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Publisher: Routledge
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UK

Royal United Services Institution. Journal

Publication details, including instructions for
authors and subscription information:

<http://www.tandfonline.com/loi/rusi19>

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Captain J. Templer

Published online: 25 Sep 2009.

To cite this article: Captain J. Templer (1879) Military Balloons, Royal United Services
Institution. Journal, 23:99, 173-184, DOI: [10.1080/03071847909417137](https://doi.org/10.1080/03071847909417137)

To link to this article: <http://dx.doi.org/10.1080/03071847909417137>

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LECTURE.

Friday, February 14, 1879.

COLONEL C. B. P. NUGENT, C.B., R.E., &c., &c., in the Chair.

MILITARY BALLOONS.

By Captain J. TEMPLER, Royal Middlesex Rifles.

I HAVE been invited to speak a few words to you this afternoon upon the subject of military balloons, and although I could wish that it could have been entrusted to some one more competent to the task of demonstrating the great and important uses to which balloons may be adapted in warfare, I feel that, in the words of the late Prince Consort, "It is the duty of every educated person, as far as in him lies, to add his humble mite of individual exertion to further the accomplishment of what he believes Providence to have ordained." The subject is one which has occupied my thoughts for a considerable time, and I think that my observations and experience have thrown some light upon the hindrances and difficulties which have hitherto militated against the practical service of balloons in time of war—difficulties which, I trust, will be eventually reduced to a minimum. It is remarkable that English, French, and American aeronauts of experience and skill have all been of the same opinion as to the immense advantages that would accrue to the Army that could make use of the balloon for military reconnaissances; and General Sir Garnet Wolseley shows, in his admirable work, "The Soldier's Pocket Book," how strongly he feels the importance that balloons might be in reconnoitring. He writes—"One of the most effective means of learning the whereabouts and doings of an enemy is by means of balloons; for although the undulations of the ground when viewed from the car of a balloon at an elevation of about 1,000 or 2,000 feet do not show, yet the position of troops can be accurately ascertained in close, still weather. Ascents by night, particularly in wooded countries, are most useful for this purpose, as the fires indicate the enemy's position, and his numbers may be roughly estimated by allowing ten men to each fire. During an action a Staff Officer in a balloon, at such an elevation, would be of infinite service. The ascent should be made from some height about a mile in rear of the skirmishers, a telegraph wire from the car should lead to the spot

"where the General in command had established himself, who could then be kept acquainted with where the enemy's reserves were posted."

Though there are divided opinions as to the value of the information derived from the ascents made by the Americans in the war of 1862-3, there is no doubt that an advance in the balloon service was made by them, especially in the successful employment of a portable field gas apparatus for filling the balloons. I quote from a lecture given by Captain Beaumont, of the Royal Engineers, at Chatham, in 1862. He said—"The gas used was hydrogen, and, indeed, for all practical purposes, all things considered, there is none other that is nearly so suitable; its low specific gravity makes it a *sine quâ non* for a military aëronaut as, independently of the ease with which it is produced, when a balloon is attached to the earth it is of the first importance that it should offer as little resistance as possible, as its stability depends upon this point. The hydrogen gas was generated by using dilute sulphuric acid and iron—any old iron, such as bits of the tires of wheels, old shot broken up, &c., was used, so that it was only necessary to provide the sulphuric acid, which in large quantities is cheap, and with proper precautions, very easy to carry. There were two-sizes of balloons used, one of small size with a capacity of 13,000 cubic feet, the other of about double the size. This larger sized balloon was the one the Americans preferred." Captain Beaumont continues, after a description of the balloons, to speak of the Balloon Staff. "With McLellan it consisted of one chief aëronaut, whose exact rank I never could make out, but it was not lower than a Captain or higher than a Brigadier. He was a civilian, and by profession an aëronaut, and he was very highly paid. Under him was a Captain of Infantry, who had been previously instructed at West Point (the American Woolwich) in the art of ballooning. The Captain commanded the men, some 50 in number, and superintended generally every arrangement, including transport. He never went up himself. Under the Captain was a proportion of non-commissioned officers, who knew more or less of the management; and the men, who, besides having a reverential awe of the machine, knew nothing whatever about it."

