AIRSHIPS IN PEACE AND WAR

By R. P. HEARNE

With An Introduction by
SIR HIRAM S. MAXIM

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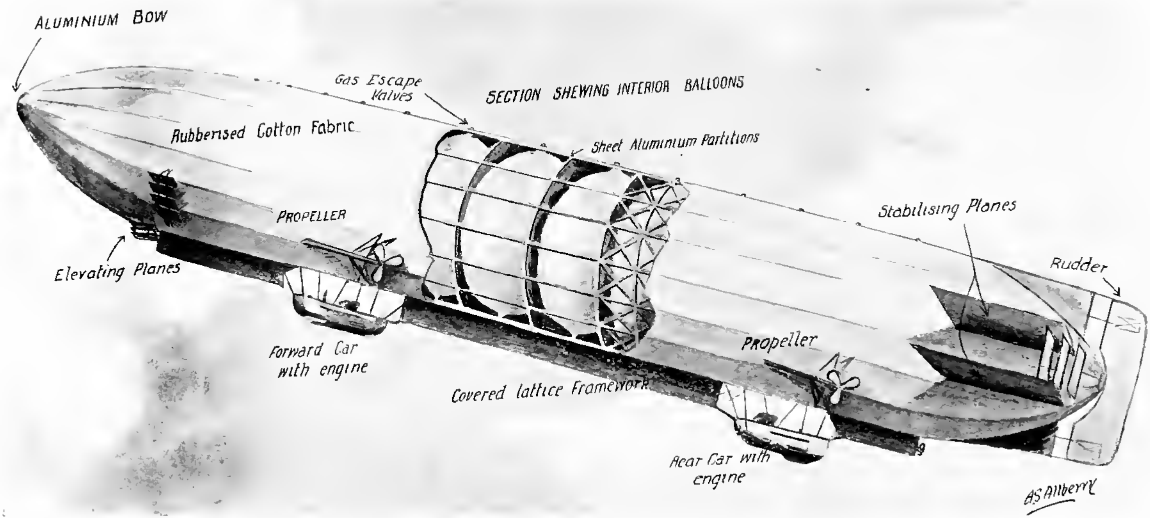

DIAGRAMMATIC SKETCH OF THE ZEPPELIN AIRSHIP [COPYRIGHT]
[In "Zeppelin III" a third car has been fitted with an additional engine and propellers]

AIRSHIPS
IN PEACE & WAR

BEING THE SECOND EDITION OF AERIAL WARFARE WITH SEVEN NEW CHAPTERS BY R. P. HEARNE AN INTRODUCTION BY SIR HIRAM MAXIM AND 73 ILLUSTRATIONS

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PREFACE TO SECOND EDITION

THE first edition of this book was written early in 1908, at a time when the aeroplane record in Europe represented a flight of only fifteen minutes' duration, and when the Wrights had given no public proof of their flying powers, even in America. Information was exceedingly difficult to obtain, especially in England, where the whole subject of mechanical flight had been shamefully neglected. By the autumn of that year the Wrights had established their fame in Europe and America, and the great movement for the development of aviation had begun.

A year of astounding progress in every direction has followed. Records upon records have been made both by flying machines and dirigible balloons. The British Government has increased its grant for aeronautical purposes from £13,000 to £78,000; aerial fleets are being built by all the Great Powers; the United States has formally adopted the Wright flying machine, after a series of official tests; the English Channel has been crossed by an aeroplane in faster time than the journey from England to France had ever hitherto been made; great aeronautical exhibitions have been held in London, Frankfurt, and Paris; a week of racing at Rheims brought forth the merit of the aeroplane in astonishing fashion; Count Zeppelin made an aerial journey of over 800 miles; and his ship has journeyed from the south of Germany to Berlin.

Thus, in breathless fashion, one could go on recounting the unprecedented progress of this new locomotion. But I will refer my readers to the book, and to the appendix, for a summary of progress.

On the main theme of the book, that is to say, the naval and military applications of aerial vessels, opinions change almost from day to day; but the number of sceptics is far smaller now than when the first edition appeared. Most wonderful of all, the British Government has been stirred into action, both in building airships for the army and navy, and in establishing a Scientific Advisory Committee.

There are several writers and thinkers who yet will admit no feasibility for aerial vessels, but they usually belong to the class who have given little study to the possibilities of aerial vessels. It is significant, however, that even those naval and military experts who deny the utility of ships of the air have not ceased to urge on the development of special guns to ward off aerial attacks.

Preface to Second Edition

As scouting agents and despatch carriers the value of aerial vessels, even in their present crude stage, is generally admitted; but the theory that airships can be used for attacking purposes (especially at night) is still stoutly resisted in many quarters. One of the most illuminating writers points out that shrapnel from high-angle guns could wreck any aerial vessel; whilst airships, when provided with ammunition, will never be able to discharge their shells accurately. Pursuing the subject, the writer argues that all artillery firing is in the nature of guesswork, and instances that the damage wreaked at Port Arthur by the big-gun fire was very much overestimated.

If we accept this latter statement that ordinary artillery fire at immovable objects like forts is inaccurate and exaggerated as to its effects, the layman can form the idea that high-angle fire at objects capable of moving quickly both in a vertical and horizontal plane will be far less accurate. If so the airship of the future will be an elusive and even dangerous target for land artillery.

The history of every new invention shows the same scepticism on the part of the experts. But the development of airships will not be checked by their opinions, nor does it seem likely that the Great Powers which have already entered upon a programme of aerial ship building will stop the work. No one can possibly foresee a limit to the developments and improvements which may accrue in airships for war purposes, and if the possibilities are such as to make war more terrible and uncertain, and thus entered into more charily, then airships will have accomplished a good purpose.

The submarine and many other inventions have proved of little or no utility save for warlike purposes; but there is always the assurance that the airship in its varied forms will be an instrument of immense utility in times of peace, and will reach its highest use in that age of civilisation and true Christianity when war will be but a barbaric relic.

Several disasters occurred during the year, and showed that progress in aerial locomotion will not be too cheaply bought. Inexpert aeronauts have been urged on to foolhardy feats, and the morbid curiosity of the public has been aroused by the ill-expressed enthusiasm suddenly displayed by a section of the press in the new locomotion.

Soon after first taking up the task of writing a work on aeronautics the idea suggested itself to me that one ought to seek out and emphasise the principal object of all this great aeronautical movement. Many writers had treated the matter as if aerial vessels had already attained a very definite object, whilst others wrote as if they knew of no useful end to be gained by aerial navigation.

It was clear that at the time when this book first appeared the military uses of airships were the most important and apparent. Thus I styled the book "Aerial Warfare," and treated the subject with a view to showing that aerial vessels could serve a very valuable purpose by making war more terrible, and consequently less liable to be hastily rushed into. In the past year the whole scope of aeronautics has broadened, and I therefore feel that the time is opportune to alter the title and contents of the book so as to show that aerial navigation is fast approaching an epoch when it will have important uses in peace as well as in war time.

There is just one other little point I would mention. I have been criticised by some English reviewers for assuming an unfriendly attitude towards Germany. It is with peculiar pleasure therefore that I saw the book go into a German edition, and meet with a very favourable reception in Germany. This fact completely disproves the criticism. A perusal of the book will show how high a tribute I pay to German genius.

INTRODUCTORY

THE events of the last few years ought to convince every thinking man that the beginning of a totally new and important epoch in the world's history has arrived. What the last century was to Electricity the present century will be to Aerial Navigation. Only a few years ago the experimenter in flying machines was looked upon and placed in the same category as those who sought to invent perpetual motion or discover the philosopher's stone. It was said of Benjamin Franklin that when he wished to make experiments with a kite, in order to ascertain if the lightning of the heavens was the same as Electricity, he took a small boy with him in order to disarm those who might have ridiculed what they thought to be a foolish and absurd experiment.

But thanks to a few earnest and clever scientific gentlemen, mathematicians, etc., one is now able to experiment and study the problem of Aerial Navigation without the least fear of ridicule.

Man has long sought to navigate the air with machines lighter than air, balloons and machines heavier than the air, flying machines. Balloons have been known for some hundreds of years, but it is only during the last few years that a motor has been available which is sufficiently powerful in proportion to its weight to be used on a true flying machine, and for this remarkable motor we are indebted to those who have spent hundreds of thousands of pounds in the development of motor-cars, especially those of the racing type.

Mathematicians have always told us that a flying machine would be possible just as soon as a suitable motor for the purpose was discovered. They have always said, "Give us the motor and we will very soon give you a flying machine."

The domestic goose weighs twelve pounds and is able to fly, and it is said that in doing so she develops the twelfth part of a horse-power. Gasoline motors have already been made that develop one horse-power for every four pounds of weight, or, say, one horse-power with the weight of a small barn-yard fowl, and I find that there is a possibility of reducing this weight to about two and a half pounds, providing that all the parts are made of high grade and carefully tempered steel.

Many philosophers have maintained, and with reason, that if mankind was ever to master the air, it would in the very nature of things be necessary to imitate Nature's flying-machines, birds, and depend altogether upon dynamic energy instead of the buoyancy of gas; but as the flying-machine motor was not invented until quite recently, the balloon men have had everything their own way. It would, however, appear to me that balloons can never be of any real value either in peace or war. A balloon in order to rise has to be lighter than a corresponding volume of air, that is, the machine, considered as a whole, has a less density than the air we breathe, therefore it must always be extremely delicate and fragile. Moreover, in order to lift any considerable amount it has to be made of enormous dimensions, and its great size, combined with its inherent weakness and lightness, renders it very difficult to manage except in a dead calm. The dirigible balloon, or airship as it is now called, may be likened to an ordinary ship. Suppose, for example, that one had a ship that could only leave the harbour or return to it in a dead calm; suppose, at the very best, that the ship leaked so badly that it could not remain afloat for more than twenty-four hours at a time; and suppose now, after waiting several weeks for a dead calm, such a ship ventures out of the harbour and sails about for a few hours, but is absolutely unable to enter the harbour in the face of even a light breeze, without being dashed about and destroyed. She is then in the position of not being able to remain afloat or return to the place of safety. What would be thought of the utility of such a ship? And this is exactly the case with dirigibles; they can only venture out of their house on rare occasions. If any attempt is made to take them out even with a light wind blowing, the work of months is destroyed in as many seconds, and, when once out, it is impossible to rehouse them, unless the weather conditions are extremely favourable.

And then again, the speed at which an airship is able to travel through the air, even of the very long Zeppelin type, is not sufficiently high to enable it to make progress against the wind that is blowing on at least two hundred days in every year. Experiments made at the top of the Eiffel Tower have demonstrated that the average velocity of the wind throughout the year at that height, is quite equal to the highest speed that an airship is able to make. Although millions of pounds have been spent during the last few years on dirigibles, they do not appear to have made much improvement on the types that existed ten years ago. I am therefore of the opinion that if we have not already come to the end of our tether with the dirigible balloon, we are certainly very near to it.

On the other hand, since the development of the gasoline motor, flying machines have made a great deal of progress. Quite true, more than twelve years ago I made a large machine that had a lifting effect of more than a ton, in addition to the weight of three men and six hundred pounds of water. But this machine was driven by a light steam engine of enormous power, and the quantity of water consumed was so large that the machine could not have remained in the air but a few minutes, even if I had had room to manœuvre and learned the knack of balancing it in the air. It was only too evident to me that it was no use to go on with the steam engine, and this state of things was fully set forth by me at the time in the letters and articles which I wrote. My large machine, however, demonstrated one very important fact, and that is, that very large aeroplanes had a fair degree of lifting power for their area. It is interesting to note that this large machine of mine was mounted on a framework made in the form of sledge runners, that it had superposed aeroplanes, fore and aft rudders with a front horizontal rudder for steering in a vertical direction, that it was propelled by large canvas-covered wooden screws running in reverse directions, that the aeroplanes were two-ply so as to conceal the framework and give a smooth surface on both sides, and that sharp fore and aft edges were produced by stretching the cloth tightly over a steel wire. In one of my patents taken about eleven years ago, I showed the front edge of wings or aeroplanes made rigid, and the after edge made thin and flexible. I also showed a device for flexing the outer and after edges of the wings or aeroplanes, in order to produce stability and to equalise the lifting effect on both sides of the machine. The most successful machine which has been made up to date has all of these features.

