



# The Use of Explosives in Aerial Warfare, with Some Remarks on Methods of Defence

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# THE USE OF EXPLOSIVES IN AERIAL WARFARE, WITH SOME REMARKS ON METHODS OF DEFENCE.

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By WALTER F. REID, F.I.C., F.C.S., President of the  
Society of Chemical Industry.

On Wednesday, 22nd February, 1911.

SIR ANDREW NOBLE, Bart., K.C.B., in the Chair.

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## HISTORICAL SURVEY

VERY soon after the invention of balloons by the French it was suggested that they might be used in warfare, and a *Compagnie d'Aérostats* was created, and did good service, especially for reconnoitring purposes. From the battle of Fleurus to that of Paardeberg balloons have proved their utility as a means of observing the position of the enemy. Their use for offensive purposes naturally suggested itself at an early date; but such trials as were made did not prove successful.

*Employment under the First Republic.*—One of the reasons why the use of balloons remained somewhat restricted under the first French Republic was the scarcity of sulphur, which was indispensable for the manufacture of gunpowder, and could not be spared for generating the hydrogen required for inflating the balloons. Captain Coutelle worked out a process for producing hydrogen by the decomposition of steam in contact with red-hot iron; but the furnaces required for this purpose were cumbersome and their transport difficult. Even now this process can scarcely be considered a practicable one for military purposes. In connection with Napoleon's schemes for the invasion of England, many suggestions were made for the use of balloons as a means of attack; but these, as well as the sketches to which they gave rise, are now more a source of amusement than of instruction.

*Employment by the Austrians, 1849.*—The Austrians appear to have been the first to put balloons to practical use as a means of attack. In 1849, during the siege of Venice, no position within range of the town could be found for the siege guns, and it was resolved to employ balloons. Montgolfier, or hot air, balloons were used, made of thin writing paper, and having a cubical capacity of 94 cubic metres each. The lifting power of

such a balloon was 31 kilogrammes (68 lb.), and bombs of 15 kilogrammes (33 lb.) could be carried by them for about half an hour. The point of departure of the balloons was necessarily dependent upon the direction of the wind and was determined with the aid of a map and pilot balloons. The charge of explosive was dropped by means of a time fuze, the distance and the velocity of the wind being taken into account. In inflating and sending up the balloons a portable screen was used, and the whole equipment required five waggon for its transport. The effect upon the enemy of this novel method of attack was more moral than material, although some of the charges were effective, one of them bursting in the Square of St. Mark. On more than one occasion the balloons, driven by unexpected air currents, discharged their missiles upon the besiegers instead of the besieged, and their use was abandoned. Although at that time only partially successful, the use of hot air balloons might well be revived at the present moment with better hopes of success. They are cheap, portable, and, with the aid of liquid fuel, can be made much more efficient than formerly. With a map, and two observers connected by telephone, the position of a balloon can be determined with a fair degree of accuracy, and a fuze, detonated by Hertzian waves, would enable the charge to be dropped within a comparatively small area. The advantage of such free balloons is the practical impossibility of defence against them, as they are not dependent upon a crew for their efficiency, and to hit them with a projectile would simply mean exploding their charge sooner.

*Employment in 1862 and other Campaigns.*—The use of balloons for directing the fire of artillery is, of course, well known. General Stoneman, at New Bridge, on May 24th, 1862, appears to have been the first to use them for this purpose against an enemy altogether out of sight of his gunners.

On the night of January 18th, 1900, the position of the Boers on the Tugela was reconnoitred by means of rockets discharged from a balloon, and much useful information was thus obtained.

Kites have also been used for the purpose of dropping explosives upon an enemy. In 1869, during the civil war in Japan, the government troops besieged the fortress of Wakamatsu. The besieged, by means of a kite, sent up a man, who dropped explosives upon the enemy; but the effect seems to have been slight. In 1866, during the war between Brazil and Paraguay, General Caxias used a balloon in the swamps of Neembucu, and the destruction of this balloon by fire was one of those remarkable cases of apparently spontaneous combustion which have occurred several times with balloons.

*Mishaps due to Electricity.*—Some of these mishaps may possibly be due to electricity. When a current of dry air passes over varnished material, especially over oiled silk, a considerable amount of electricity is generated, and this may accumulate

in the balloon to such an extent that sparks are generated should the balloon approach any conductor of electricity. With a free spherical balloon there is little friction against the air, except during ascent and descent; but with dirigibles and captive balloons, danger may arise during dry weather. Explosives carried in balloons should be packed in materials that are bad conductors of electricity, and they should not be placed in the vicinity of metal articles such as grapnels. Electricity, however, is destined to play an important part in the working of aerial craft. Already in 1854 experiments were made at Vincennes with an electrical apparatus for dropping projectiles from a captive balloon. These experiments were only partially successful; but with the recent progress in the science of electricity, as well as in the construction of balloons, much better results may be hoped for. Since these experiments were made, the science of aeronautics has advanced by leaps and bounds. A city like Paris, if besieged, could now communicate with the outer world, either by dirigible or aeroplane, and might make use of either for offence as well as defence.