Reconnaissances in a difficult wooded and undulating country seem to have been made with success. Captain Beaumont, however, appears doubtful as to the great use of balloons in siege operations, but it is to be remarked that the system was far from perfect. I remarked that the Americans' employment of a portable field gas apparatus was an advance in the right direction; but still it must have been inconveniently heavy to move, and in all details there was room for great improvement.

Military balloons were actually employed so far back as 1794 by the French, as will be seen in the very interesting lecture given on the subject by Captain Grover, R.E.; and there are several other instances of their employment, but they have never been successfully adopted in our own armies.

It will be in the memory of everyone that during the siege of Paris

in the Franco-Prussian War, the Parisians, finding their communications entirely destroyed, had recourse to the balloon for carrying on their postal service, but there had been of course no previous preparation in anticipation of such a contingency.

I will read you a brief extract from Mr. Glaisher's work, "Travels in the Air," in the preface to the second edition of which he gives a short but an interesting account of their successes and failures. He remarks that—"The need was urgent, there was no time to originate fresh constructions or introduce new principles. The old invention as it stood was to be stimulated into success, if success were to be had. But it was necessary that new balloons should be made, and at once, for not a balloon in Paris, at the commencement of the siege, proved, on examination, to be sufficiently trustworthy to pass over the besieging lines in safety. No pains were spared to avoid failure, and no detail was thought trifling enough to be overlooked. Two factories were established, one at the Orleans, and the other at the Northern Railway Station. The first was placed under the management of M. Godard, the latter under the direction of Messrs. Yon and Dartris. Messrs. Godard and Yon are known in London as having superintended and directed the ascents of M. Giffard's *Captive Balloon* at Ashburnham Park, Chelsea, in 1869. Both factories were under the direction of the Post Office. Each of the two railway stations presented an extraordinary scene. The balloons, which were constructed to contain about 70,000 cubic feet, were generally inflated with ordinary gas. The bags of letters and despatches were firmly fixed outside the car. Higher up was secured a cage containing carrier pigeons, intended to bring back news and replies to the outgoing letters."

Sixty-four departures took place between the 23rd of September, 1870, and the 28th of January, 1871, inclusive. On the 7th of October, a balloon, containing 52,800 cubic feet, was sent up from Mont Martre, with Tricket, a cousin of M. Godard, as *aéronaut*, and M. Gambetta and his nephew as passengers, and 22 lbs. of despatches, and pigeons; and on the 12th of October, another balloon, containing 72,125 cubic feet, carrying 3 men and 600 lbs. of despatches and pigeons. From the list of these balloons furnished in Mr. Glaisher's book, I gather that the failures were of those which ascended under the care of seamen and men who had not been trained to their management and use.

M. Tissandier has published a very interesting history of all these ascents and balloon posts, and has done me the kindness to send me a copy of his work. With reference to this very subject, he says that MM. Eugène Godard, D'Artais, and Yon were commissioned to find *aéronauts* for the conduct of these balloon posts. Sailors were selected, and of the sixty-four ascents, thirty were directed by these brave fellows. They received a few lessons, but what lessons! A car was suspended to one of the iron girders of the roof of the railway station, to which the pupil climbed, and then called out "let go"! But it is needless to say that it remained stationary. He was instructed to throw out ballast, and open a valve. Then he let go

the anchor, and went through the forms of descending to earth. A curious apprenticeship, which reminds one of the swimming lessons on dry land!

This report of an eye-witness—of the difficulties attending these Parisian attempts—inevitable as they doubtless were under the circumstances, confirms my opinion, that it would be a fatal mistake to act upon the assumption that any man of spirit and courage was capable of the management of balloons; I am convinced that experience of many ascents, under a competent person, is necessary for the success of travelling balloons. After the first novelty is passed, it seems so perfectly easy that men are apt to overlook the necessary precautions, even if they are thoroughly acquainted with the general rules to be observed. To make ballooning fulfil successfully all its possible duties, a careful education in all branches of its management will be as essential as in any other branch of military service.

Another probable reason, in my opinion, why more success has not been obtained where balloons have been employed, is that there has never been any military corps trained for this branch of the Service.