The Wright Brothers, of Dayton, Ohio, seem to have commenced experiments about ten years ago with what is known as gliding machines, and it was only after they had made a profound study of the subject and performed hundreds of experiments that they applied a screw and a propeller, and converted their gliding machine into a true flying machine. There is no question about it, the Wright Brothers were the first to perform free flight in the air. Not only this, but the work they have done and the machines they have constructed are so much superior to the machines of the Farman and Delagrange type as to be considered in a totally different category. It has been my great pleasure to witness some flights with the Wright machine near Le Mans, in France, and I can testify that with Mr. Wright on board he had as complete control of his machine as a skilful boatman would have on a placid stream. The machine rose from the ground, mounted at a fair height, and travelled at a high velocity. It turned corners the same as a bird would have done, the outer wings being much the higher, and when travelling in a straight line it moved with the rapidity and evenness of an express train. On passing over our heads Mr. Wright mounted at least one hundred feet in the air, and after performing another circle came near the ground, and after slowing up he pitched the front end of the machine upward, bringing the hind end of the sledge runners in contact with the ground, which acted as an excellent brake, and brought the machine to a state of rest on the ground very much after the manner of a bird and without the least shock.

Mr. Wright's machine is, I believe, about forty feet wide from port to starboard, and is provided with a small four-cylinder gasoline engine of 24 h.p. He has already carried a load of 240 pounds in addition to the water, the gasoline, and his own weight, and he has been able at least on one occasion to remain in the air considerably over an hour and to travel fifty-six miles.

The Wright machine, however, although well designed (the proof of the pudding is in the eating), is, as a whole, a very rough piece of mechanism, and is susceptible of a good many improvements in many directions. The motor has four cylinders and a heavy cast-iron fly-wheel. The iron that is in this fly-wheel would easily make two more cylinders without increasing the weight an ounce. With six cylinders no fly-wheel would be required, and the engine would develop 36 h.p., instead of 24. With this increase of power, and several changes for reducing the atmospheric resistance, 10 feet might be added to the length of the aeroplanes, and under these conditions the machine would probably carry a load of 300 lbs. for a distance of at least one hundred miles at the rate of fifty miles an hour.

But why should we stop at 36 h.p. with aeroplanes 50 feet long? Why not use aeroplanes 70 or 80 feet long, and a motor of 60 h.p., and then if all the work is well executed and the light motor equal, as far as reliability is concerned, to the best motors now in the market we should be able to attain a speed of sixty miles an hour, and keep it up for at least three hours at a stretch with a load of fully 500 lbs. in addition to the weight of the driver? Such a machine is now in sight. Mr. Wright's machine, as it now stands, could cross and re-cross the Channel without replenishing its gasoline, and the machine which I have suggested would do a good deal better, and would be able to carry a considerable load besides the weight of the operator.

It is not necessary for me to point out to any one who has an imagination what this means. The dullest intellect ought to be able to grasp the situation and to realise what this new departure means. It is interesting to note in this connection why it is that the Wright machine is so much superior to the machines of Delagrange and Farman. Both have superposed aeroplanes, both are about the same size and the same weight, and both have fore and aft horizontal rudders. The workmanship on the French machines appears to be much better than on the Wright machine, still as far as flying is concerned the French machines are not in it. Wright does very much better with 24 h.p. than his competitors are able to do with 50 h.p.

Let us see now what the details are that make these French machines so much inferior to the Wright machine. In the first place they have a very complicated and rather heavy arrangement of spiral springs, levers, wheels, steel tubes, etc., to give elasticity in landing, and as this apparatus is very bulky, it not only weighs the machine down, but at the same time offers great atmospheric resistance. Then again, on the French machines the wooden framework of the aeroplanes is not covered in, but exposed on the top side, and this prevents the air from running smoothly over the top side and joining the current from the underneath side of the aeroplane. This arrangement not only increases the resistance, but also diminishes the lifting effect. The French machines have only one screw and that made of metal; the blades are riveted on to a steel bar and the bar projects on the rear side of the blade; this prevents the air from following both sides of the blade, and so increases the friction and diminishes the thrust. The French propellers are much smaller than Wright's, and they only use one on each machine, while Wright uses two and consequently engages more than double the quantity of air. The speed of Wright's propeller screws is much less, and the slip of his screws in the air and the waste of power resulting therefrom is much less than in the French machines. The Wright machine s i able to travel in a straight line without the least irregularity, to swing round corners without any pitching or rearing, and to sail on an even keel under all conditions, while the French machines take a very erratic path, pitch and toss, and are very difficult to handle, especially while turning a corner.

A good deal of this is due to the gyroscopic action of the screws. In the French machines, as I have said before, there is but one screw. This is of metal and of considerable weight, and, as it is connected directly to the motor shaft, it has a very high rotatory velocity, and therefore acts as a very powerful gyroscope. Suppose now that one of these screws has a right-hand pitch, and suppose that the machine is travelling in a straight line, neither turning to the right, left, up nor down. Under these conditions there will be no gyroscopic action; but suppose that the driver wishes to make a quarter turn, that is, to swing round 90° to the left, the gyroscope will then have a strong tendency to throw the front of the machine upward and the rear downward, whereas, if the driver attempts to turn to the right, the gyroscopic action of the screw exerts great force in the other direction, that is, forcing the front end of the machine downward and the rear end upward.

With a single screw working at a high velocity the steering will always be difficult, because the changing of the angle of the machine in the air will always have an influence on steering it in a horizontal direction. In fact the gyroscope is a very remarkable instrument, very little understood, and always wishes to have its own way. Like Paddy's pig, it never wishes to turn in the direction that the pressure is applied, but to start off on its own account in quite another direction. Then, again, the power applied in rotating the screw has a tendency to rotate the machine in a contrary direction.

In my large machine these troubles were obviated by the use of two screws rotating in opposite directions.

The Wright machine, like my own, has two screws; they are both of the same size and the same diameter and rotate at the same velocity in opposite directions, therefore there is no disturbing influence, because whatever gyroscopic action is set up by one screw is exactly neutralised by the gyroscopic action of the other screw, which is of exactly equal force and operates in the opposite direction; therefore the Wright machine may be steered as easily as a boat without any of the erratic influences and disturbances which have so greatly puzzled those who did not understand the cause of the trouble.

When we take into consideration the lightness and cheapness of aeroplanes, the rapidity with which they can be produced, and the velocity at which they are able to travel, I think it will be seen that a fleet of dirigible balloons would stand a very poor chance when pitted against a fleet of flying machines. As flying machines will have a speed at least double that of airships, and will be much easier to manœuvre, they would not en-counter a great deal of trouble nor danger in pricking the bubble and letting the gas out of their bulky opponents.

I fully agree with what the author has so strongly and so ably set forth in the admirable work which I have read with much pleasure. It is no longer a safe expedient to hide our heads in the sand like the ostrich in order not to witness what is going on in other parts of the world. On the contrary, we should accept the situation as we find it. The flying machine has come, and come to stay, whether we like it or not. It is a subject that we have to deal with, I might say that it is the burning subject of the moment, and the sooner this fact is acknowledged by the authorities, and measures taken to put us abreast with other nations, the better it will be for the safety of the nation.

HIRAM S. MAXIM.

[∴ Sir Hiram Maxim is now engaged on a very interesting flying machine of his own invention.]

FOREWORD

I ABHOR war: but it is hopeless to expect that a state of affairs will be reached in our time which will render it unnecessary. Warfare is a barbarous method of settling differences; but when barbaric wrongs have been done, it is in human nature to avenge them by blood; and cruelty and barbarity may never wholly disappear from our natures. Though the humanitarian feeling may become stronger and more widespread, there are, and will be, causes within and without nations which will long conduce to war. The struggle for commercial supremacy, for the preservation of markets, for the maintenance of claims and rights have, in a large measure, taken the place of the wars of religion, rapine, and racial animosity. Multitudinous little wars have given way to more terrible struggles which take longer to prepare for, and longer to recover from.

Apart from the menace caused by ever-growing armaments, in which the rich nations literally force their poorer rivals into bankruptcy by necessitating ever-growing military and naval expenditure, there are internal causes in every commercial nation which predispose to war. Congestion of population; increase of labour-saving devices; increase of town life, with all its evils and artificialities; insensate and unscrupulous business competition; stock-market gambling; political, financial, and civic corruption; the rapid acquisition of wealth by vice, 'sweating,' speculation, fraud, gambling, and extravagant follies; coupled with the struggles between Capital and Labour, between Socialists and Individualists, have created many new conditions and new difficulties, the only popular palliative for which is good trade, that is to say, ever-growing trade. The greed for wealth and material comforts affects all classes, and grows more insatiable.

Once business declines in the wealthiest country, there is acute distress amongst thousands of people, disaffection becomes widespread, and the war of the political parties becomes more violent. Every great nation finds it imperative to keep up her trade. Competition between the different countries grows more keen, rates of production of manufactured articles increase out of proportion to the demand as more nations enter the competitive arena, and there is a mad scramble in the market-places of the world.

We are now at the stage where a battle of wits is in progress between the nations to keep up their trade, but at any moment this may lead to the final test of war. Armaments have increased on every hand, and, indeed, if the grim trade of preparing for war were not carried on extensively by each nation, thousands of people would be thrown out of employment, and grave discontent would arise. Despite the protests and appeals of peace congresses, armies and navies are increased, and war stores accumulate: the situation in the world's market-places grows more strained, too, as the competition becomes fiercer, and the difficulty of doing good business is felt. Commercialism of the coarsest type predominates, and almost every one and everything are judged by the money standard.

Notwithstanding the cultivation of international good feeling, nations will readily attack each other if they feel a material advantage can be gained. If one power takes too much of the world's trade, the others will become jealous, their peoples will feel the pinch of poverty, and war will be favoured under any pretext. War, in fact, has become the final appeal court of commercial procedure, and with hungry nations clamouring for food or employment, war will recommend itself as the only way of satisfying their needs.

But if the world has grown more mercenary it has also gained in common sense and self-control. A nation will carefully weigh up the cost of war now before entering upon it, and will seek to determine what material advantages may be gained from it. War in effect to the commercial mind is a form of speculative investment—just a little more hazardous than many other investments which are permitted to be laid before the public.

The character of war, too, has changed : it has become more costly and more terrible. Every science has been pressed into its aid, with the result that it has advanced in destructiveness to a stage which is appalling to contemplate. And this fact makes nations pause; and it has led men who are good students of human nature to assert that the best way to preserve peace is to make war as terrible as possible—terrible in its toll of blood and money, terrible in its widespread ravages, and terrible in its uncertainty.

But restless ingenuity tends to equalise matters and give conviction that victory will fall to the big battalions—to the nation which has "invested" most money in its war-shop. Every new device which increases the killing power of ship or regiment for one country is speedily equalised by similar improvements, stolen, bought, or invented, by rival nations, and once again the nations count their men, ships, and guns, tot up their war-chest, place their allies' forces on the same side of the account-book, and then on the other side set down the power of their rivals. The aim of diplomats is to keep the balance even, as it is the aim of the men who are responsible for the efficiency of the fighting forces to turn the balance in their own favour.

It is a delicate balance, and any day may be upset by some nation rendered desperate through the ever-growing expenditure in war armament, with no sign of a "dividend" on its "investment." To avoid national bankruptcy an appeal to arms may be forced. The time will be rendered propitious if one nation, by a happy investment in some new and highly speculative form of war engine, obtains what she considers a valuable addition to her fighting power, a new force which is despised or untried by her rivals.

Thus comes the aerial warship as a new factor. France, after the awful debacle of 1870, cast about wildly at first for weapons of revenge; later, for weapons which would defend her against her unconquerable enemy. The airship was one of the latest of her schemes after many others had been tried; and in recent years, with a declining population and internal troubles, the airship fleet of France has been one of her few hopes.

Fortune and good diplomacy, together with the growing trade rivalry between Germany and England, have shifted the danger zone from the French frontier, but at the same time England and Germany have come into fierce competition.

Next it was the turn of Germany to cast about for new factors which would give her an advantage over her wealthy rival. The great army alone was useless: there must be a great fleet too. And so we have seen the frantic efforts of Germany to build a fleet which will enable her to get on level terms with England; and there was no more distressing, no more infuriating spectacle to the fervid German patriot of the day than the huge British fleet as it stands out proudly predominant, a marvellous demonstration of invested capital.

But the German does not tire easily. He is making steady progress, he takes advantage of every lull in his rival's work, and whilst pushing on the task of fleet-building with an activity which has almost involved him in bankruptcy, he has taken example from France in casting about for new methods of equalising power, and so we have the aerial fleet as cherished an ideal with the German as his seaship fleet; and we have Count Zeppelin looked to as the hero who will create for his nation the auxiliary power they require. Already the German people have given to Zeppelin several hundred thousand pounds—invested the money in him, hoping that the speculation will give the necessary "dividend."