#### POSSIBILITIES OF OFFENCE BY AERIAL CRAFT

*International Agreements.*—There seems to be a general impression that the use of explosives from aerial craft is prohibited by international agreement, but this is not the case. At the peace conference at the Hague, in 1898, the great Powers agreed to prohibit the dropping of explosives and projectiles from balloons for five years; but in 1907 Germany and France withdrew from this undertaking. There can be no doubt, therefore, that in the next European war this, the most recent means of attack, will be fully utilised. It behoves the British nation to make such preparations that we shall not be caught unprepared. In making our preparation, however, it would be folly to overestimate the dangers we may have to meet, as is so frequently done by some alarmists. Let us calmly consider, in the light of experience, what damage could be done by such charges of explosives as might be carried by dirigibles or aeroplanes.

*Possible Objectives of Dirigibles.*—As regards dirigibles, they could only approach an enemy having aeroplanes at his disposal, if they themselves were protected by a fleet of aeroplanes. Night attacks might indeed be made, but would be of little use, not only on account of the difficulty of steering, but also because it would be almost impossible to aim accurately without a good light.

Attacks upon individuals however eminent, may be disregarded from the national point of view; they would but spur us on to reprisals. I have heard a distinguished general say that much of the splendid work done by our troops during the Indian Mutiny was inspired by the memory of the women and

children murdered by the mutineers. At any rate, among civilised nations the lives of non-combatants are spared, and aeronauts wilfully sacrificing them would have a short shrift, if caught. Public buildings and hospitals are usually spared, and one use to which captive balloons have been put has been to indicate to the artillery of their own side the positions of such buildings so that they might not be struck by shells. On the other hand, arsenals, dockyards, fortresses of all kinds and especially powder magazines are targets that would at once attract an aerial enemy. Explosive factories, as I have pointed out elsewhere, have little to fear, for the buildings are so sub-divided and protected by mounds that even if half a ton of dynamite were dropped upon one of them, and exploded, the damage would be but local. Explosive magazines belonging to private owners are also in such positions, and the quantities are so reduced that nothing but local damage would result from attacks upon them. Some of the government magazines, however, contain unnecessarily large quantities of explosives massed together, and one of the largest of them is so near a populous town that a great disaster might be produced under the new conditions of warfare. The War Office should, at the earliest possible moment, sub-divide these masses of explosives and isolate each magazine from its neighbours, as is done by private manufacturers under the Explosives Act. Modern smokeless powder would probably keep better if stored underground, and such a method of storage would afford additional security against aerial attack.

As regards arsenals much damage might be done if an attacking aeronaut could make sure of hitting one particular building among many, which is at present very doubtful. In connection with dockyards it will be remembered that the Japanese, on entering Port Arthur, expressed their surprise at the small amount of damage done by their heavy shells, which had rained vertically upon the Russian ironclads for weeks. It must also be remembered that the penetrative power of a shell is much greater than that of a charge of explosive.

As regards fortresses, they are already prepared to resist such attacks as might be made upon them from above. Here, as well as in the field, horizontal screens of canvas might be used to hide the movements of bodies of men or specially vulnerable points.

*Powers of Offence of Aeroplanes.*—Unless some quite new and unexpected developments should take place in aeroplanes they will be unable to carry charges of explosives that could do more than local damage, always remembering the limited radius within which destruction is wrought by modern high explosives. Rapid motion is essential to them, and to aim correctly from a rapidly moving station must always remain a very difficult matter, requiring great skill and practice to obtain even average results.

Dirigible balloons can carry larger charges and provide steadier platforms; but these unwieldy craft are already at the mercy of such aeroplanes as we now possess and, before this year comes to a close, we shall have a sufficient number of British aeronauts to deal with any foreign dirigibles that may reach our shores, provided that some little assistance is afforded by the War Office in the matter of weapons, and instruction in the use of explosives. Having come into contact with many of our aeronauts, I have no hesitation in saying that they are a great national asset. For courage, coolness and fertility of resource no body of men can surpass them, and I feel assured that there is not one of them who would not willingly place himself and his craft at the service of our country should the necessity arise. Such men should meet with every encouragement from those who are responsible for the defence of this country.