I believe it to be quite impossible for an *aéronaut* single-handed to effect any great result in reconnoitring—practically you would, in this case, be sending one man 500 feet high, to do the whole outpost work of an army. He cannot accurately report upon the whole of what he is able actually to see, as you cannot observe correctly when you attempt too wide an expanse of country.

By the employment of three balloons, placed at intervals of two to three miles, with plenty of men who have been previously trained and taught to rely upon one another, I am of opinion that the whole outpost duty of a ten-mile front would be efficiently performed by day, and by making continual ascents at night, the whereabouts and disposition of the enemy's camp would be ascertained by the fires, &c., as Sir Garnet Wolseley suggests.

For the successful navigation of free balloons, it is of the highest importance to ascertain the force and direction of the wind, and how many varying currents and changes of direction there may be. My experience teaches me that you generally find three currents in 5,000 feet elevation. It will then depend on their variance as to where you can take the balloon; it will make this more apparent if I show you on the board the direction of the currents as they actually existed in an ascent I lately made. You may almost liken this course to the moves of certain pieces on the chess board, the bishop advancing and the castles move, illustrating the currents at right angles.

In the first balloon sent up at night from the Northern Railway Station during the siege at Paris, M. Tissandier says the *aéronauts* were ten hours in the balloon, and descended only a few leagues distant from Paris. They believed that they must have passed over Paris several times during the night, which is quite possible—supposing that they encountered several contrary currents at different altitudes.

My opinion is that these currents might have been utilized for the purpose of delivering the despatches and bringing back replies.

One of the most singular of these voyages was that of M. Rolier,

an engineer, and M. Deshamps, a franc-tireur. They left Paris on the 24th of November at a quarter to eight in the evening, hoping to go towards Tours. The balloon soon attained a height of 2,000 metres beyond the range of the Prussian fire, and it commanded a full view of the whole Prussian camp; then it passed over several towns in the north. Presently the aeronauts thought they heard the noise of a great number of locomotives; they had reached the sea coast, and it was in reality the noise of the waves breaking on the rocks which they could perfectly distinguish. Then they were enveloped in a thick fog, and had no means of determining their aspect or the horizontal movement of the balloon. When the fog dispersed, they found themselves above the sea, and saw a succession of ships. Amongst others a French corvette, to which they made signals, which, doubtless, were not understood, for they were not answered. Their intention was to have allowed themselves to descend into the sea, and to float until they were picked up by the corvette. Later on, they were fired upon, doubtless by a German vessel, but were not touched. They were advancing still to the north with bewildering rapidity. Out of sight of any land, and finding themselves again in a fog, they let fly one of their carrier pigeons announcing that they believed themselves to be lost. They then threw out a long rope from the car which checked their progress, the end of the cord touching the water. At last they perceived land, and threw out a bag of letters and newspapers. The balloon thus lightened rose higher, and took an easterly direction. This was a happy accident; without it, in all probability, the balloon would have gone to the Arctic Sea. Once in this fresh current, the balloon continued its course over terra firma. Losing ballast, it rose to a great height. The valve was opened to let out the gas and descend. At Mar Liffeld, in Norway, the balloon touched the tree tops. By the help of the rope that the travellers had previously thrown out, they reached the ground almost safe and sound. But relieved of a large portion of the weight, the balloon (naturally) rose with such rapidity that it could not be held. It was then twenty minutes to four in the afternoon of November 25th, Paris time. Fifteen hours had elapsed since their departure from Paris; they were entirely ignorant of what country they had fallen into, and were famished with hunger.

To test the direction the balloon is travelling, and not approving of the celebrated aeronaut Mr. Green's method of working it off a trailing pilot line, I have endeavoured to obtain my direction by other means, and finding no existing instrument that marked the course with sufficient accuracy to satisfy me, Mr. Casella, the eminent instrument maker, constructed for me the instrument I have here, which has answered very well. It may also interest some of my audience to see the anemometer, made also by Mr. Casella, which measures the rates of ascension and descension.

One of the most useful auxiliaries in testing the direction of air-currents is the small balloon, made of oiled silk, containing about 200 cubic feet of gas, which will mount about 2,000 feet from the large balloon, and is easily discernible at that distance either above or below.