If any one nation develops an aerial flotilla, and arrives at the conclusion that she has acquired a new power which will give her a telling advantage over a rival, we may expect that she will use that power at the earliest possible moment, with all that inexorable promptitude born of modern commercialism.

In this respect the airship as applied to warfare will disturb the balance of power and may precipitate war. On the other hand, if rival nations are alert and take up aerial navigation also, there will have to be a general recasting up of forces and possibilities; war will be deemed more uncertain, more costly, more terrible; and the enterprise will be too rash to commend itself to any business nation until something more definite is known about aerial navigation. Therefore the general adoption of airships will defer war, until the new arm can be given its correct value.

Many great moral and social reforms will have to be made ere we can hope for universal peace or even for an honest limitation of armament, and meantime every great power will in duty to itself have to adopt aerial navigation in its war scheme, or else a few enterprising nations by rapid advancement in the new art may so readjust the balance of power as to feel justified in embarking upon war.

The Napoleonic idea of reducing Europe to a great federated state by conquest was perhaps after all not such a fantastic method of securing general peace; but this no longer being practicable we may have to hope for a federated commercial union in which Capital and Labour could be harmonised, demand and supply regulated on some common-sense basis, and cut-throat commercial competition, sweated labour, trust frauds, gambling in food and fuel supplies, trade rivalries, and all the hideous suffering born of our haphazard mercenary age might disappear.

In modern times of peace the richest nation has its hapless civilian garrisons ever beleaguered by the grim enemies Hunger and Want; thousands of people in our cities die more hideous deaths than soldiers on the field; and hundreds of thousands of hapless individuals are maimed and broken in body and spirit by the fiendish cruelty of the social conditions under which they are born, the condition into which they are driven by their own countrymen!

Until human nature is improved enough to alter some of those conditions, war will be the final appeal, fighting courage the ultimate test between man and man.

I have found it necessary to touch on some of these matters, as I notice that many advocates of peace have suggested that aerial navigation be not applied to warfare for fear of making it more destructive. Balloons, however, have been and must be used in war, and if they are fair targets to be shot at by the enemy it is only equitable that airships should have the right to discharge projectiles. I agree that airships will make war more terrible, but I have endeavoured to show that its very terror will delay an outbreak.

Airships will also render warfare more localised in its destruction (that is to say, more humane), more decisive, and more rapid. By skilfully directing artillery fire, by more accurate location of enemies' positions, and by the discharge of aerial projectiles the destruction will be more closely restricted to the combatants, and there will be far less of that cruel slaughter of non-combatants and that widespread and useless destruction of property which are likely to result from ordinary methods of warfare.

It may be objected that I am taking too much for granted in presuming that airships can be applied to warfare, but I devote a large portion of my book to elaborating two great points :—

(*a*) Airships have made extraordinary strides in the last six years since a suitable motor has been found. Only minor mechanical difficulties stand in the way of further development.

(*b*) The nations which have spent money and labour, and achieved most success in developing the airship, are the most zealous in applying it to warlike purposes.

These and the other proofs adduced will make a good case, and as I firmly believe that the airship by its astounding possibilities is an important factor in temporarily preserving peace, I do not regret its present application to military usage, sincerely hoping, however, that it may long defer war and thus give the nations more time to adjust those errors which are the main causes of modern war. Of course I do not fail to admit the limitations of aerial navigation, its great risks and its great uncertainty: nor do I expect that complete success will be readily achieved. But the promise of success is truly remarkable.

Before touching on the applications of airships to warfare it will be necessary to sketch the development of aerial navigation in order that the reader can appreciate how baffling was the pursuit until the turning-point came less than six years ago in the discovery of a suitable engine. The astounding progress made since that time is the best indication of future success.

Perhaps my one regret in writing this book is that I have to give some prominence to the idea that the rapid development of Germany's aerial power may be a serious menace to England if efforts are not made to keep pace with it. I am a great admirer of the genius of the German nation, and it is with a sickening feeling that the growing apprehension of impending war between Germany and England has to be admitted. War between the two nations will be calamitous for both, and yet the political air is so charged with the antagonistic energies of the two races that it behoves the naval and military authorities of both nations to prepare for eventualities. Germany, beyond doubt, has realised the position, and is pressing every new arm into its service. But the action of the British authorities in not keeping pace with Germany in aerial development is deserving of strong criticism. The surest guarantee of peace is to balance fighting forces, and allow no other nation to suddenly acquire an overwhelming advantage. War may come with terrible suddenness, an important improvement in airships may be rapidly availed of by an alert rival, and this may prove no small factor in determining the issue of a campaign against a country unprepared for such developments.

The desire to adapt airships to warlike purposes has done much to hasten the development of aerial navigation, for it is generally realised that the application of these vessels to military and naval use is at present more feasible than to commercial purposes. The continued interest of the great powers in airships will thus help on airship progress, and if peace can only be preserved meantime we can be truly thankful for the patronage thus extended to the new science. When England takes her right place amongst the rulers of the air, when her army and navy have been equipped with the best airships extant, and when her inventors, designers, and aeronauts have full scope for their talents we may expect that the peace of the world will be more secure than ever; and then we may look forward with some hope to that glorious day when the great nations will strive to end those internal disorders and inhuman practices which predispose to war; whilst aerial locomotion, by leaping over many old barriers, will open the way to international amity, and perhaps to universal and uninterrupted peace.

I have found it essential in tracing the progress of all types of airships to give a good deal of space to the dirigible balloon, as at the present time this is the only form of airship actually employed in military service; but I cannot help thinking with Sir Hiram Maxim that future development lies almost entirely with the aeroplane. However, even if regarded as a passing type, the dirigible balloon is a most interesting study, and as it has reached a practicable stage before the flying machine it must be reckoned with in aerial warfare for some time to come. I have endeavoured to state the case clearly for each type of machine, and in treating of the application of the vessels to naval and military uses I have, where possible, used the general term "airships," under which I include both dirigible balloons and flying machines. To the strategist it is of secondary importance whether the vessel employed is a dirigible or a flying machine, provided it can carry out the required work in the best manner; but the military authorities will need to experiment with all types, and whilst employing as far as possible those vessels which are now practicable, they should in the most thorough way keep in touch with every development of the other types.

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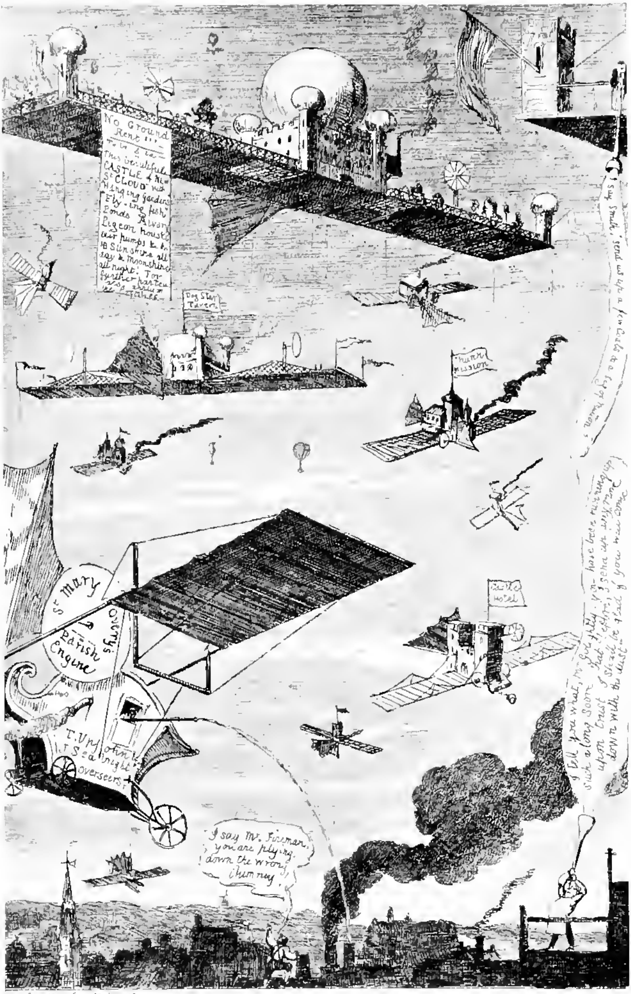


THE HEIGHT OF SPECULATION – Groundless Expectations.

GEORGE CRUIKSHANK'S IDEALS IN AIRSHIPS
(From the collection of Mr. John Lane)

AERIAL WARFARE

CHAPTER I

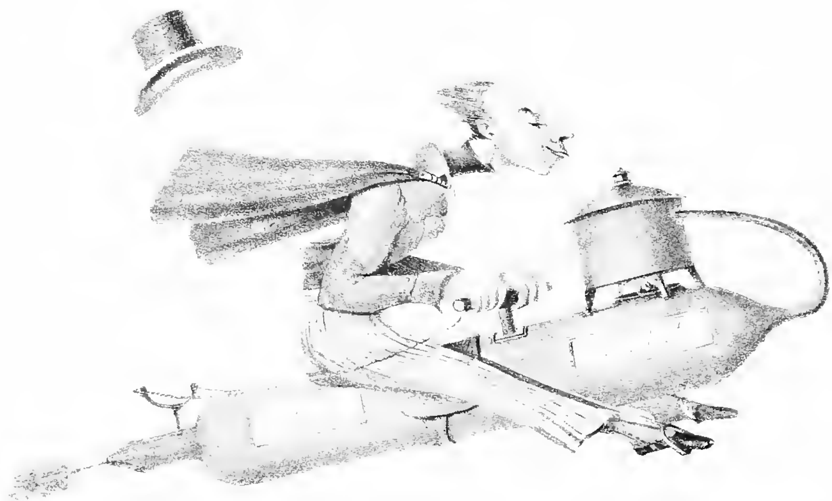
FLYING MACHINES

THE conquest of the air must have been amongst the earliest ambitions of mankind, and of all forms of locomotion it has presented the most baffling problems. At practically every period it must have been recognised that birds flew by reason of certain physical powers, and the process was seemingly simple enough to encourage man to imitate it. But when experimenters and philosophers came to inquire into the matter they found that the problem was incapable of a satisfactory solution, and century after century passed without success being attainable. Repeated failure did not diminish the fascination of the pursuit, though, as years went on, the subject was abandoned by practical people, who confined their attention to locomotion on land and water.

From time to time, as some enthusiast arose with new ideas for aerial locomotion, interest was again stirred up, but invariably the experimenter failed, until at length the impossibility of flying became almost proverbial. But all through the history of aeronautics must be noted the compelling fascination which in every century drew men to make fresh attempts at the solution of the problem, despite the accumulation of failures which stood out to warn them; and notable, too, despite the improvements in locomotion by land and water, is the strong and universal desire for the mastery of the air. We have ever been envious of the freedom of the birds, their speed, power, and graceful evolutions; and the beautiful prospects which their position in the air affords have always been subjects of wistful admiration to those for whom developments in sea and land travel had little interest.

In my treatment of the subject I have placed flying machines first, since they were obviously the earliest form of aerial locomotion to be suggested to man's mind, and under the term flying machine I shall include all those devices which are heavier than air, and which rise in the air by mechanical means.

The full tragedy and pathos of the many



THE "STEAM RIDING ROCKET," ONE OF THE MANY QUAINT SUGGESTIONS FOR AIRSHIPS PUBLISHED IN THE LAST CENTURY
(From the collection of Mr. John Lane)

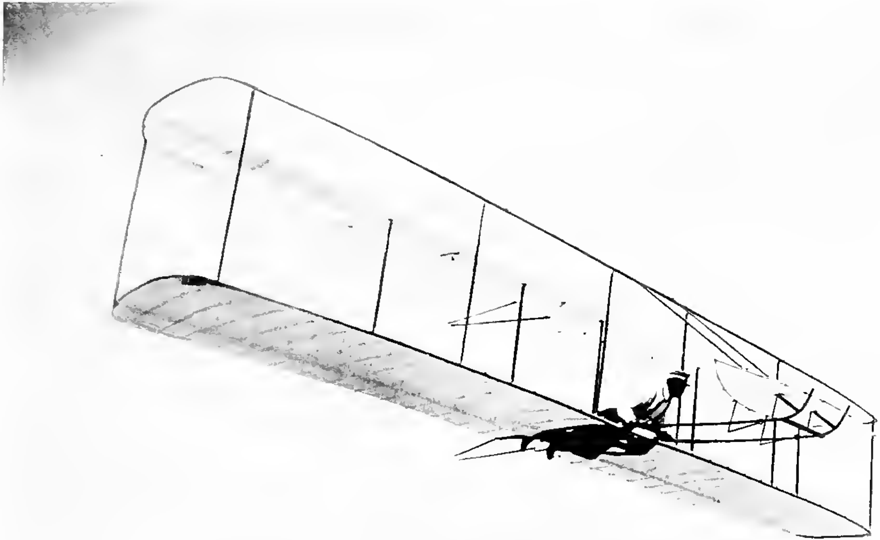
attempts to devise flying machines has not yet been brought out by the historian of aeronautics, for it was only within recent years that we were able to analyse the relative worth of the various contrivances and theories, and thus mark out for distinction those men who were the discoverers of anything really useful. Time and circumstances held success from them: they were looked upon as madmen by their contemporaries, and only now are some of them receiving credit for their contributions to the science of aeronautics.