#### DIRIGIBLES VERSUS AEROPLANES

*Rapid Development of the Aeroplane.*—Although the prospects of dirigibles as instruments of warfare appeared bright a few years ago the rapid development of mechanical flight has, in my opinion, now pushed them into the background. So high an authority as Colonel Capper said, in October last, that, in the future, the aeroplane will knock the dirigible out from war; but he qualified that opinion by saying that we are not in the future yet. At that time the carrying of passengers on an aeroplane was exceptional, now it is an everyday occurrence and, although the nervous strain on the pilot may still be as great as ever, yet the second occupant of the craft is as free to attend to aggressive matters as a passenger in a dirigible. If aeroplanes had not appeared upon the scene dirigibles might have inflicted serious injury upon our navy, and, even now, our ships will not be safe until they have a sufficient supply of aeroplanes. Such aeroplanes can be constructed to rise from and alight upon the water, as has recently been done with the Curtiss biplane; but refuge ships will have to be provided for stormy weather.

*Relative Value in Rough Weather.*—When the water is too rough for an aeroplane, starting platforms may be necessary; but an attack by dirigibles is scarcely to be feared in windy weather. One by one the much-vaunted Zeppelins have come to grief, and no means have yet been devised to enable a large dirigible to land with safety even in a moderate wind. The true position of affairs was well summed up in the reply recently made to a member of the Advisory Committee for Aeronautics who inquired when the Barrow airship would be taken out of the shed for the first trip. He was told that "Nobody with the slightest sense would expect a 512 feet airship to be taken out in the worst months of the year on her first trials. The trials will be undertaken when the winter weather breaks." The

*Times* correspondent adds: "Although indefinite, this is about all that can be said with certainty." We trust that, after this announcement, our enemies will kindly abstain from attacking us during the winter months. During these worst months of the year, however, numbers of aeroplanes have been making their trial flights and practising at the various flying grounds throughout the country, especially at Brooklands. Aeroplanes can therefore, even in their present stage of development, fly in weather that dirigibles seldom venture to face.

#### RELATIVE FIGHTING VALUE OF DIRIGIBLES AND AEROPLANES

As regards the relative speeds of the two kinds of craft there is no doubt that aeroplanes can be propelled at such a rate that they could easily overtake the swiftest dirigible. Not only can they overtake it, but they can without difficulty rise above it and, in that position, could destroy it without themselves being exposed to any appreciable danger. With so helpless and fragile an enemy lying beneath him the airman need not be particular in his choice of the numerous methods of destruction that are available. A simple missile thrown by hand from a sufficient height would suffice to pierce the fabric of the balloon; for instance, a bullet dropped from a height of 3,000 feet would acquire a velocity of about 450 feet per second. But perhaps the most effective missiles would be small bombs provided with contact ignition. A charge of half an ounce of blasting gelatine will tear a hole more than a foot in diameter in balloon fabric under moderate tension; but nitro-glycerine would be preferable as an explosive, because the larger proportion of oxygen in its products of combustion would more readily ignite the gas in the balloon. The construction of such bombs is easy, but they would be quite different from those now in use. As they are not discharged from a gun the contact fuzes may be very sensitive and a simple ribbon or streamer attached to the upper end of the missile ensures a straight fall. With a self-opening tin, half a pint of petrol and a box of safety matches, any aeroplane can improvise a projectile that would put an end to a dirigible in a few minutes. Strong acids that would rapidly destroy the balloon fabric would cause a certain, if less sudden, collapse.

#### DEFENCE AGAINST AEROPLANES

While there appears to be no reasonable doubt that aeroplanes can protect us from dirigibles, the more serious question arises: How are we to protect ourselves from aeroplanes? As they can rise beyond any serious danger from artillery it is obvious that we must adopt what is at present the sole means of pursuit available, namely, other aeroplanes. The position as it now stands, therefore, seems to be that aeroplanes of the highest speed and efficiency are the best means of both attack

and defence. Probably nothing can prevent aeroplanes or even dirigibles at night from entering British territory; but a fleet of aeroplanes on our frontiers, combined with an efficient telephone service, would effectually prevent the repatriation of any of these undesirable immigrants.

#### EMPLOYMENT OF AERIAL CRAFT IN BATTLES

As to the use to be made of aerial craft in the battles of the future I feel much diffidence in speaking in the presence of so many experts in the art of war. Generally, however, they will have to descend within rifle range if they are to be of any practical use in active combat. The difficulty of hitting a rapidly moving object at an unknown distance will be their chief defence; but an aeronaut would have an even greater difficulty in hitting anything, and even a machine-gun mounted upon an aeroplane would probably do less damage than if fired at ground level.