We have made several useful and interesting experiments at Wool-

wich in field gas-making apparatus, field-gasometers, in the manufacture of compressed gas, and receivers for the gas, attachment ropes, car attachment, and in the construction of balloons generally, inclusive of trials for perfecting day and night telegraphic signalling.

I might enter into details of all this work, which, doubtless, would prove of considerable interest; but at this stage it would be neither fair to the Government nor to myself to make such details public.

I will now, therefore, read to you a few extracts from my own log, descriptive of some ascents I have made, with the object of descending at some given place, with a certainty, which I may say, has not before been attained.

Having the advantage of taking the management of one balloon (the "Excelsior") in a double ascent from the Crystal Palace (Mr. Wright commanding the other, a balloon called the "Crystal Palace"), I determined to make my descent at Barnet, as my brother Officers much wanted to see a balloon. Before leaving Barnet I took an observation of the wind by means of the small balloon, and found that there was no direct current; but by remarking the scud flying from the east, and the low current being S.W., I told my brother Officers I would bring the balloon on to the parade-ground at half-past seven that evening; the time of the ascent being six o'clock p.m., and the distance from the Crystal Palace to Barnet being about twenty miles. I may here mention that you ought to be able to give the exact run of a balloon in twenty miles, as if you cannot work it correctly in that distance, the further you go, the more you would be losing the named course. And in naming the place where you mean to descend, you have a very great advantage in having another balloon up, particularly when the aeronaut in charge will obey your directions by signal, as you can make him ascend and take an observation from him, or descend and test the ground or under currents.

Punctually at six, both being ready to start, Mr. Bocoock simultaneously slipped the let-go lines of the two balloons, with the last caution to both, to mind the tower, as the wind seemed to set us on it. I, to fulfil my object, made a slow ascent; and at 1,000 feet, finding myself proceeding in a north-westerly direction, I checked the balloon rising further, and took Mr. Wright's direction, and found that he was well to my east, and going to the east of north-east. His elevation was 4,000 feet. This he gave me by disc-signal, Morse code. I quickly saw that I had the advancing bishop's move; I then got out my large field-glasses and had a look for the camp. On crossing the Thames over Westminster Bridge the altitude was 2,000 feet. The formation of our camp at Barnet (a distance of 12 miles) flashed through the glasses. The tents appeared like so many eggs dotted about. I said to my assistant, "I have seen the camp, so we are sure to get there." I then let the balloon gradually ascend, to make a bit of east, as it is far preferable to go in on the low current, as you have so much less distance to descend.

In passing over London, I had a most magnificent spectacle, and I again obtained the formation of our camp in the field-glasses. I also had a look at Mr. Wright; and, though he had been at one time

5 miles to my east, I found he had lowered into the ground current, and was coming straight towards me, as I was then going on his old course. On passing over the Alexandra Palace, I thought I had better get a little more west, so I let the balloon go just into the top of the under current. I quickly saw that I must again ascend, so I went up again, passing over New Barnet at 4,000 feet. My assistant here could see the camp, and became excited, and begged me to lower, but by the last short run I found that we must tack well over and make a rapid descent into the low current. This we did, and in a few seconds we dropped to 400 feet elevation, and the quick, under current immediately took us over the encampment. I could not drop my anchor, as the men were as thick over the field as so many bees, so I opened my valves and let the pilot-line go, and made my descent in the parade ground, as I had intended.