To trace all the legendary attempts at flight, and follow the progress of events through the early ages cannot be accomplished in this book, though it is necessary for the reader to have some knowledge of the efforts which have been made to navigate the air if he is to appreciate its real difficulty. Passing over the masses of legend and unauthentic record, mention must be made of the ingenious suggestions of the great artist Leonardo da Vinci (1452–1519). His knowledge of anatomy helped him to devise a flying machine with many remarkable features, and the jointed wings which contracted on the upward stroke and expanded on the downward, as also the method of using a man's arms and legs in the work, show him to have made a profound study of the subject.

Many adaptations of the idea were tried, and there must have been as many failures, though only a small portion is recorded. After each series of unfortunate attempts came the usual wave of pessimism, in which it was formulated that the regions of the upper air were closed to man. The old inventors, as a rule, were too impetuous, and they did not fully understand the risks which threatened the safety of even those contrivances which could take the air. It was perhaps a fortunate circumstance that their crude machines generally failed to show any aviatic power, as the time was not ripe for aerial expeditions until experimenters had more closely studied the conditions which had to be contended with in navigating the air.

Gradually there came about a settled idea that man was physically unfitted to work flying machines of the winged type, in that his strength was not sufficient in proportion to the weight to be carried and the size of the wings to be actuated. Then, by a slow process of evolution and trial, the idea was arrived at that some form of soaring apparatus might be employed which would lessen the aeronaut's efforts by enabling him to use smaller and lighter wings.

Whom to attribute this discovery is not clear, but to Stringfellow, Henson, and Wenham must be given a large share of the honour of devising the prototype of the aeroplane. Wen-



THE ORIGINAL WRIGHT GLIDING MACHINE
(In this aeroplane the operator lay face downwards)

ham, for instance, arranged a series of cloth planes one above the other. At the sides were wings worked by the aviator, and he also devised rudders to control the steering. In 1866 he patented such a machine, but many causes prevented him from achieving any success with it, and he died without any recognition of the great services he had rendered to aeronautics. Failing better evidence, I regard the late Mr. F. H. Wenham (he died in August, 1908) as the inventor of the aeroplane of the type now used by the Wrights, etc., and thus to England goes the honour of this discovery.

It remained for Otto Lilienthal (1848–96) and his brother to carry the aeroplane some steps further, and these clever Germans may be heralded as the first men to devise a successful aeroplane. Otto Lilienthal has left us several important works on the problem of flight, and aeronautical science received a great blow through the fatal accident which, in 1896, cost him his life. He had made many successful glides on his aeroplanes, leaping off from a hill and sailing for distances up to three hundred yards ere coming gently to earth. As he gained skill he was able to steer the machine to some extent, and he had the idea of fitting a light motor to the aeroplane when the calamity occurred which ended his life. He was gliding at a height of about twenty feet from the ground when a sudden gust of wind upset the equilibrium of the machine, and he was thrown heavily to the earth, receiving fatal injuries. Pilcher's name is another which ranks high in the records of aeronautics, and he did much to help on progress. Like Lilienthal, he sacrificed his life in the attempt to solve the grand problem. This clever young English engineer was probably the first to design an oil engine for use on an aeroplane, and he was killed near Rugby in October, 1899, when demonstrating with this machine before the engine was fitted.

Perhaps the most remarkable work done in the early days of the movement was that achieved by Sir Hiram Maxim. To him belongs the credit of having designed and built the first full-size power-driven flying machine constructed in the British Isles, and the long and costly series of experiments which he carried out have furnished us with an immense amount of useful data. In 1889 he made most exhaustive trials of screws and aeroplanes, and, as a result, he built a machine fitted with a 350 h.p. steam engine, which, even at this time of day, must be regarded as one of the most ingenious airships ever built.

The aeroplanes were of remarkable size, and they were supported by a light but immensely strong platform, which also carried the engine.

PLAN VIEW OF THE MODERN WRIGHT AEROPLANE

In front are the twin planes which control up and down motion: in the rear are the twin vertical rudders which govern steering to right or left)

The propellers were 18 feet in diameter, and the weight of the whole machine was over 7000 lbs. The engines developed about 350 h.p. and weighed only 700 lbs., an instance in itself of the extraordinary skill displayed in designing the machine. This airship was built to run along a railway track, so constructed that although the lifting power could be measured, the machine was prevented from leaving the tracks. Speeds up to forty miles an hour were attained, and the machine so successfully demonstrated its lifting power that it broke away from the guard rails and lifted itself from the ground when Sir Hiram Maxim and his assistant were on board. At a speed of twenty-seven miles an hour the rear wheels recorded a lift of nearly 3000 lbs., whilst the front wheels indicated a lift of 2500 lbs.

On another occasion, at the same speed, a total lift of 6500 lbs. was recorded. These experiments clearly demonstrated in most striking fashion the immense lifting power which a well-designed machine possessed, and Sir Hiram Maxim thus gave great encouragement to succeeding inventors by his researches. He realised, however, that his task was by no means complete, as he had still to perfect the balancing and steering arrangements, but he was unable to carry through the labour contemplated in this direction, and, after spending over £20,000 on his work, he had to abandon it, for as a matter of fact he was too far in advance of his time; and, needless to say, the public and the governments in 1889 did not give the attention to aerial navigation which they have now been compelled to do.

The fate of Lilienthal, however, checked further aeroplane experiment in Europe, a further cause being the progress made in ballooning and the work then contemplated in connection with dirigible balloons. The centre of activity as regards flying machines shifted to America, and the problem was there tackled with characteristic enthusiasm and ingenuity.

It had been demonstrated that a machine consisting of planes or flat surfaces could be made to glide through the air if projected against it from a height, and the next step was to apply motive power which would work wings or propellers, and so prolong the time which the machine could keep aloft. For suitable engines we had to await the development of the light petrol motor, and by a curious coincidence it came about that just as gliding machines were being built in America, the motor-car was making rapid headway in Europe, and marvellous progress was shown in the building of light-weight engines. It may truly be said that aerial navigation was only rendered possible by the coming of the motor-car, with its remarkably light,

THE WRIGHT AEROPLANE, SHOWING GENERAL ARRANGEMENT OF THE PLANES AND RUDDERS

(At the rear is the rudder: in front the planes which govern upward and downward motion)

compact, and simple engine, in which petrol vapour is the source of energy.

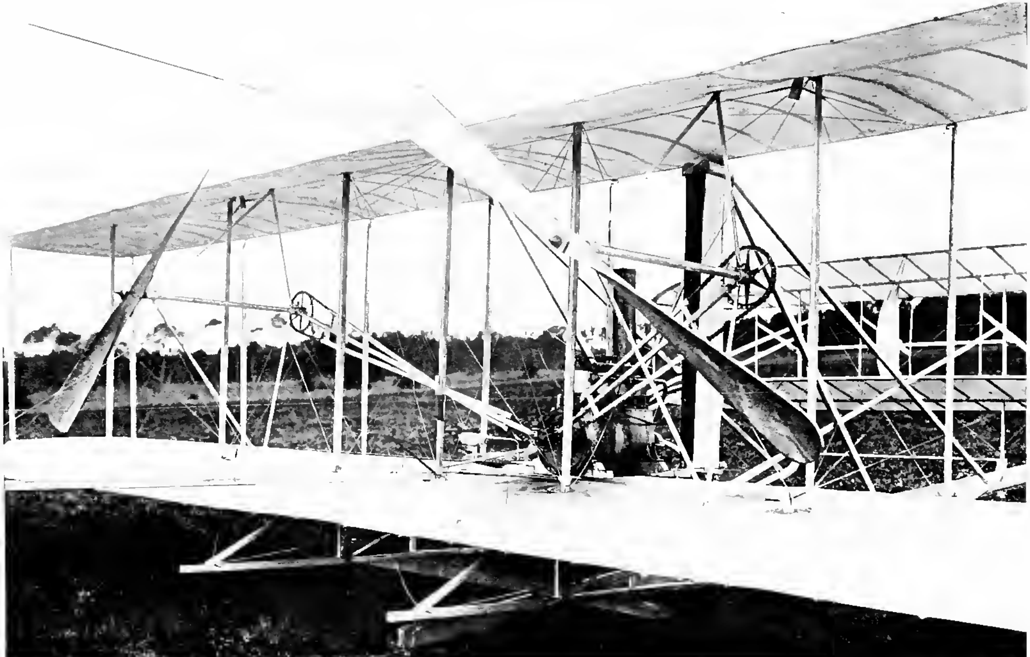
We owe much to the labours of Messrs. Chanute and Herring, who accomplished many extraordinary glides, and aroused much interest in America by their feats; and the invaluable researches of Langley served to pave the way for later workers; but the first real success was scored by the Brothers Wright. They have achieved, in an unofficial way, the earliest record in this branch of aerial navigation, and they were the first to make really successful flights with motor-propelled aeroplanes. Unfortunately, there is no scientific or official record of their early performances, and the secrecy and modesty of the brothers have prevented many important facts being made public. But from long experience of the men, and from correspondence with them, I feel quite confident about the statements and claims which they make, and they have very kindly verified many points for me.

Their anxiety not to make any rash promises or prognostications, and their desire to keep their methods of working secret, saved them for years from the notoriety which most American inventors obtain; and even in the United States up to the year 1908 very little was really known of the Wright Brothers—the men whose names will live in the history of aeronautics as being the first to carry out successful flights on machines which did not depend on balloons for buoyancy.

It was in 1900 that they seriously commenced their experiments with gliding machines of the double deck type, and natural circumstances conduced much to their success. They selected the sandy coast of North Carolina for their experiments, a coast over which sea breezes of most extraordinary regularity and equality of power blow. In other places men have had to rely on fitful and variable winds, and they have had to project themselves from dangerous heights in order to give their flying machines the necessary impetus. Usually the wind failed, the experimenter lost nerve, or the machine broke or got out of balance, and thus many lives were sacrificed.

But the Wrights could rely implicitly on the breeze which blew from the sea over Carolina, and they soon found that this breeze supported plane machines during long glides. Leaping off from a low sand-hill, they were able to glide through the air for considerable distances, and even if a mishap occurred the aeronaut fell on the soft sand and came to small harm.

Continued practice made them very skilled in balancing, and soon they learned the intricate art of steering and controlling the machine. Their longest glide was 622 feet at Kitty Hawk in



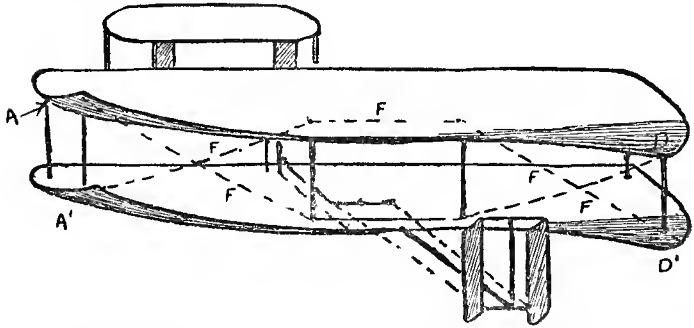
REAR VIEW OF THE WRIGHT AEROPLANE, SHOWING PROPELLERS, TRANSMISSION SYSTEM, ETC.
(Note the wires along each plane, which are used for warping or bending their extremities)

October, 1902, and then, having acquired a skill in gliding possessed by no other men, they spent the next year in making a larger aeroplane, on which they mounted a petrol motor to supply propulsive power. The first motor aeroplane was built and tested in 1903, and photographs of this machine in the air have been published. We can thus date the motor aeroplane from 1903. The longest flight accomplished that year was of fifty-nine seconds' duration.