#### ANTI-BALLOON ARTILLERY

Foreign nations have for some time directed their attention to the subject of artillery for use against aerial enemies. The firm of Krupp, especially, has produced several guns for this purpose. During the siege of Paris, Krupp constructed a special gun for attacking balloons; this may now be seen in the Berlin arsenal. As soon as it was brought into use, however, the French escaped any possible danger from it by sending off their balloons in the night. The diameter of the French balloons was known to the Germans and, with the aid of a special telescope, the distance could be calculated. The head of a human being affords an approximate measure that may also be used for range-finding. In those days the Germans obtained their first balloons from England, Coxwell going out with them to instruct the aeronauts in their use.

Krupp's 7.5-cm. gun has seats for five men, and storage for 62 shells. It is mounted on a car which weighs 4,300 kilogrammes (4 tons), the weight of the gun alone being 1,065 kilogrammes (21 cwt.). Each projectile weighs 5.5 kilogrammes (12 lb. 2 oz.), and the horizontal range is given as 9 kilometres (9,900 yards). The vertical range is 6,300 metres (6,930 yards). A lighter gun of 6.5-cm. gauge weighs with car 875 kilogrammes (17 cwt.), the gun weighing 352 kilogrammes (7 cwt.). Each projectile weighs 4 kilogrammes (8 lb. 13 oz.), and the extreme horizontal range is stated to be 8,650 metres (9,450 yards). The height of fire obtainable is 5,700 metres (18,700 feet). The initial velocity of the projectile is 620 metres (2,034 feet) per second. A coiled spring balances the weight of the gun when pointed above the horizontal.

For naval purposes Krupp has constructed a 10.5-cm. gun weighing 3,500 kilogrammes (69 cwt.) with carriage. The pro-



jectile weighs 18 kilogrammes (40 lb.). The muzzle velocity is 2,100 feet per second, and the shells discharge a train of smoke to facilitate aiming.

Ehrhardt, at Düsseldorf, has also built a special gun for use against aerial craft. Its bore is 5-cm. and its barrel is 30 calibres long, while the length of the Krupp barrels is 35 calibres. The weight of the Ehrhardt gun alone is 400 kilogrammes (7.8 cwt.); with car, ammunition and five men the weight is 3,200 kilogrammes (63 cwt.).

The French have also been busy in the same direction, and the French army has guns especially made for use against balloons or aeroplanes. At the present moment there is in Paris a Voisin biplane carrying a small quick-firing gun; but it does not yet appear to have been put to a practical test. Le Creusot have made trials with a new 305-mm. gun, 39 feet long, firing a shell weighing 2 cwt. to a distance of 18 miles.

So far the effects of artillery fire against balloons have been disappointing. Captive balloons which wait patiently until they are hit have indeed been brought down; but, even if hit, they are not necessarily placed *hors de combat*. Colonel F. C. Trollope mentions that only one case occurred of a balloon being hit during the Boer war. A shrapnel shell, fired at a range of about 600 yards, burst in front of it and made 68 holes; but the balloon took twenty minutes to come down and was subsequently mended.

A new form of the old chain shot might be used against aerial craft with advantage. If the shrapnel balls were made in two halves, these halves being joined by steel wire coiled up inside them, then the damage done to a balloon or aeroplane would be considerably greater than with the present projectiles.

We have still much to learn as to the damage which the pressure of an adjoining explosion might cause to a balloon. In the case of a spherical balloon, not very tightly distended, the structural injury caused by air pressure would probably be much less than in the case of a dirigible which has to be rigid in order to steer. With an aeroplane, a side blast would be more dangerous than a rising or falling rush of air.

On these and many other points experiments should be made, and the nation that makes them first will be in the best position for utilising aerial craft as a means of offence or defence.

THE CHAIRMAN (SIR ANDREW NOBLE, BART., K.C.B.). Gentlemen.—We have had the pleasure of listening to a most important and interesting lecture upon a most important and interesting subject, and it now becomes my duty to invite you to take part in a discussion on it. But before you discuss the paper, I would venture to draw your attention to one or two points on which I think it would be of the greatest advantage to obtain the views of the members. Those points are:—First, the effect of balloons against towns, whether fortified or otherwise; secondly, what is the possibility, considering the ignorance of the aeronaut, both of the exact height and of the exact velocity with which he is moving, of his

hitting any desired object; thirdly, what weight of shell can be carried, and if dropped from a very considerable height, what effect will such a shell have? The difficulty of hitting any particular object would, I think, be considerable; but in discussing the very important subject, which has been so well brought before us to-day, it is very important indeed that we should hear the views of experts upon it. It is my duty to ask you that the questions I have mentioned shall be raised in the course of the discussion.