The remark was made by a witness of the descent, "Ah! that is all very well, but you cannot do it again." Now, I differed entirely with him, as I think if you can do a thing once, you can do it again. The night previous to an ascent that I was going to make from the Crystal Palace, I promised Captain Lee to take him to Aldershot. The next morning the wind had slackened to 12 miles an hour, and was due east. Now, I knew I must get some north to drive me south, so leaving the Crystal Palace at six, accompanied by Captain Lee and Mr. Apsley Pellatt, Mr. Wright having charge of the other balloon, we both started to find a north current, and it was not until we had attained 5,000 feet altitude that we could get any south at all. Having a pretty good load on board, and not very much ballast, and being a very slow day, and passing over the house of an old friend of mine at Leatherhead, I proposed to Captain Lee to go down. He said, "Yes, you can go down, but you must come up again, and go on to Aldershot, as proposed." I said, "Well, we shall be up all night, for it seems so slow. However, we will keep on. We are sure to get there some time or other, for we have the 'castle's move.' We will go down and have a look at Randall's Park." Randall's Park is a very charming and pretty place, with the Mole running through the park. It looked to me to be a little smaller than one would have imagined, but the first thing that strikes you on a first aspect is the insignificance of the works that man takes so much time to construct. Again, as the altitude increases, so the undulations become a plane, until, at 5,000 feet, England at any rate looks like a vast plane. It is then that it is difficult to distinguish the different towns, but if the course of the balloon has been regularly marked on the chart, the towns, railways, roads, or rivers correct the chart. We now found that it was necessary to assume our old elevation of 5,000 feet, and I told Captain Lee that we should have to descend the whole distance, as we could not make Aldershot.

A most beautiful view of Aldershot from this elevation was seen, and it was a very pretty sight to see it all lighted up. About ten minutes after they had lit all the lamps, I found that the time had come, so throwing out a thousand pieces of paper to accurately get the low current, I opened the large valve and away we went and made a very good descent in the North Camp.

General Sir Thomas Steele came up and told us he had been watching us for an hour and had enjoyed the sight very much. The soldiers ran down by thousands and I let them pack the balloon as they liked, as they were so delighted with it.

This was certainly the hardest trial I ever had, as it was an exceedingly difficult day, the upper current being very slow and not quite reliable.

In order to prove my theories of how useful the alteration of the base departure of the balloon is (the portable field service gas works not being completed), I arranged with the Southall Gas Works for a cargo of gas. I was then enabled to fill at three places ten miles apart, namely at Woolwich Arsenal, at the Crystal Palace, and at Southall. Wishing to descend at Harrow, and finding the wind west, and high current north-west, I decided to fill at Southall; with the desired object of descending in the Cricket Ground at Harrow. Accompanied by Mr. Pellatt, we loosed the "Crusader," and with some little difficulty we descended in the desired spot. Having some long pilot ropes with us, we made many captive ascents up to 400 feet elevation. I then made another short free ascent and then sent Mr. Pellatt away by himself; he eventually took the balloon in at Hatfield. We made several interesting notes on this ascent. I should mention that the rising of the ground does not affect the true direction or elevation of the ground current. Ascending from Woolwich Arsenal, accompanied by Captain Watson and Mr. Pellatt, we quickly ran into a severe storm cloud. As the wind was entirely superseded by the terrific violence of the storm, and I found that it would not be advisable to go above the rain storm, as we were nearly over London, I looked out a nice clear space to come down, and descended at the Bricklayers' Arms Station. The number of roughs overpowered us, and as the station master wished us to get away, I decided to take the balloon away alone. She went up at a good speed, and I thought I would let her go as long and as far as it liked, as it was important to get through the rain cloud. This cloud was the heaviest I had ever seen, about 12,000 feet thick. I found that the balloon came to her natural elevation at 14,000 to 15,000 feet elevation, and there we stayed for three hours and a-half, with a very slow direction anywhere. When the severity of the storm ceased, I had a magnificent view of the surrounding county, and being very wet decided to come down at a friend's house at Watford. I quickly recognised the spot, and descended at Mr. Sedgwick's. The notes on this ascent prove the slowness of the upper current in storms.

I may say that the object we have all thought of the first importance is, to reduce weight as much as possible, secondly, the portability of the field gas-making machines, and the manufacture of gas from wood or any fuel that a foreign country may afford. The furnace must not weigh more than 6 tons complete, and no piece of it more than 5 cwt., and it must be capable of producing 5,000 feet of hydrogen an hour.

From the results obtained from these and many other ascents and experiments, we may confidently conclude that with a properly trained

company of Engineers, the "captive" balloon may be made of immense service to an army for the various duties of outpost work; for reconnoissances; for the survey of surrounding country, of the roads means for an army to march; for the selection of fresh camping grounds and water; for signalling both by day and night; and that the balloon may be used for acquiring information in conveying messages and directions under circumstances when no other means of communication could be adopted.