Not until 1905 was a satisfactory aeroplane evolved by the Wrights, for they were much handicapped by not being able to find a suitable motor. Many trials were necessary ere success was attained, and they kept the matter quite secret until late that year, when their successful flights were noted by many people, and the machine became a topic for general discussion.

Eventually on October 5th, 1905, they made a record flight of twenty-four miles in thirty-eight minutes three seconds, or at an average speed of over thirty-seven miles an hour. This and previous flights were observed by many people, and the Wrights not welcoming the publicity which ensued, stopped the experiments. Between September and October, 1905, they had made flights of eleven, twelve, thirteen, fifteen and a quarter, twenty and three-quarters, and twenty-four and one-fifth miles, all at good

The machine used by them deserves special description, as it placed them in the front rank of aeronauts, and embodied the findings of all their years of trial and experiments. Built staunchly of hickory wood and stout fabric, it had many novel features, the most notable being the wing-



THE WARPING ARRANGEMENT ON THE WRIGHT AEROPLANE

A, D, left and right tips of upper plane; A^1, D^1, tips of lower plane; F, F, cables connected with ends of the planes, and actuated by a lever, so that when one side is tilted up the opposite side is moved downwards. If a gust of wind strikes under the left side and tends to lift it the operator warps A and A^1 upwards, and automatically D and D^1 are curved downwards. The left side now presents less lifting surface and so tends to sink, whilst the right tends to rise by the manner in which it is presented to the air. Thus balance is restored.

warping device used for balancing and to facilitate sharp turns being made.

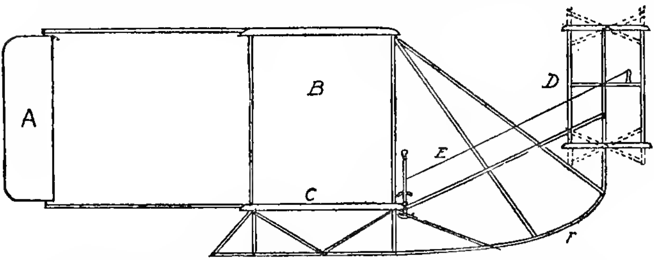
This flexing device, worked by wires running over pulleys, is perhaps the most important feature of the Wrights' invention, and it is patented in this country by them. It allows the operator to tilt up one plane and bend down the other, and at the same time automatically operate the rudder, so that all three functions happening together maintain equilibrium just in the manner that a bird might use its wings. With the Wrights this motion became as natural as the bird's instinctive action to maintain its balance when any current of air tends to disturb it. Other machines depend on more or less rigid planes for their balancing, and these are worked independently of the main planes. They are slow and clumsy functions as compared with the bird-like motion of the Wright machine, which acts as a whole at the will of the operator in carrying out balancing movements. The Wrights, in effect, can control the aeroplane as if the wings were extensions of their limbs, and the whole structure tilts and twists in the air as if it were a living thing. By their long experience in the air, they have gained an unique skill in coping with the varying conditions which prevail in the troubled and unstable aerial sea.

The manner in which the Wrights got their machine into the air is interesting, though it has been improved upon by the method adopted by the French school. The aeroplane was placed upon a truck provided with one wheel running on a single rail. By giving the apparatus impetus the whole affair was set in motion and ran along the rail, balance being kept by the aeronaut as

THE DELAGRANGE AEROPLANE

when in the air. The engine having been set going previously, the aeroplane was thus launched from the truck and took to the air. It was usually allowed to rise to a height of about sixty feet, so as to clear the trees. A minimum height of about twenty-five feet was maintained when turning, as one side of the vessel inclined downwards.

Very interesting details are given as to the



DIAGRAMMATIC SIDE VIEW OF THE WRIGHT AEROPLANE

A, vertical rudder; D, elevating rudders worked by lever E; B, space between the two planes; C, the lower plane; F, runner on which machine is mounted.

difficulties encountered in controlling the machine at first, and these go to show that the handling of an aeroplane is exceedingly delicate work. For instance, it was found that the various controlling devices did not always produce the effects desired, and many extraordinary mishaps occurred. Long experience and acute observation of a number of things gave the brothers the power of knowing the right thing to do, and have confirmed them in their theory that just at present it is the man and not the machine which counts most.

The Wrights, having discovered the possibilities of their machine, next devoted themselves to the task of selling the patent and the secret to some military power, but they found this less easy of accomplishment than the mastery of the air. Their terms did not meet with acceptance, and after visiting Europe in 1907 they returned to America, there to resume their work with a more up-to-date machine.

Meantime much progress had been made in Europe. Fired with the success of the Wrights M. Archdeacon, a French aeronaut, built an aeroplane, in 1906, on practically similar lines, but was unable to attain any satisfactory result. Santos Dumont also attempted to emulate them, but after many failures and narrow escapes he had to rest content with a flight of about two hundred yards. On September 13th, 1906, he made the first officially recorded flight. Ellehammer, a Danish aeronaut, made a free flight on September 9th, 1906, but this is not officially certified.

In 1907 a new aeronaut appeared in France, and by a combination of skill, luck, perseverance, and courage he accomplished the first really successful aeroplane flights in Europe. Mr.

AN EARLY TYPE OF THE BLERIOT MONOPLANE

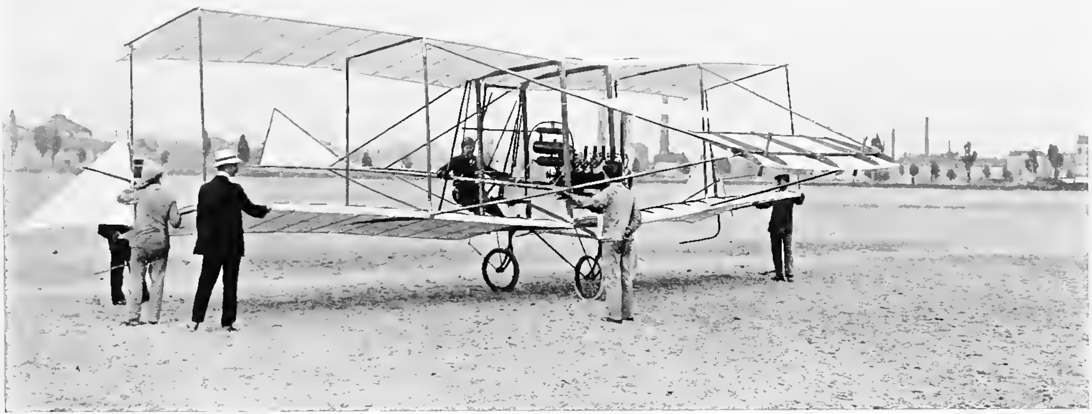
Henry Farman, after a brilliant career as a cyclist and a motorist, turned his attention to aeronautics a few years ago, and during August and September, 1907, he was able to make so many short flights that he decided to attempt a public trial in October, and on the 27th of that month, at Issy-les-Moulineaux, near Paris, he flew 771 metres, or nearly half a mile, on his Voisin machine. On January 13th, 1908, he won the Deutsch-Archdeacon prize of £2000 for making a circular flight of one kilometre, the first flight of such a distance to be officially recorded.

Since that time he has made wonderful progress, and a host of rivals have grown up in France, the best known of whom are Delagrange, Bleriot, Bertin, Gastambidé, and Esnault-Pelterie, whilst men like Ferber, who have worked for many years at aeronautics, have been inspired to new efforts. The types of machines are highly varied, some, like Bleriot's, being of the single-plane variety and approximating to the shape of a bird, others having two planes, and a few three planes. The monoplane showed the highest speed, but it was very difficult to manage.

Most success has attended Farman and Delagrange, and the rivalry between those two has been very keen. On March 22nd, 1908, Farman travelled over two kilometres, and on the same day M. Delagrange took a passenger on a short flight, the first authentic case on record of two people having been carried on a motor aeroplane.

On April 11th Delagrange made a new record by travelling close on five miles; by June he had advanced the distance to nine and three-eighth miles, and by July to eleven miles. Earlier in the summer sensational reports came from America of flights made by the Wright Brothers on their new machine, and distances up to seven miles were reported to have been flown ere an unfortunate mishap put a stop to experiments. In this machine two persons could be taken, and a new steering gear was employed.

The modern Wright aeroplane consists of a double framework forming two planes, one above the other. These are 41 feet long and 7 feet wide. In front there are a pair of similar horizontal planes, but considerably smaller and capable of being turned from the horizontal. These are for purposes of causing the aeroplane to rise or to fall, acting as a horizontal rudder. At the back there is a double plane somewhat similar, but placed vertically and capable of being moved horizontally. This acts as a vertical rudder to divert the aeroplane either to the right or to the left. When in flight the aeroplane can be caused to ascend by turning the horizontal



THE FERBER AEROPLANE

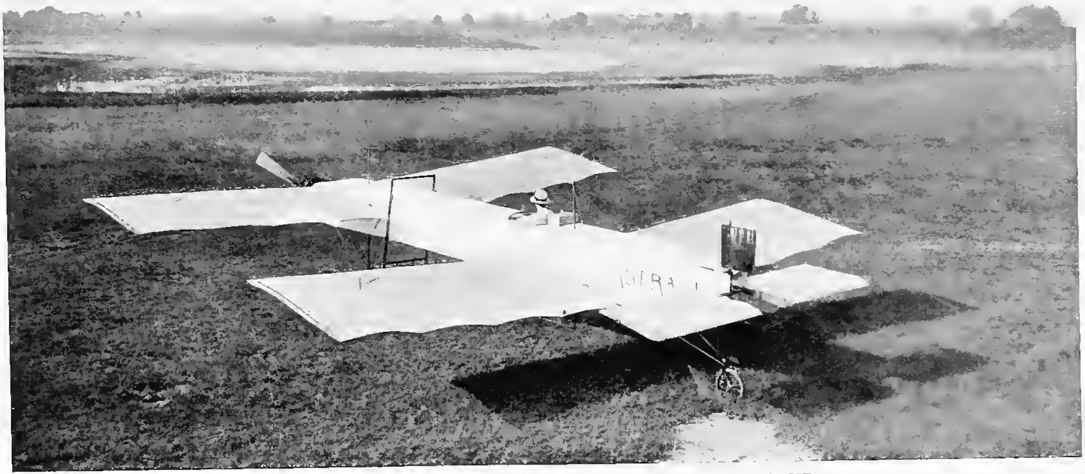
rudders slightly upwards, and similarly to descend by turning them slightly downwards, while for the purpose of steering the machine sideways the vertical rudder at the back is used. Between the two horizontal main planes the engine is mounted. This is water-cooled and of 25 h.p. It drives two wooden propellers, 2.8 metres in diameter, each propeller having two blades. They are driven direct from the engine crank shaft by chains, sprocket wheels being fitted on the hubs of the propellers. Both chains run through guide tubes.

At present, as I have said, the Wrights balance their machine through the ingenious and very responsive tilting device; but until an automatic stabilising device is arrived at the aeroplane will be defective in this respect, and much will depend on the skill of the aviator. Several years ago the application of the gyroscope was suggested for this purpose, but practical difficulties have so far prevented this being adopted.

On July 6th, 1908, Farman again gained the record by a flight of 20 mins. 19 secs., and this stood until September 6th, when Delagrange flew for 29 mins. 53 secs. Then came the most remarkable developments of this most remarkable year. The Wrights planned a masterly move, one brother, Wilbur, travelling to France, and the other, Orville, remaining in America, with the idea of carrying out almost simultaneous flights in both continents. Wilbur Wright made his first flight in France on August 8th, but remained in the air only 1 min. 45 secs. His engine gave much trouble, and during that month his best flight was one of 8 mins. 13 secs. He was thus far behind the French records, but his American-built engine was manifestly "unacclimatised" and was not running at all well. On September 3rd, however, he had improved matters, and flew 10 mins. 40 secs., and on the 15th of that month he remained in the air for 19 mins. 48 secs.

Orville Wright was meantime working at For Myers, Virginia, in presence of the American military authorities, and on September 9th he flew for 57 mins. 31 secs., thus eclipsing all previous records. Later on the same day he flew for 1 hour 3 mins., and also remained in the air for six minutes with a passenger, thus securing every record in aeroplane flight.