COLONEL FRANCIS G. STONE, R.A. : This is not the first time I have had the pleasure of listening to Mr. Reid, and as usual I have learned a great deal from him. With regard to the division of the subject which the Chairman has asked us to devote our attention to, I should say myself, with regard to the effect of high explosives, that, no matter whether they are discharged from dirigibles or aeroplanes or anything else, I entirely agree with Mr. Reid that the effect of all high explosives hitherto has been extremely disappointing, even to their most sanguine supporters.

#### BOMB DROPPING

The effect is intensely local. There have been one or two experiments made quite recently which promised to give us an enhanced effect from high explosives; but the question is only at present in its infancy, and I cannot say any more about it. I do not suppose, however, it will revolutionize warfare in any way. With regard to the chances of hitting, speaking as a gunner, I know pretty well what the difficulties are of hitting anything, even under the most favourable conditions, on land and on sea. The difficulties of hitting anything from a moving platform in the air, at an uncertain distance from the target, must undoubtedly be infinitely greater; and, although I shall have something to say later on about specific targets, I must say I have very little faith in anything like wholesale successful practice from the air upon enemies upon the earth. I think the useful limitations of such practice will be very restricted, and a little later on I shall suggest what those restrictions will probably be. With regard to the weight of shell and the effect, I think there are so many considerations against the discharge of heavy bombs from aeroplanes, that, at present, we need hardly consider the question as within the realm of practical politics. With regard to the discharge of heavy bombs from dirigibles, calculations can very easily be made as to the useful loading which any dirigible in existence can carry, and, I think, speaking quite roughly from memory, one may take it as a useful guide that a dirigible with 500,000 cubic feet capacity could very easily, in addition to its ordinary load, carry high explosives, for the purpose of discharging them, to the amount of at least 1,500 lb. I think that is a very conservative estimate indeed. As the Lecturer pointed out, the discharge of a bomb, as such, will not be so efficacious as that of a shell which, in itself, has high penetrating power, owing to its velocity. The effects produced by the Russian shells and also by the Japanese shells, notwithstanding the penetrating power they possessed through being discharged from guns or howitzers, were extremely disappointing to all concerned. The examination of the Russian ships, which were struck in the harbour at Port Arthur by the shells from the 13.5-inch Japanese mortars, showed that the effect had been very much smaller than had been anticipated, and it is very doubtful whether the actual sinking of any ship was due to that cause.

## THE HAGUE CONVENTION

There are one or two points which I should like, if time allows, to refer to, in addition to the three which the Chairman has put before us; and the first is with regard to the Convention agreed to at the Hague Conference of 1907. I was not able to get a copy of the Lecture before it was read this afternoon, so I did not come prepared with any data, but, speaking from memory, I think that article 25 of Convention 6 laid down absolutely that the discharge of explosives against undefended towns or villages or localities, by any means whatsoever, was prohibited. The history of that particular Convention was that at the previous Hague Conference the discharge of high explosives, or explosives of any kind from airships, was prohibited, but all the Powers did not agree. Great Britain agreed, but I do not think the United States agreed, and there was one other Power which did not agree. At the next Conference, held in 1907, the question came up again, and it was generally recognized that it was not fair to expect occupants of a dirigible to refrain from retaliation if they were attacked, as naturally they would be attacked. If you were using a dirigible for the purpose of strategical reconnaissance, even though you might not be using it for any deadly purpose, it would naturally be attacked if the enemy had the means of attacking it; and it was generally agreed by the representatives of the Powers that to prohibit the discharge of particular projectiles from a dirigible under such conditions would be ridiculous. Still, at the same time, the Powers wished to keep the discharge of explosives from dirigibles within the limitations of civilized warfare; in other words, they wanted to restrict it absolutely within the same limitations as bombardment from ships or bombardment from guns on shore; and the custom of war, long before the Hague Conference started, as everybody knows, was that undefended towns should not be bombarded without due warning being given. A warning would be given if the town resisted an attack, in which case it would cease to be an undefended town, so that the whole point I wish to bring out is that the discharge of bombs, or any kind of explosives, from dirigibles or aeroplanes is under precisely the same limitations as the discharge of explosives from guns on shore or from guns on ships; and the hysterical effusions which, I am sorry to say, one has not only read in the Press and in light literature, but has also heard from a great many people who might have considered more deeply before they spoke—with regard to an enemy's dirigibles coming and laying our towns waste, creating panics in Fleet Street, and playing general havoc with the whole of our complex civilized organism—should, I think, once and for all be dispelled from the public mind, and I am very glad the Lecturer has given me the opportunity of bringing that point forward.