I have now given you a brief outline of my interesting subject, and it only remains for me to thank you cordially for the kind patience with which you have listened to me this afternoon.

Captain WATSON, R.E., said he had been connected with the experiments respecting the employment of balloons for military purposes during the last few years. Very considerable progress had been made, and he hoped we should soon have a very good equipment for military purposes. The most important point was to have everything ready in peace time and the men thoroughly trained. If an attempt were made to organize an equipment after war had broken out, it would probably result in failure, and people would say it was the fault of the balloons, whereas it would actually be the result of the men not being properly trained. Practice was requisite, not only to manage the balloon, but also to read the ground; for if a Staff Officer, however good at reconnoitring, were sent up in a balloon, the chances were he would not understand what he saw, the appearance being so very different. For instance, at a height of 2,000 feet, a hill 500 feet high would not be seen at all, except by the shadow it cast over the ground. That was one point upon which they must specially take care to train the Officers and men employed.

Professor ABEL said he had listened with great interest and pleasure to the very modest account given by Captain Templer, of his experience and skill as an aeronaut, and having himself had some practical experience, he was glad to bear testimony to the perseverance, the skill, science, and thorough practical knowledge shown by the lecturer in his labours connected with the development of balloon equipment. It was some eighteen or nineteen years since Mr. Abel first made experiments for the Government, with reference to the generation of hydrogen gas, by the method so successfully adopted by Captain Templer, viz., by the action of steam on iron. That method had been known for many years, but Captain Templer had, by simple expedients and arrangements, succeeded in making an operation which was difficult to carry out on a large scale with anything approaching success, as they required an admirably continuous one, he had succeeded in bringing steam so to bear in its action upon the iron as to enable them to utilize practically the whole of the iron, and to obtain, not only at first but continuously, a copious supply of gas. He had also effected a considerable reduction in the weight of the plant which it would be necessary to carry into the field for the inflation of captive balloons of moderate dimensions, and thus one of the chief difficulties connected with their possible extensive employment in connection with military operations, was likely to be removed through the successful labours of Captain Templer.

Captain GILMORE, R.N., asked if the balloon travelled at the same speed as the wind.

Captain TEMPLER: Exactly at the same speed.

Captain GILMORE asked if it was possible to construct a balloon in compartments, so that, in the event of being struck by shot, it might still retain sufficient buoyancy by means of the uninjured compartments. Balloons had been used in the attack on Venice. They were sent up from the side or the deck of the "Silvio," and endeavoured to be brought over Venice, in order to drop shells into the town. Several of the balloons came very nearly over the town, but no damage was done by the shells.

Captain COLOMB said he had been considerably puzzled as to how the instrument for taking the direction of the balloon would work. If the balloon was travelling

with and at the same speed as the current, what action could the wind have in moving the vane?

Captain GILMORE asked if it was possible to influence the course of the balloon, or must they always go before the wind?

SIR HARRY VERNY inquired how Captain Templer could ascertain the direction of the wind above a certain height. He could quite understand a small balloon being sent up 500 feet, but was it possible to ascertain the direction of the wind at a height of 1,500 or 2,000 feet, until the balloon itself ascends?

Mr. SCOTT RUSSELL said he had been in the habit of looking down on ground-plans of towns, and fields, and countries from heights of 5,000 to 8,000, or 10,000 feet, and could certify all that had been said as to the utterly different appearance they presented to what would have been imagined, judging from their appearance when viewed from below.

Lieut.-Col. BAYLIS, R.V., said great credit was due to Captain Templer for his discoveries. The production of hydrogen by the action of dilute sulphuric acid upon iron filings was known in the last century, but none the less credit was due to Captain Templer, for having put in practice, so as to make useful, that which was known many years ago.

Lieutenant FERRIS, R.N., asked if any information could be given with reference to the balloon guns used against the balloons during the siege of Paris.