By September 16th Wilbur Wright, in France, had his machine in good trim, and he flew 39 mins. 18 secs., thus beating the French record. He also took up a passenger for a flight lasting 2 mins. 20 secs. The Wrights were almost at the height of their triumph when, on September 17th, an unfortunate accident befell Orville Wright at Fort Myers, causing the death of a promising young aeronaut, Lieutenant Selfridge,



THE "ASTRA," A NOVEL TYPE OF FRENCH MONOPLANE

and severe injuries to Wright. Lieutenant Selfridge had gone up with Wright as a passenger, and the machine behaved very well until one of the propellers fouled the stays of the rudder, and the vessel plunged downwards. There was not space enough for it to right itself, and it struck the ground with terrific force, wrecking the machine and killing poor Selfridge. He was the fifth victim of flying machines, and the first since motors had been adopted, the list being—Letour (1854), De Groof (1854), Lilienthal (1896), Pilcher (1899), Selfridge (1908).

Wilbur Wright made no flight for some days in consequence of the distressing news, but on September 21st, to reassure his supporters, he established a new record, flying for 1 hour 31 mins. 25 secs., and travelling a distance of over fifty-two miles. Since then he has made record after record. In the additional chapters at the end I trace the later progress in aviation.

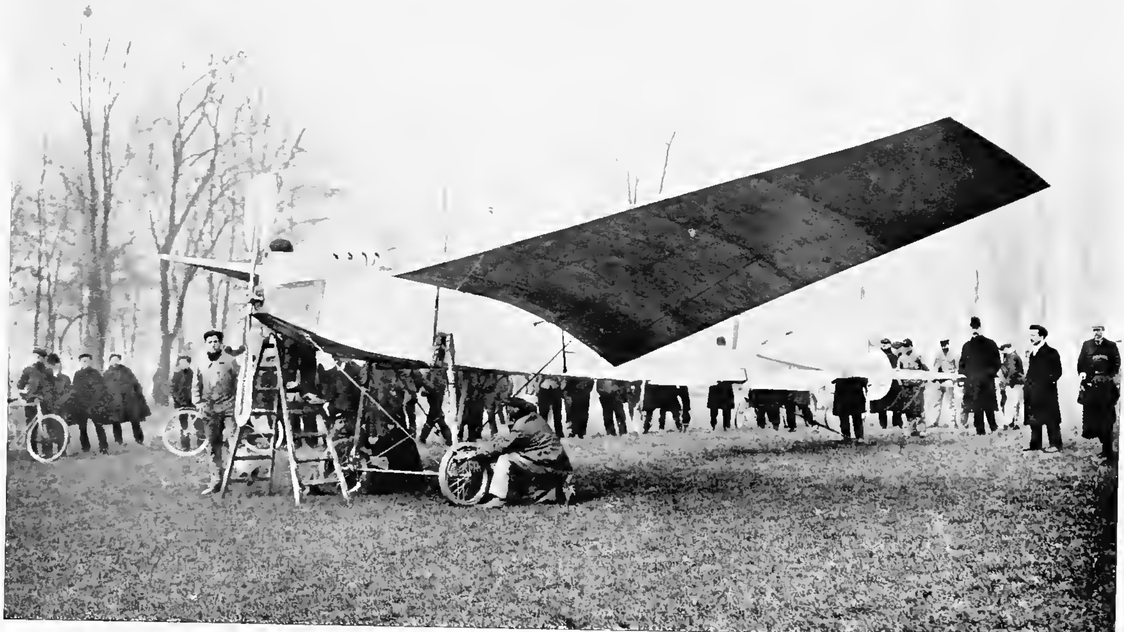
The appended table shows the most important of the fully authenticated records, and illustrates in striking fashion the marvellous progress made during 1908, the time record increasing from 1 min. 28 secs. on January 13th to 1 hour 31 mins. 25⅘ secs. on September 21st, and the distance from 1093 yards to 56 miles. In many cases the distances cannot be given, and of those set down the majority are only approximations.

AEROPLANE RECORDS

				h.	m.	s.	Distance miles	Distance yds.	
1906	Sep.	13	Santos Dumont .	—	—	—	—	12	(a)
„	Nov.	12	„ „ . .	—	—	21⅕	—	230	
1907	Oct.	26	Henry Farman . .	—	—	52⅗	—	820	
1908	Jan.	13	„ „ . .	—	1	28	—	1093	
„	Mar.	21	„ „ . .	—	3	31	1	430	
„	Apr.	11	Leon Delagrange .	—	6	30	2	769	
„	May	30	„ „ .	—	15	26⅘	7	1641	
„	June	22	„ „ .	—	16	30	—	—	
„	July	6	Henry Farman .	—	20	19⅗	—	—	
„	Sept.	6	Leon Delagrange .	—	29	53⅘	14	1402	
„	„	9	Orville Wright .	—	57	31	—	—	
„	„	9	„ „ .	1	3	15	—	—	
„	„	9	Orville Wright and F. P. Lahm .	—	6	—	3	1684	
„	„	12	Orville Wright .	1	14	20	45	—	
„	„	16	Wilbur Wright .	—	39	18	—	—	
„	„	16	Wilbur Wright and E. Zens . .	—	2	20	—	—	
„	„	21	Wilbur Wright . .	1	31	25⅘	56	—	
„	„	28	Wilbur Wright and M. Tissandier .	—	11	35	—	—	
„	„	29	Henry Farman .	—	42	—	24	800	
„	Oct.	2	„ „ .	—	44	32	25	—	
„	„	3	Wilbur Wright and passenger . .	—	55	31	36	—	
„	„	3	L. Bleriot . .	—	4	30	3	—	(b)
„	„	11	Wilbur Wright and passenger . .	1	9	—	50	—	
„	Dec.	31	Wilbur Wright . .	2	20	23	—	—	
1909	July	17	Curtiss . . .	—	52	—	—	—	
„	„	21	Orville Wright . .	1	29	12	—	—	(c)
„	„	22	Orville Wright and passenger . .	1	12	40	45	—	
„	„	25	L. Bleriot crossed English Channel from Calais to Dover, estimated distance 31 miles, in 40 mins.						
„	Aug.	26	H. Latham . .	2	13	—	96½	—	(d)
„	„	27	H. Farman . .	3	4	6	112	—	(e)

(a) The first officially recorded flight in Europe on a motor aeroplane.
(b) Monoplane record in 1908. (c) American record.
(d) Monoplane record. (e) World's record for all flying machines.

[See Appendix for other records.]



THE BIRD-LIKE GASTAMBIDE—MENGIN AEROPLANE
(An interesting example of the French monoplane type)

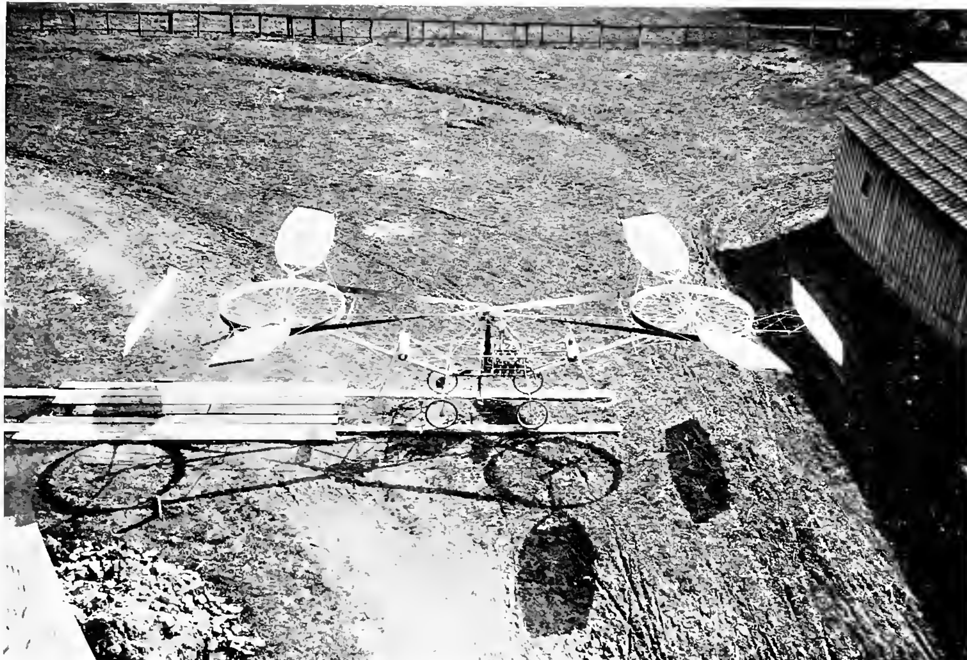
As a result of these trials of the Wright machines a syndicate has purchased the French rights in these machines, and it was believed that the French War Office and the Ministry of Marine would purchase a number of the machines for both military and naval work.

At this time considerable interest was aroused by the first details of a new machine designed by a young Russian, Prince Bolotoff. This vessel was of the tri-plane type, of bird-like shape, and mounted a very powerful engine of 100 h.p. Nothing, however, was effected by it during 1908, and the machine was not completed until August, 1909.

During all this time no successful aeroplane had been flown in the British Isles, and though many inventors were at work the majority contented themselves with trying small and generally useless models. The Army authorities were making preliminary trials of two machines, one designed by Mr. Cody and the other by Captain Dunn. The former after a short flight was wrecked, October 15th, 1908. The machine was rebuilt in 1909, and Mr. Cody succeeded in making several satisfactory flights. In August, 1909, he accomplished the first cross-country flight of eight miles, and in September a flight of thirty miles.

HELICOPTERES

So far we have considered machines in which horizontal planes are driven against the air by horizontal propellers. The idea has long existed of using propellers to give an upward motion also, and many preposterous arrangements have been suggested. The difficulty of applying the power is but one of the many peculiar obstacles which have stood in the way of this machine, and very few modern inventors give it any study. A Frenchman, M. Cornu, has worked industriously at the task, and he professes to be able to build a machine which can rise quickly and can travel horizontally at a fast or a slow rate. He points out that a great defect in the aeroplane is that it must travel at high speed to maintain its position in the air, whereas the helicoptere, since it has vertical lifting screws, can keep aloft without horizontal motion. He also claims greater lifting force per horse-power, and asserts that a far less bulky apparatus need be employed. Many of his contentions are quite just, and it is by no means improbable that eventually the helicoptere or vertical lifting device may not serve an important purpose, either singly or in conjunction with aeroplanes or dirigible balloons.



PLAN VIEW OF THE CORNU HELICOPTERE, OR VERTICAL LIFT AEROPLANE

CHAPTER II

BALLOONS

THE phenomenon of the rise of smoke and heated air must have early suggested to philosophers the possibility of utilising this power in raising bodies from the earth; and in the fifteenth and sixteenth centuries various schemes were formulated for constructing ships to sail upon the aerial sea. But the difficulty of making suitable envelopes to hold the heated air was but one of the many obstacles which prevented anything being achieved.

When, in 1776, Cavendish discovered hydrogen gas and pointed out that it was much lighter than air, attention was directed afresh to the problem of making balloons; but the first practical work was done by the Montgolfier Brothers, who from 1771 had been diligently studying aeronautics. They are said to have tested steam and even hydrogen, but had no success with either, as the steam quickly condensed, and the hydrogen leaked through the pores of the paper envelopes or balloons they employed. Heated air proved more suitable, and by lighting fires underneath great paper balloons they were able to fill these and cause them to ascend to considerable heights.

The French nation was soon stirred to great enthusiasm by the feats of the Montgolfiers; and by 1783 balloons were constructed on which daring individuals made ascents. To Professor Charles, a rival of the Montgolfiers, must be ascribed the credit of devising the prototype of the modern balloon. He employed rubber-coated silk for the gas envelope, and inflated this with hydrogen. To him also we owe the net which partly covers the balloon, and the wooden ring from which the car is suspended. In fact, very little difference exists between the balloons of to-day and those designed by Charles towards the end of the eighteenth century.

Very considerable improvement has been made in the constructional details, of course, and the modern vessels are larger, more reliable, and more easily controlled than the earlier types; but they still remain the non-steerable, non-propellable vessels known to our ancestors. Progress has come, however, in the control and management of balloons. Men have become emboldened enough to journey up to a thousand miles in them, to set out on gales travelling at terrific speeds, and to rise to heights where life can scarcely be maintained.

PRINT, PUBLISHED IN 1785, DEPICTING THE START OF BLANCHARD AND JEFFERIES' ADVENTUROUS CROSS CHANNEL TRIP IN THAT YEAR
(From Major Baden-Powell's collection)

Nowadays either coal gas or hydrogen is used for the inflation of the balloon, the advantages of the former being that it is cheaper and more readily procurable : its disadvantage is that it is heavier than hydrogen and thus gives the balloon less lifting power.

