yellow deal we found, and made another bar exactly the same size and same shape. We then put them at the same distance apart, as supports, and tested them by weight. We found the common deal was 20 per cent. stronger than the Kauri pine! Why, then, have that very expensive material? It could not have been a bad bit; it was a choice bit sent from Chatham on purpose. There is another thing that I should like to say, and I think it is very important, and that is with reference to galvanised iron. Galvanised iron comes a great deal into use in all our very simple hinges. We never find them go wrong now, and we never have an accident with them at all. If, however, I was to send that iron to any galvaniser in England I should have no confidence in it. It is well known in the Service, and also in the Civil Service, that galvanised iron loses something like 23 or 24 per cent. of its strength in galvanising. This is a very important thing, and I should like gentlemen present to know it. I sent about to more than one place to try and find out what the cause was. I was told that it could not be explained, but so it was. I determined to try another thing. I can assure you that our iron is improved by being galvanised. It should be "galvinised," not "galvanised"—it is an "i" and not an "a"—it is "galvinised," from Galvin, the Frenchman. In all the works that take iron to be galvanised, some clean, some dirty, and some in a middle state, they pitch it all into the bath of diluted hydrochloric acid, and leave it there for about twelve or fourteen hours. The chemical action upon the surface of the iron has the same crystallising effect upon the iron itself as certain conditions of climate will have upon railway wheels and axles, and so forth—they become crystallised and break. If, however, the iron is moderately clean before it goes into the bath and is only allowed to remain there two minutes, that is quite enough. Then you take it, galvanise it, and let it cool gradually, and it will be found to be much better than it was before. That, I think, is a most important thing. I do not know whether any members of the R.E. Committee or others know this circumstance. I have mentioned it once or twice before, but I think it is worth considering, and I take this opportunity of again mentioning it.

Major RAWSON: You have told us that the repairs are easily carried out: I should like to know how they are carried out. Do you paste on a piece of skin?

Rev. E. L. BERTON: We have published a little sheet giving directions how to make repairs. There is a way of making almost instantaneous repairs, and there is another way by which a sailmaker, or anybody else who understands the use of a needle, can do it. You then apply some of our flexible paint over it, and the repairs are easily made. I hope what I have said about anchors, kedges, and so forth has not been out of place. I cannot help thinking that kedges would be a very good substitute for anchors. I quite agree with what Major Dickinson said about the effect of wind. As far as stream was concerned that is so, but with

very strong winds we should want the same ratio, as in the case of the ordinary pontoon.

Colonel CAVE : Can you give us the relative cost ?

Rev. E. L. BERTHON : The pontoons which I have been sending to Germany think are forty-one guineas each.

Colonel CAVE : What is the cost of a wooden pontoon ?

Rev. E. L. BERTHON : I do not know, but perhaps Major Dickinson could tell us. I should like to make a few more observations upon what has been said by him. I do not think the present audience will conclude that what I claim as the chief advantage of my system consists in putting the pontoons for bridge work closer together. The real merit is in carrying *double the number* on a wagon, and reducing the length of the load from 21 feet to 12 feet. As to the utility of 15-foot baulks mentioned by Major Dickinson, if made *fish-bellied*, with 2 feet 6 inches of rectangle at each end, they could be used of any length from 10 feet, and weigh far less. It must be remembered too that I have *twelve* baulks, instead of only five ; mine weigh 31 lbs. each, and are *very* much stronger than the Service baulks weighing 84 lbs. Connected with this point, Major Dickinson has told us that by using half-pontoons he can make a narrow bridge of twice the length. I grant that placing the chesses diagonally there would be enough of planking for a road 4 feet 6 inches wide ; but for guns, etc., it must be 6 feet wide. But as there must be at least three baulks and two ribands to each bay, one of the former and two of the latter would be wanted, adding 258 lbs. to the load. In my narrow bridge the chesses placed longitudinally and resting on the saddles do duty as bearers, with the addition of a baulk on each side connected by short cross pieces ; this has been tested up to 4 tons. I do not think Major Dickinson took cognizance of the fact that I carry a pontoon bridge of one-third greater length, and, at least, two-thirds more displacement, on a given number of wagons, than in the Service team ; and that, moreover, my wagon load will be only a little more than half the length, and the wagon itself lighter. One Service wagon and unit complete cannot make a raft. My wagon and unit complete will make a raft for two guns and limbers, or two heavy wagons. Some officers present have kindly (and generally in favour) remarked upon the durability of these boats, and of canvas in particular. We have in our yard a 22-foot boat which was built in 1879. This boat has been in nearly all the European exhibitions, has been used many years at sea in all climates, and except four times painting it has had *not a farthing's worth* of repair ; yet the canvas is as sound as ever. It is still on a ship's side under davits, and has never been under cover except when it was exhibited at the " Fisheries."