## USE OF DIRIGIBLES BY NIGHT

Then again, with regard to the difficulty of navigation, and of finding your way about by night in a dirigible, I have no personal experience of doing it, but very experienced officers—of whom I will quote two, Colonel Capper and Captain King, both of the Balloon School, who have spoken on the subject—have said that, given a certain amount of previous reconnaissance, they were both surprised at the facility with which they could find their way about at night, the accuracy with which they could read properly prepared maps, and find their way by that aid from point to

point. I think any objective which is likely to be attacked by a dirigible at night would be of such a conspicuous nature—in other words, the objective would be something, we will say, in a dockyard or a harbour—that a proper reconnaissance by any hostile power should make it quite an easy matter for the dirigible to find its way. I think the Lecturer has conveyed the idea that that is rather more difficult than it really is. The great point in favour of the dirigible at night is that the lower down it is on the horizon the more difficult it is to detect, and therefore the nearer it can get to its target before it is seen, which I think is a very important point. It appears to me to be quite a feasible mode of attack for a dirigible, having previously reconnoitred the position with the greatest care, to come up wind in the evening, and, after taking up its station with the greatest care, come down wind at night without using its propellers, so as not to attract attention, until it has got as near as it can by those means to its objective, which we will say, for the sake of example, is a dockyard. By the time it had to use its propellers in order to correct its position with a view to discharging its missiles, it appears to me quite possible that it would be able to effect its object before it could be interfered with. It is customary in discussing this question to lose sight altogether of the fact that no dirigible will venture to attack in daylight—at least I should think not. As the Lecturer has said, an aeroplane would very soon knock it out; but the discussion on how such an attack is to be prevented by night has been extremely meagre on every occasion on which I have heard the question raised. Perhaps the Lecturer could throw out a suggestion as to how such an attack should be made, if he thinks it is feasible. I do not see any difficulty whatever in meeting an attack by daylight by retaliating by means of aeroplanes.

CAPTAIN J. BURKE, Royal Irish Regiment:—I have lately had the opportunity of visiting France, and discussing with officers of the French army the question of the use of aerial craft in warfare, and I should like this afternoon to hear what the opinion of the Lecturer is on the subject.

#### THE TACTICAL RÔLE OF THE AEROPLANE

The opinion of French officers, quite openly expressed to me, was that as a means of offence the aeroplane, in the stage it has reached at present, is not worth the trouble and expense it costs. They consider, however, that it is all-important for scouting purposes. General Bonnal has written an article in which he says that the advent of the aeroplane has distinctly altered modern warfare; and he gives the great weight of his opinion to the statement that the aeroplane has made the difficulties of a general far greater than they hitherto have been. The French have, therefore, decided, so far as one can judge by what they say and have done, not to worry about organizing for attack by means of aeroplanes on armed forces, but to organize aeroplanes as a means of reconnaissance. They are at the present moment thinking how aeroplanes should defend themselves against kindred craft, that is, other creatures of the air. If it is possible to use explosives and fight from an aeroplane you will have to organize for a dual objective; and therefore I would like to ask whether it is the Lecturer's opinion, and the opinion of other experts in this country, that we should organize with a dual objective, that is, organize aeroplanes for scouting, and organize them as a weapon of attack. Only a certain amount of money will be expended on aerial craft, and the question we have therefore to consider

is: Will it pay for us to renounce the great advantage of scouting which, it is now considered on the Continent, can be gained by the use of aeroplanes, by attempting to organize these craft for attack as well as for reconnaissance? We have been shown on the screen some very interesting photographs of guns specially designed for attacking air-vessels. I was at Mourmélon during November and December, and was almost every day in what corresponds to the officers' waiting-room of the French air corps at Farman's works, and I noticed that the aim of the French officers is to endeavour to practise flying every day at a height of 2,000 feet. I must say that they did it perfectly, because, during the whole of the time I was there, there was only one day on which there was no flying. This was in November and December, and the weather was awful, but they went out whenever they could get a moment, and there was not a day, except one, when they were not out for half an hour. They always flew at a height of 2,000 feet, because they consider that at that height the risks of a direct hit are very small. There is a point that I have since thought of that I did not discuss with them, namely: Is it possible by means of the detonation of a bursting shell to cause such a disturbance of the air as to upset the airman? Personally I do not know anything about explosives, but I would far rather risk a direct hit from any weapon, while flying, than risk a disturbance of the air caused by the bursting of a shell. Therefore I ask the second question: Is it possible to cause an explosive to explode in the air in such a way as to make a disturbance sufficient to upset the aeroplane? Then there is a point which has not hitherto cropped up which has impressed me very much. We are inclined only to consider operations in England, in connection with air work; but we do not hope ever to fight in England; we hope to fight on the Continent.