It will be convenient here to study a few general principles which apply to all balloons, and to make matters quite clear I will treat of all types of aerial vessels so as to compare their various attributes. Aerial machines or airships may be divided into two great classes, viz. (1) *aerostatic machines*, or those which derive buoyancy from the use of gases lighter than air, (2) *aerodynamic machines*, or those heavier than air, which rise through mechanical means.

Aerostatic type (lighter than air)	Balloons, Dirigible balloons.
Aerodynamic type (heavier than air)	Aeroplanes, Helicopteres, and flying machines generally.

There is properly a third type, viz. combined aeroplane and dirigible balloon, but for the present we may include it in the aerostatic type. Eventually a more exact and detailed method of classification will have to be adopted, for many of the dirigible balloons and combined machines will not properly belong to the "lighter than air" type.

With the flying machines I have already dealt, but the general principles governing the balloon have yet to be touched upon. The action of the balloon is based upon the law of physics which proves that every body completely immersed in a fluid displaces a volume of the fluid equal to its volume, and is acted upon by an upward force proportionate to the *weight* of the fluid displaced. The law applies to gases as well as to liquids, and its application to balloons is obvious. We must first clearly distinguish between volume and weight. We can compress a substance to reduce its volume, or expand it to increase its volume, but the weight will remain the same. The greater the volume of a substance the more air or liquid it will displace if immersed in them, and the greater will be its buoyancy.

If we filled a balloon envelope with iron, for instance, it would sink to the ground, because the weight of the volume of air displaced by the balloon is less than the iron-filled balloon, and therefore cannot support it. But if we filled the balloon to the same size or volume with hydrogen gas the balloon would float, because in this case the weight of the displaced air is heavier than the weight of the hydrogen-filled balloon. The greater the difference between the *weight* of the balloon and the weight of the displaced air, the greater buoyancy will it have; in other words, the lighter the balloon the more lifting power it will possess for the same volume.

Comparing the weight of a cubic foot of air, coal gas, and hydrogen at the same temperature and pressure, we get these round figures :—

Air .	. 0·080 lbs. per cubic ft., or 200 cubic ft.	=	16 lbs.
Coal gas .	0·040 lbs. ,, ,, ,, ,,	=	8 lbs.
Hydrogen	0·0057 lbs. ,, ,, ,, ,,	=	$1\frac{1}{10}$ lbs.

Theoretically we can take it that 1000 cubic feet of pure hydrogen will lift 80 lbs., and a 1000 cubic feet of coal gas will lift 40 lbs. at sea-level. Thus we can calculate the lifting power of a balloon if we know the volume of the gas envelope, the nature and density of the gas used, and the total weight of the balloon and car. Suppose we have a balloon of 20,000 cubic feet capacity, and when empty weighing, complete with car, 500 lbs. When the balloon is filled with hydrogen it displaces its own volume of air, that is 20,000 cubic feet of air, weighing 1600 lbs. Now the weight of 20,000 cubic feet of hydrogen is only 110 lbs., thus we have :—

Weight of balloon and car	500 lbs.
Weight of hydrogen	110 lbs.
	610 lbs.
Weight of 20,000 cubic feet of air displaced by the balloon	1600 lbs.

Consequently we have an upward force or lift equivalent to 990 lbs., and the balloon will rise until the density of the air is such that the weight of 20,000 cubic feet of the displaced air will only amount to about 610 lbs., when a state of equilibrium will be attained. The atmosphere is estimated to be over one hundred miles high, and varies in density or weight according to height. Thus, at the surface of the earth a cubic foot of air is denser, or weighs more, than a similar volume at 1000 feet, and if we ascend higher the difference is greater. This fact determines in the main the height to which a balloon will rise. All other things being equal, a balloon will have greatest buoyancy, or lifting power, at the surface of the earth, since the air will be heaviest there, and can bear up a greater weight. Thus if we take a balloon to weigh 700 lbs., and the weight of the displaced air at the surface of the earth to be 1600 lbs., the vessel is said to have a lifting power of 900 lbs. At a height of 5000 feet the weight of the air would be considerably diminished, and thus the balloon would have less lifting power. In round figures the air decreases one-thirtieth in weight for every thousand feet we ascend.

Ultimately a stage would be reached in which the balloon would remain in equilibrium, that is it would have no more lifting power, since the weight of the displaced air would equal the weight of the balloon and the gas in it. Other factors help to limit the height attainable, notably the decrease in temperature as the altitude increases.

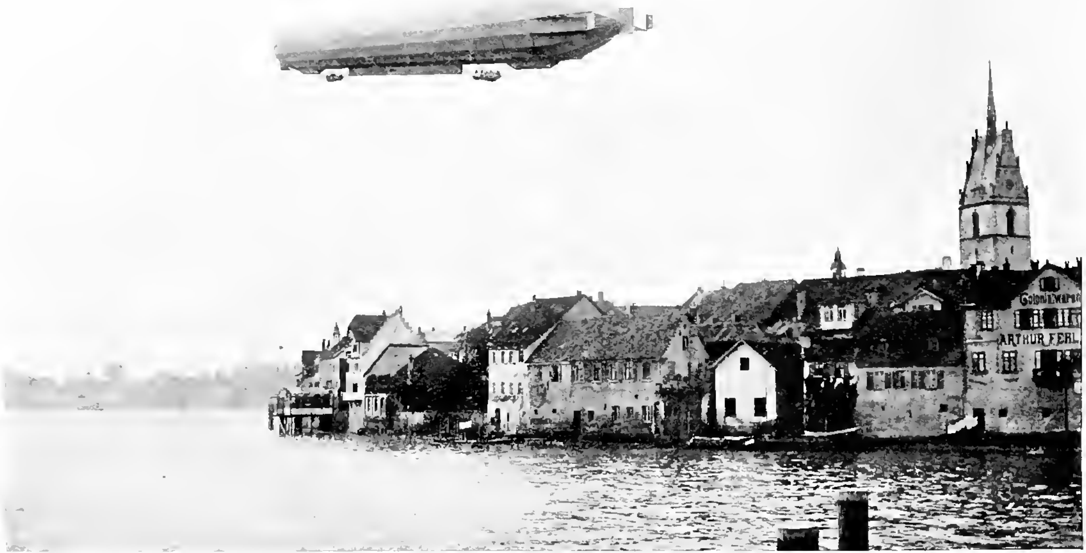
The effect of this fall in temperature is to decrease the volume of the hydrogen in the balloon, and thus it will displace a smaller volume of air. On the other hand, the higher a balloon rises the less powerful is the air pressure upon it, and thus, the more the gas will expand, and the more air will it displace. But as the balloon envelope cannot expand beyond a certain degree, some of the gas must be automatically allowed to escape or the balloon will burst.

Furthermore, the extraordinary diffusive powers of such gases as hydrogen and coal gas must be taken into account. The lighter the gas the more quickly as a rule does it diffuse, and hydrogen can diffuse or leak through every substance yet devised for gas envelopes.

All these factors will serve to show how varied are the problems the aeronaut has to contend with. Some influences tend to send the balloon higher, and these he can check by opening a valve and letting some gas escape. Other influences tend to prevent his rising any higher, and to overcome this he lessens the weight of the balloon by throwing away ballast, this being stored in the car of the balloon in the shape of bags of sand.

The skilful balloonist will husband his resources, since if he loses too much gas he will come down too low, and if he casts away all his ballast he can have no reserve lifting power.

Various instruments are employed to determine altitude, to show whether the balloon is rising or falling, to determine pressure, meteorological conditions, etc., and all these have helped to make ballooning a scientific sport as fascinating as it is exciting. But from a practical and a military point of view, the limit of development has long since been reached.



THE ZEPPELIN AIRSHIP OVER FRIEDRICHSHAFEN

CHAPTER III

DIRIGIBLE BALLOONS

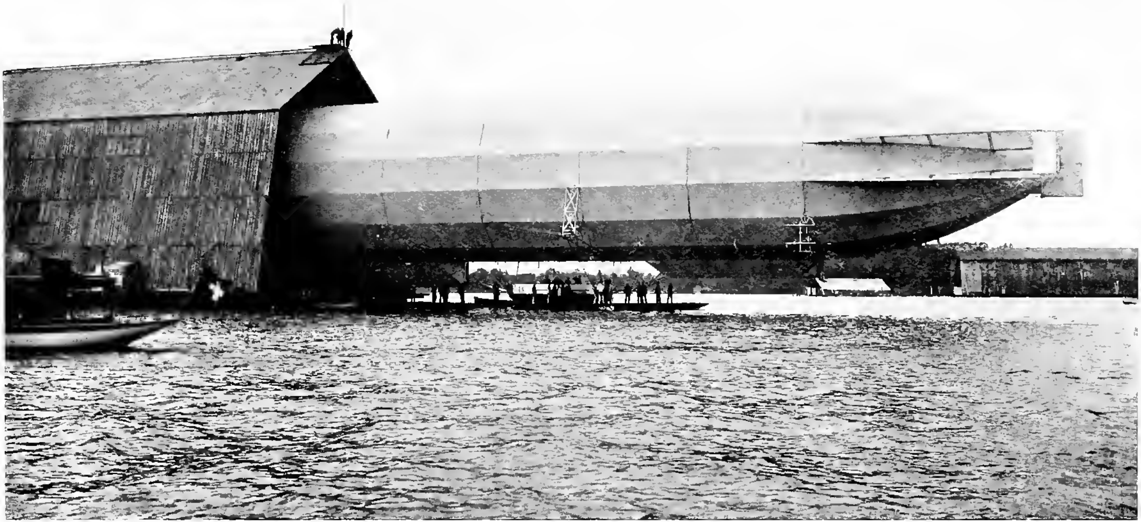
TO the adventurous or the scientific mind there must have always been something irritating in the difficulty of controlling the ordinary balloon according to one's wishes. Non-steerable and non-propellable as it is, the balloon is completely at the mercy of the wind, and even the most skilful aeronaut has little power in shaping a course.

But though attempts were made in the last century to adopt steam or electric power, the problem of making a dirigible balloon had to remain unsolved until the coming of the petrol motor. It may be truly said that the airship in any form was impossible until the internal combustion engine was perfected, and came to be the light, simple, compact and efficient power producer that it is to-day. The motor-car has thus led the way for the airship, and we may expect the most successful aeronauts in the future to be possessed of no mean mechanical skill, in addition to the other attributes that are called for in navigating the air.

The mistaken idea of attaching sails to balloons led to variations in the shapes of the vessels, and the suggestion was obvious that a fishlike shape would be the most suitable. But while hopeless efforts were being made to produce dirigible balloons in the eighteenth century, a most remarkable invention was made by a distinguished Frenchman, General Meusnier, which had a great influence on all subsequent designs. He planned an egg-shaped balloon, of which the gas envelope was surrounded by another envelope into which air was pumped.

Meusnier was thus the originator of the balloonet, or air bladder, which is an important part of almost every modern airship. By his device air is used as ballast, in this wise : When the space between the two envelopes is filled with compressed air the weight of this air is added to the balloon, and thus its "lift" is decreased. The air pressure also compresses the gas envelope and reduces its volume, which further checks the rising power of the balloon. If, however, the aeronaut desires to rise, he pumps less air into the air space or balloonet. The weight of the air decreases, and the gas envelope expands as the air pressure on it diminishes. Thus the balloon rises.

With a vessel of this kind, fitted with oars worked by hand, various ascents were made



"ZEPPELIN IV" LEAVING HER FLOATING DOCK

about 1784, but owing to lack of suitable propelling power no success was attained. Nevertheless, Meusnier will always stand out as one of the grand names in aerial navigation.