Captain LEE, R.E., said his *locus standi* on that occasion consisted in having served an apprenticeship in ballooning to Captain Templer for the last few months, during which time they had made many ascents together. It was not at all the easy thing to work a balloon successfully that most people think. The aeronaut not only required general experience, but also to know the particular balloon in which he was sailing just as a yachtsman must know the peculiarities of his vessel.¹ In sailing a vessel on the sea observations were necessary to determine the speed and course, and in ballooning the man working the balloon had in addition to give, without a moment's hesitation, information as to speed and position in a vertical plane, for any faltering might be productive of serious consequences. Going up from Woolwich they were continually crossing the numerous bends of the river and getting among the creeks of the sea; on the east coast in foggy weather they had to see, at a moment's notice, where they were, and to decide at once upon the best course of operation. The eye must also be constantly kept on the compass, especially in foggy weather, on account of the twisting of the balloon. He once mistook the south bank of the Thames for the north through losing sight of the compass for a minute or two. With regard to free ballooning during the siege of Paris they believed that the partial success attending those operations would have been greatly increased with proper instruction, training, and organization for the men. In fact, he looked forward to the day when an Officer would be able to say to his aeronauts, "I give you two balloons; I shall expect you to go to such-and-such an area, to deliver despatches and return to the city within such-and-such a time." With proper organization and appliances he should not object to receive such an order, nor refuse to recognise its practicability. As to captive balloons his experience was rather limited, his attention having been chiefly drawn to the production of the gas and the envelope to retain it; but so far as it had gone, it was strongly in favour of erring on the liberal side in the way of buoyancy or size in the balloon. An inadequately buoyant captive balloon in an otherwise than open country was an extremely troublesome customer. There were some matters still under consideration, the principal points being the attachment; that the car should hang free from the hoop without being attached to the rope, that the latter should be provided with a swivel, a strong india-rubber spring and disconnecting gear, for it is obvious that

¹ This particular experience is especially requisite in guarding against and controlling the vagaries of a balloon in a vertical plane; as it is obvious that to have a balloon rushing up and down, as it will do in inexperienced hands, will result in the loss of both gas and ballast. Hence the escape after descent of a balloon (with a passenger) when half empty of gas is to be particularly guarded against, as it has become so rarefied that to attempt to pull the valve has resulted in the collapse of the head of the balloon.

either with or against the will of the observer, the disconnection of the balloon from its captive state must always be foreseen, and the proper appliances and ballast should always be provided for such an eventuality. With these precautions he saw a probable success in the future for military balloons, especially if the system was in duplicate or triplicate, as it should be, so that too much should not be placed on the shoulders of one observer.

Mr. THOMAS MOX suggested the use of asbestos cloth for the construction of balloons, as being an unflammable material. Instead of using gas at all they might use air heated up to 500° or 600°, which would give great lifting power. That could be provided by means of a small steam engine of very light construction, and the heat from the chimney would inflate the balloon. A vertical screw could be worked by the engine, and so they could get any height they wished, though he did not propose to drive a balloon against the wind.

Captain TEMPLER, in reply, said the speed of the balloon was the same as of the wind. Captain Colomb had asked how the direction instrument would work in such circumstances. They could not make it work if they were to be exactly stationary, but in fact they never were. The instrument went up with them, and the force of going up caught the fan and so helped it to take the direction. Then in a crossing current they got circular motion in the balloon. Sometimes, on a very still day, they had to put a little piece of paper on the breeze fan, so as to give it a little more power, but it would give the direction of the balloon. The balloon would not, as a rule, twist unless it was going from one current into another, and the change of current sometimes might give it a twist. It was then they would lose the points of the compass, and if relying only on that instrument they would want some mark on the ground. Making a balloon in compartments, to secure it against shot and shell, would be useless, because a shot going through the balloon would not hurt it. By going a little higher they would obtain a little more expansion, which would expand through the shot hole instead of through the valve. It had never been ascertained how high a shot could really go, and they contemplated sending up an empty balloon to a height of 800 feet, and then letting a battalion of infantry shoot at it. For that purpose Mr. Casella had made a self-indicating aneroid barometer, the indices of which were so extremely light that it would absolutely mark the highest and lowest point. That would correctly give the height of the balloon. It would probably also be tried at a height of 700 feet, and he much doubted whether it could be hit even at that distance. He should feel himself quite safe at 1,000 feet. They did not propose in actual service to take the balloons into places where they could be reached by shot and shell. The object of ballooning was to know where the enemy were, and if they were fired at, they would be very much obliged, as it would disclose the position of the enemy. It was not possible to influence the course of the balloon; it must go with the wind. They might find a current, and that would influence the balloon, but they could do nothing else. The only plan was to select the right base at starting. He had been asked how the direction of the wind could be obtained above a given height. Captain Watson had a very ingenious device which prevented their lowering paper from the balloon or wasting gas. He had a small balloon holding, say 200 feet, with a small silk cord attached. When they had obtained an elevation of 500 feet the small balloon, with its car full of sand, was suspended below the large balloon; and as they went up and took the high current they could see the divergence of the rope from the balloon below. In the same way, if they wished to test a higher current they would unload the car by a jerk, and let the balloon ascend, say 1,000 feet above them; so that they could get the top current by means of the small balloon as well as the under current. With reference to the siege of Paris, he believed that some shots reached one French balloon; but that was, he expected, only about 100 feet up. Mr. Godard, jun., described the shells as coming up and turning, but he did not say what height he was at. As to the balloon fabric, they had made very many experiments as to the best means of construction, and were very well satisfied with the fabric manufactured especially for them, and which had only been got out with a very great deal of labour.