#### AEROPLANES IN SAVAGE WARFARE

It has also to be borne in mind that the British army, more frequently than not, fights against savages. Therefore I should like to ask the question with regard to aerial combats with the aeroplane: Would it be possible for our aeroplanes to come close down upon some body of ill-armed natives and attack them with explosives? Take Northern Nigeria, for example, where they have a terror still in the shape of a Mahdi. The people there are poorly armed and are very fanatical, and would not the great moral effect of a bomb coming from an aeroplane make it worth while to try it on them? I think it might be advisable to send an aeroplane out there. I put that forward, because I happen to have been in Northern Nigeria, and I know that the climatic conditions there are very good for flying, and there is the possibility of a Mahdi rising up at any time. Then the Lecturer mentioned the fact that the Viosin has a machine-gun mounted on it.

#### MACHINE GUNS ON AEROPLANES

I do not think the Voisin has ever fired that gun, in fact I am practically certain that it has not, for the good and excellent reason that, with a machine-gun, you have to get rid of your empty cartridge cases. In the Voisin the propeller is behind the man, and the cartridge cases would go straight into the propeller, and would break it (a cap blown into an ordinary wooden propeller will break it). There is that difficulty to contend with; in fact I do not think firing a gun is feasible from an aeroplane. To repeat, the questions I would like to ask are: (1) Is it worth while

to try and organise our aeroplanes for a dual objective, that is, scouting and attacking? (2) Is it possible to upset an aeroplane by detonating some explosive in the air within a certain radius of it? and (3) Should we not consider the question of utilizing the aeroplane in our wars against savages in different parts of the Empire?

Mr. WALTER F. REID, in reply, said:—I should like to thank Colonel Stone for the information he has given on this occasion, as he did on the previous occasion on which this subject was discussed. Being in a very responsible command, Colonel Stone has the opportunity of seeing things and learning things that are denied to a civilian; and I am sure it was very good of him to give us so much fuller information about this Convention than anything I could tell you. So far as I understand his remarks we are in this position, that we are not supposed to shower down explosives on persons who are not combatants, or upon towns that are undefended, and there is now no undertaking by any of the Powers that explosives shall not be sent down from aeroplanes or aerial craft of any kind. I believe the first point that I mentioned in my paper was that no explosives of any kind should be sent down from aerial craft.

#### USE OF AIRCRAFT BY NIGHT

I venture still to differ a little from Colonel Stone's view with regard to attacks by dirigibles at night. A stranger coming over here, unless he has had previous opportunities of scouting, would, even with a map, be a little bit at sea as to the towns or buildings that were passed over. He would not himself be detected so soon if he flew low—that is quite true; but on the other hand, he would much more rapidly approach the spot that he wished to attack, and would pass it quickly. Colonel Stone has mentioned one point which I omitted to refer to in my paper, namely, that the noise of a propeller of an aeroplane will, even in the dark, give you a very good notice of its arrival. We have had some most interesting information given us by Captain Burke of the work that has been done in France. The French are undoubtedly very strenuous in their studies, and they are doing very good work. No doubt many of our own officers have become qualified as experts and are quite able to work an aeroplane, but I am afraid they do not obtain the same facilities from the War Office as the French Government give their officers. I think 2,000 feet is a very safe height at which to fly; you are not very likely to be hit under such conditions. I would not mind taking the chance myself at 2,000 feet. Captain Burke asked three questions, the first of which dealt with the utility of organizing for scouting purposes. There can be no question at all about the advisability of doing that. Whatever views may prevail as to aeroplanes from the point of view of aggressive tactics, there can be no doubt at all as to their utility for going over the ground, and for taking photographs, or taking notes of what the aeronaut sees. Therefore for scouting purposes they should be organized, and at the earliest possible moment.