Major DICKINSON : I do not know.

Major RAWSON : A new pattern 21-foot pontoon, as manufactured at the Arsenal, would cost a great deal less than one made at Portsmouth, where, I understand, the private tender comes out at something like £60 apiece. That, of course, is done by outside labour.

The CHAIRMAN : Ladies and gentlemen,—Allow me, in the first place, to say what a satisfaction it has been to me—one of the oldest members of the Royal United Service Institution—to be in the Chair for the first time in this fine Theatre, so different from the place we have been accustomed to. This building is so pleasantly and well arranged, and has such a beautiful Library, and is altogether so adapted to the object for which this Institution was created, that I do hope the officers of the Army and Navy in large numbers will subscribe the comparatively small sum to belong to it and make use of it. I am sure it will be of the greatest possible service to the officers of the Army and Navy to have such a Library as this, and to come here and hear the lectures, which I have no doubt will be of great value in the future to them as they have been in the past. I cannot speak much

from a scientific point of view with regard to the lecture which we have heard to-day, as the question of the transport of armies is hardly within my province. I have rather looked at this question from a cavalry and horse artillery point of view. It is some years ago—I think about seven—since the Duke of Connaught wrote to me from Germany to say that he had seen a system carried out whereby a division of cavalry crossed a river in a new way, under an officer of the Ziethen Hussars. The horses swam alongside the boats, the men holding on to the head-collars—the horses pulling the boats across. The Duke had been very much struck by this, and afterwards wrote to me on the subject of Mr. Berthon's boats, as he was very much interested in what he saw of them at Portsmouth. It is really to the Duke of Connaught, I think, that we owe the fact that Mr. Berthon is here to-day and given us his views. He has always taken the greatest interest in the subject, and I was reading one of his letters only to-day, in which he said he hoped that I, as Inspector-General of the Cavalry, would take up the subject, and that he would be able to obtain permission to try the boats at Aldershot. I have frequently been present at the German manœuvres. I was at Mayence three or four years ago, and a German cavalry general, who had been A.D.C. to the famous American confederate, General Stuart, said to me, "You are very lucky in England; you have that capital plan of crossing rivers for your cavalry, the collapsible boat. You were kind enough to send one to us, and we are now getting them altogether, I believe." I asked what it was, and said that I had never heard of it. He said, "Surely you have it, because we have it. We have them in our cavalry regiments. We have a few now, and we are going to have more of them. You were very lucky to get them before." I had to explain to him that I had never even heard of them, and it was only after I became very much interested in the subject and corresponded with Mr. Berthon, and went down last year to see them, in connection with the artillery and crossing the river, that I became convinced of the advantage of having these boats for cavalry and horse artillery. It is necessary to have light transport. What is the good of having the finest cavalry in the world, if you come to a small river and cannot get across it? There seems to be a strange belief among the people in England—at least, I have often read it—that cavalry ought to be able to jump into a river, swim to the other side, and thus cross the river. That is not the way that armies cross rivers. With a heavy equipment the men would probably be drowned—at least, very few of them would be able to get across. A man very likely could swim with his horse, with his carbine and a light kit, but he could not possibly carry his cloak and forage. It is only exceptional horses and exceptional men that could possibly do it; both men and horses must be good swimmers. A patrol, perhaps, might be got across in that way. I know that in 1813 the Russians crossed the Elbe in boats, holding on to their horses in the same way as the Germans do now. When I was in Germany I spoke to two Inspector-Generals of Cavalry, and one of them, General von Rosenberg, said that the *only* way was to have boats and cross over with the horses alongside, the men and kits being inside the boats. When you come to small rivers and small water-courses no doubt there are many ways of crossing. During the last two or three years in England we have taken up this subject of crossing rivers much more than before, and the necessity has been recognised by regiments. They have responded so far as they have been able, but it has been a difficult matter, as they have said that they had no money, but that if they could get money to hire or buy boats they could do a great deal more. I am glad to say that by degrees we are getting a small allowance, so that we have been able to hire boats for cavalry practice in the crossing of rivers. Captain Rivington's system of eight corn sacks has been referred to. The raft will carry 1,200 lbs. With regard to the trial of Mr. Berthon's boats by the cavalry, I may mention that he was kind enough to lend one to the Royal Horse