Mr. MOX said he spoke of asbestos fabric as being fire-proof.

Professor ABEL said asbestos would be far too heavy even in the thinnest condition.

The CHAIRMAN said that Captain Templer had not only brought to perfection many of the instruments exhibited on the table, but the material for the balloon was his own manufacture, the ropes were his own manufacture, and the car was his own manufacture, and that he had shown himself a skilful and resolute aeronaut. The French had given much consideration many years to the application of balloons to military purposes. In 1794, the French Army under Jourdan made considerable use of a balloon equipage for purposes of reconnaissance, and owed some of their success near Fleurus to the information thus derived. In the campaign in Egypt, Napoleon had with him an apparatus for reconnoitring balloons, but the English fortunately got hold of the essential portion of it, and no use was made of it. Balloons were also tried at Solferino, but there were very conflicting accounts of the advantage that was derived from them. Reading the history of the American Civil War, they must come to the conclusion that the Americans with all their ingenuity did not derive much advantage from ballooning. No doubt, however, a certain measure of success was achieved during the siege of Paris. From sixty-four to sixty-six balloons were sent out of the city, of which ten fell in neutral ground, two or three went out to sea, five fell into the hands of the enemy, and the remainder more or less reached their destination. They carried 3,000,000 letters, and about 200 people from first to last. They also carried a quantity of pigeons and some dogs; none of the dogs came back and very few of the pigeons. The intention was that the pigeons and dogs should be a return post. He believed that was principally owing to the fact that they had not the proper kind of pigeon. But what they did not succeed in doing was, to get back into the city with balloons. It was not always very easy to make a place from the outside, although Captain Templer had shown to demonstration on the board that he was able to do this, and could descend where he pleased. No doubt a great deal could be done by organization. The War Department did not give so much attention to free ballooning as to captive ballooning. It had portable arrangements for making gas; it had a balloon of a moderate size, and hoped to carry it with them, in the field and to train and equip, not a very large body of men, but a small number who should perform their part (and a very important part if taken up and acted upon with discretion) in warfare. No class of men were so sanguine as inventors, and of all inventors balloon inventors appeared to be the most sanguine, in fact it was a very strange fascination which the science of balloon-aërostation exercised over its followers, and all kinds of inventions, many of them utterly ridiculous were brought forward. He believed that but one satisfactory answer was ever given to an inventor of balloons. An American proposed a large balloon to the War Department and asked a large remittance to start. He was told if he would come over in his balloon the matter would be considered, but he has not arrived yet. They had also heard of balloons which dropped missiles into besieged cities, and on the previous day he had received a letter from a very distinguished Officer, General Sir J. Bisset, pointing out that he was not able to be present, and asking credit for having suggested two or three years back a balloon that should drop a rocket or some analogous composition into the kraals of the Kaffirs. No doubt that suggestion was made by the gallant Officer, but it was also made exactly 200 years ago by a man called Francis Lama. They had derived much pleasure from Captain Templer's interesting paper, and he therefore had much satisfaction in proposing that the thanks of the Institution should be accorded to him.