#### EFFECT OF EXPLOSIONS ON AEROPLANES

Then with regard to Captain Burke's question as to the action of an explosive in upsetting an aeroplane, from the very nature of things we have not yet built an aeroplane that will be stable without a human being in it, although we are already progressing rapidly towards auto-

matic stability. Some very interesting experiments have been made in that direction, and before very long it may be possible for us to have an aeroplane flying through the air without a human being in it; then we can make actual experiments as to what happens to the aeroplane while it is flying through the air when an explosive bursts close to it. My own opinion is that if you detonate sufficient explosive on the ground the current of air that would be driven upwards would be enormous, and I should not like to be in an aeroplane that was moving in the air over that spot. But the difficulty is in doing it. Major Baden Powell, I think, suggested that plan when I last read a paper on a similar subject—that the explosion of a mass of explosive on the ground would create such a turbulent mass of air moving upwards that an aeroplane might be upset. Captain Cody, who was in the room at the time said, with his usual intrepidity, that if anyone would detonate a charge of 100 lb. of gun cotton on the ground he would be very pleased to fly over it. That shows his courage, but I do not think it proves the point.

#### MORAL EFFECT

Next with regard to moral effect. Moral effect is good as long as it lasts, if you do not presume upon it too much. You will remember what took place during the siege of Mafeking, where the ladies used to sit out in the streets doing their needlework, with a bomb-proof shelter close at hand, and when the signal was given that the Long Tom had been discharged they all popped into the bomb-proof shelter; and as soon as the shell had exploded, they came out again and went on with their work. As I say, moral effect is good as long as it lasts. The French had a very interesting experience in Morocco. They brought a captive balloon over there, and the Arabs when they saw it simply ran away. They said, "If Allah allows these infidels to pitch their tents in the skies it is no good us fighting against them." But when they came, within two or three weeks, to find out what it was, they used to keep a look-out for the balloon to find out where the French position was, so the French packed up their balloon and sent it back home again, especially as it was not very much good in fighting against such a disorganized rabble as they had to contend against. The moral effect was great at the beginning, but it was lost afterwards. I quite agree with the view Captain Burke expressed about the gun on the Voisin aeroplane. I mentioned in my paper that I had not heard of it having been tried. I did not like to infer that it was a useless thing, but reasons have been given to-day why its efficiency at any rate cannot be very great. Sir Andrew Noble asked what was the weight of the shell that could be discharged from an aeroplane. Quite recently some most marvellous things have been done with aeroplanes. For instance, an aeroplane that was supposed to carry only one passenger has gone up with two or three. Perhaps you have seen illustrations in the papers of some flights made by Cody, in which you have noticed that a man is standing right out on one of the spars of the aeroplane on one side, showing that the balance can be kept very well indeed on an aeroplane. Therefore I think that an aeroplane could carry a charge of explosive—in fact it is almost demonstrated that it can by actual tests—if it were suspended as near as possible in the centre of gravity of some 200 or 300 lb. at least. With regard to the weight of explosive that can be carried in a dirigible and dropped; if a charge of about 1,000 lb. were dropped from a dirigible. I should be very sorry

indeed to be in that dirigible. First of all, you have to keep your balance, and that is a very critical thing to do. The dirigible is balanced at the start with that weight of 1,000 lb. If you have the weight precisely in the centre of gravity, what would happen would be this: the balloon, when such an enormous weight was released from it, would shoot upwards, and a body of that shape will invariably go point first. A dirigible would almost certainly capsize. I should not like to discharge suddenly a weight of anything more than, say, 100 lb. from a dirigible. Even that might be dangerous to those who were undertaking it.

I would like, before sitting down, to thank you, Sir, very much indeed for having come all the way from Newcastle to preside over this meeting. It is not the first service of this kind you have rendered to us by any means.

THE CHAIRMAN (SIR A. NOBLE, BART., K.C.B.):—Ladies and Gentlemen, —It is my duty now to propose a special vote of thanks to Mr. Reid for the most important and most interesting Lecture he has given us to-day. The question of the weight of the shell which can be carried is one on which a great deal of information is required; while another point of some importance is the mode of ensuring that the projectile shall explode when it strikes the ground. It is not like something fired from a rifled gun, because you do not know how it may hit the ground. In that case you could not very well tell whether the fuse, unless it was a specially designed fuse, would explode immediately or not. That is a subject that should be very carefully considered. At present the opinion is very much that which is given in France, among other countries, namely, that it may be a cause of much annoyance but it would not be exceedingly serious unless the point to which I have alluded was complied with. I think this is a matter of very considerable importance that should be properly studied. I only regret that I did not think of bringing with me a diagram, which I had made some considerable time ago, showing the position of dirigibles at various heights, and the elevations necessary to hit them. I should say, speaking roughly, that it is a waste of ammunition to fire at balloons, at an unknown height, at angles of between, I will say, 65 and 90 degrees. The chances of your doing any good are practically nil; but at angles considerably less than those the chances of hitting are very great indeed. I can only express our great thanks to Mr. Reid for the most interesting Lecture which he has given us to-day.