Guards at Windsor. I can only repeat what Captain Fergusson has told you. On an outpost reconnoitring day of the Blues, I went down to see them in the morning before the people were about. The patrol of the Blues arrived at the Brocas at Eton. When they got there they were supposed to find that Windsor Bridge had been blown up. The officer and the men took off their things, got on their horses, and swam them across to the other side. I think there were in all half-a-dozen men and the officer. Arriving at the other side they found a Berthon boat and two ordinary punts, which had been placed there on purpose. They brought the boat and the two punts across, which I think took them altogether about eight minutes. They then took their kits into one punt, and by that time the squadron had arrived. They crossed over themselves, and went right away on with the patrol. When the squadron came up the men dismounted, put their kits into the Berthon boat, led their horses alongside, and when they got a good many alongside the boat the others followed. The river was thus crossed, and the whole squadron was mounted again and away on the other side in twenty-five minutes, and reconnoitred the country towards Bagshot. The operation, I believe, was performed afterwards in a quarter of an hour. Nothing could have been more practical or better done. Many other regiments have tried to do the same thing with boats. I wish each regiment could have a Berthon boat. The Germans have them, but they have at the same time a heavy wagon with four horses. I know that Colonel Lonsdale Hale takes a different view from that which I take, but I myself like a light cart. I think where cavalry can go, horse artillery can go or ought to go. I do think that a little horse boat would be most useful in getting three or four men across, for if you can get three or four men across more can follow. If Wilson's party in South Africa had had a boat of that description, undoubtedly they would have been saved. For the large boats for cavalry, I think, you must have something like the system shown on the light cart. The pontoons at present in use are enormously heavy, and it would be quite out of possibility to use them with cavalry. I do not see, also, how you could turn them round in a lane or narrow road. I think we must all feel grateful to Mr. Berthon for coming here and giving us this most interesting lecture. There is only one regret that I have, that he is not a soldier. Anybody who has heard him speak here can see what sort of a man he is and what a good soldier he would have made, and how useful he would have been to us. I have great pleasure in proposing a vote of thanks to him.

Colonel CAVE: I have great pleasure in seconding this vote of thanks. Although Mr. Berthon is not a soldier, I can testify that most of his people are Volunteers.

The vote was carried by acclamation.

Rev. E. L. BERTHON: I feel very grateful for your kindness in passing this vote of thanks to me. It has given me great pleasure to lecture before such a distinguished audience as this. There are one or two things I should like to say. As to being a clergyman and doing things of this kind, perhaps you may quote, *Ne sutor ultra crepidam*: "Let the cobbler stick to his last," and the clergyman stick to his sermon. I think it has been remarked that a clergyman as a civilian, and as a professional, ought to have nothing to do with military matters—least of all ought he to try to improve engines of war or anything that makes war destructive. Now, I do not hold with that view, and I will tell you why. I think that everything which tends to make war more destructive tends to bring it to an end more quickly, and, therefore, in the end diminishes the great suffering which is caused by it. Who is it that suffers most—the men who go at the expense of their bodies, or the poor wives and children who are left at home? I do think if it pleases God to put it in the mind of a clergyman to do something of this kind that he would be guilty of a dereliction of duty if he did not bring it forward. I know that there is a difference of opinion between the

Chairman and another excellent speaker, that one should embrace the boats or carts that can only go along moderate roads where horse artillery can go. But the other can go wherever cavalry can go, over ditches, hedges, and everything else. Another point has struck me since I came into this building. The cart weighs only 12 cwt., and the boat with the saddle and everything else weighs only 98 lbs. Why should not you put them together, and having two horses to the cart you can then have that cart following horse artillery or cavalry as far as the road is practicable; and when you want to go across country and come to a river you can put the light boat on one of the horses, the other being quite enough to deal with the cart alone, and you have the two things complete. You will notice in the raft that I have shown, that not only will it carry a gun up to 3 tons, but by placing the skids as I do there is sitting room for no less than forty men.