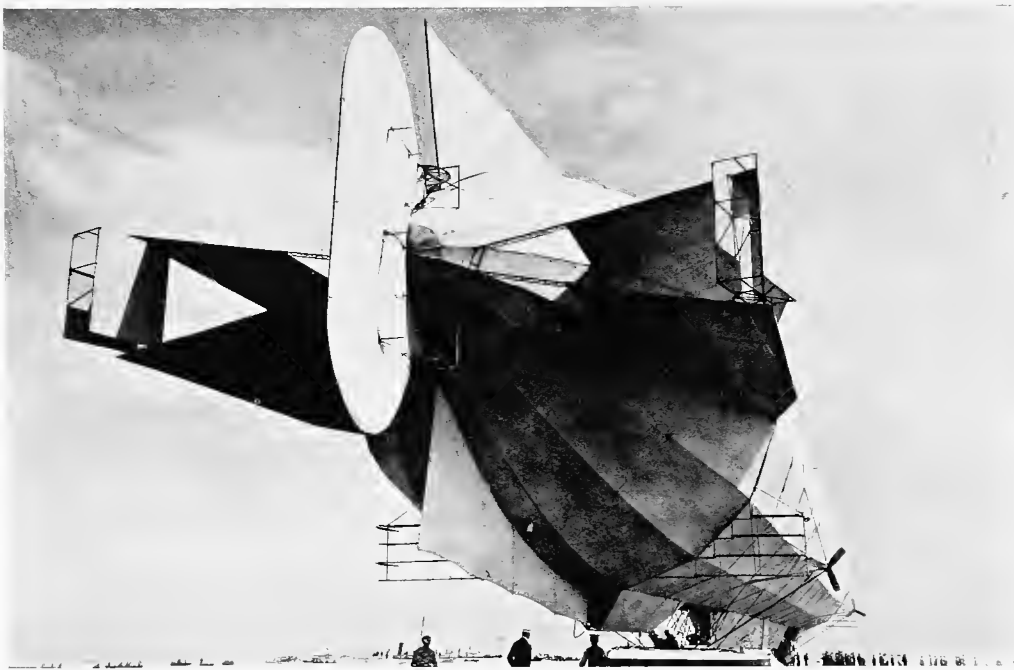
The use of balloons in the later stages of the Franco-Prussian War (1870–1) directed fresh attention to aerial navigation, and many daring voyages were made by French aeronauts in ordinary balloons. After the war efforts were made to develop dirigible balloons, but it soon was realised that the problem was unsolvable until a light and powerful motor was discovered. About 1850 the eminent French engineer, Henri Giffard, built a cigar-shaped balloon and fitted a 3 h.p. steam engine, driving a propeller. This is the first veritable power-driven dirigible, but though a speed of four or five miles an hour was attained, the vessel was not successful, and in 1855 was injured in an accident due to its instability. The crude and heavy engine, the dangers attendant upon the use of such a motor, and the generally faulty construction, rendered it impracticable. But as a prototype it was a truly wonderful production, and as worthy of veneration as George Stephenson's first railway engine.

The gas engine was applied as early as 1872 to a dirigible by Haenlein, and he made many valuable improvements, but complete success was denied him. He devised a far better shape of envelope than any of his predecessors, and his idea is still partly adopted in the graceful and speed-giving lines of the modern French vessels.

Another lapse, and we pass to the wonderful Renard and Krebs airship of 1884 with a fusiform envelope similar to Haenlein's, a rigidly attached car, an improved rudder, and a sliding balance weight. This might have been a very successful vessel had a good engine been attainable; but with only an electric motor worked from cells it had no chance of proving a lasting success. Nevertheless, on a short run it attained a speed of about six miles an hour, and it was probably the first dirigible balloon ever to make a practical trip.

Spasmodic efforts were made in the following years to produce an effective airship, but every attempt more fully confirmed the theory that success was unattainable until the requisite motor was forthcoming. In 1893, however, a remarkable inventor named David Schwartz designed an aluminium airship, and in the opinion of some experts he is the founder of the rigid type of vessel.

The tragedy of poor Schwartz is one of the most pitiful in the history of aeronautics. His first vessel collapsed during inflation, and for years he vainly strove to get funds to complete his work. Late in 1897 he had built another



THREE-QUARTER VIEW OF "ZEPPELIN IV," SHOWING RUDDER AND LIFTING PLANES

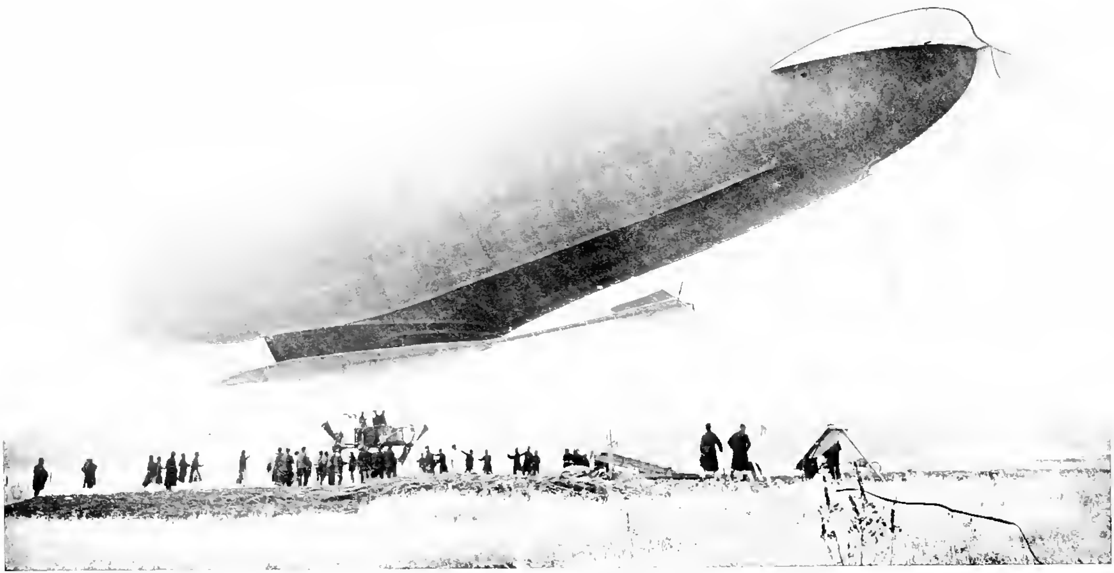
vessel to which a 12 h.p. petrol motor was fitted. He was anticipated by some months in being the first to use a petrol motor, as earlier in the same year a German aeronaut named Wolfert had built a cigar-shaped dirigible, to which he fitted a small motor. Whilst in the air the petrol caught fire and the vessel was blown up, Wolfert and a companion being killed.

Undeterred by this, Schwartz pursued his work, and he launched his aluminium ship in November, 1897, making an ascent in a very strong wind. In the struggle against the breeze, the crude propellers went out of order, and, after drifting for some time, the vessel came down. The impact of this solid body with the ground damaged the ship somewhat, and the subsequent buffeting on the earth, aided by a mob of disappointed spectators, completed the wreck. Poor Schwartz never recovered from this mishap, which blighted all his hopes, and he died suddenly some time after,—another of the vast army of unappreciated workers.

To Schwartz is largely attributed the credit for inventing the aluminium airship, and one day, perhaps, a modification of this system may triumph over all others. To him also can be awarded the distinction of being the first man to drive a rigid airship fitted with a petrol motor, and there is every probability that he had the idea of using such a motor before Wolfert took up the work.

In 1898 the famous German soldier, Count Zeppelin, had carried to a practical stage his long-cherished idea to build an airship of the rigid type. Like Schwartz he had been much impressed with the theory of using aluminium, but he employed it in a more scientific manner, by devising a strong skeleton framework. Within this he imprisoned the gas envelopes, and outside the aluminium frame he fitted another envelope. Thus there was an air space between the two envelopes, and the gas-bags were well protected from injury and from too sudden variations of temperature. He employed a number of independent gas-bags to limit the risk of losing all the gas if any bag were injured.

Other novel features of the Zeppelin airship were the aluminium keel and the sliding weight to preserve the balance of the vessel. Zeppelin planned his vessel on a grand scale, giving it a length of over three hundred feet. To lift the great weight due to the rigid frame a very large gas envelope was required, and it is one inherent defect of the rigid-type vessels that they must be built of enormous size in order to get the necessary buoyancy. Two cars were fitted, each provided with a petrol motor driving two four-



THE FRENCH MILITARY AIRSHIP "PATRIE"

bladed propellers, gear-driven. A reversing arrangement was also provided to simplify the manœuvring of this gigantic vessel. Planes were fitted to assist the vessel in rising; and, to minimise the risk of concussion when coming down, the experiments were made over the surface of Lake Constance.

Various trials were carried out between 1899 and 1902, but as might be expected in a vessel marking such a radical departure, there arose a number of defects, which could only be slowly corrected. For short distances a still-air speed of sixteen miles an hour was shown.

The work entailed enormous expenditure, and to the credit of the German people it must be recorded that in the dark days when success seemed almost impossible they lent their aid to Count Zeppelin and enabled him to go on with his labours. He was derided by many rival aeronauts, and his early failures were humorous themes to writers and experts in other countries, but he lived to enjoy his triumph.

Meantime in France a daring young Brazilian, Santos Dumont, had since the year 1899 experimented with small balloons to which he attached motors, and by 1901 he had evolved a trim little ship, cigar-shaped, and fitted with a light motor, which made many successful runs. In October, 1902, he achieved the remarkable feat of making a circular journey round the Eiffel Tower in Paris, and by this he won the Deutsch prize of 100,000 francs. Dumont's vessels were of the non-rigid type, and though he built fourteen in all up to 1906, and made improvements in each, he did not succeed in having his plans adopted by the military authorities. Of late years he devoted his attention to flying machines and combined aeroplanes and balloons, but without remarkable success. Nevertheless, to his pluck and daring we must attribute a share of the rapid development which took place in dirigible balloon construction early in this century.

The year 1902 was disastrous for the progress of aeronautics, as two vessels were lost with their crews through accidents which taught salutary lessons. Severo's airship burst when at a great height over Paris, and he and his mechanic were killed. It is supposed that the motors were not properly protected, and that the petrol took fire and exploded the gas envelope. Later in the same year Baron Bradsky made a trial trip of another airship near Paris, but when moving from one part of the vessel to another he placed too much strain on the supporting wires, and the framework broke away from the vessel, Bradsky and his companion being killed by the fall. This vessel was of the non-rigid type in which the car

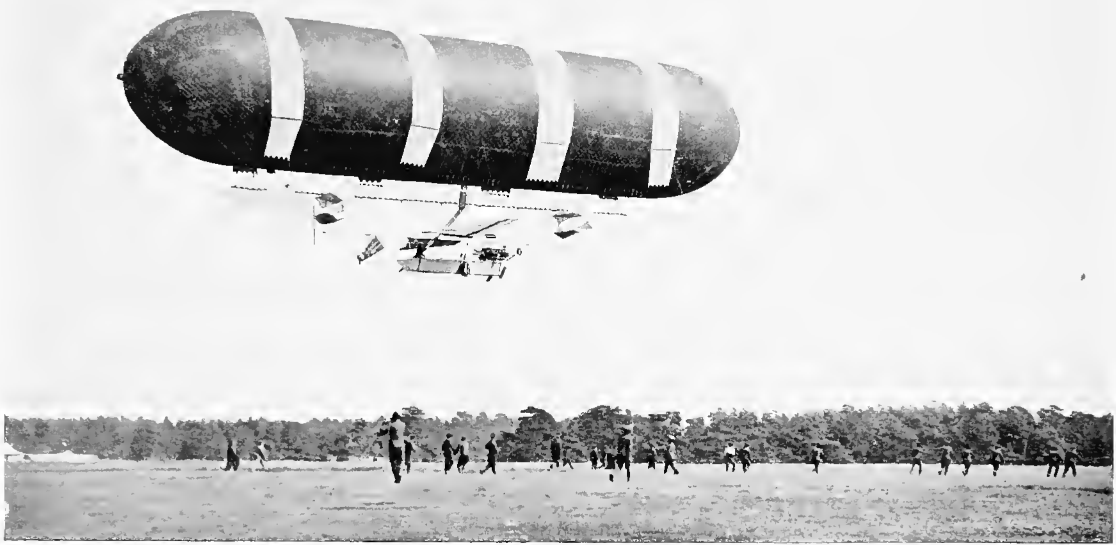
THE "VILLE DE PARIS" LEAVING HARBOUR
(Note the cruciform stability bags at the stern)

is slung from the balloon, and the accident showed an inherent defect in the type, though it still has some supporters.

But black though 1902 was, it gave France the first of her future aerial fleet, thanks to the devotion of the Lebaudy brothers. They entrusted the work to MM. Julliot and Surcouf, the one an engineer, the other an aeronaut, and between them was evolved the most remarkable type of airship yet built in France. The first Lebaudy airship was deep in the centre section and pointed at both ends. It was secured to a metallic keel made up of tubing, this keel giving stability and strength to the whole structure.

Here we have the first example of the semi-rigid type of construction, a type which has been proved so successful. The bending and buckling strains are taken off the gas envelope, and the whole structure is given admirable stability. Suspended rigidly from the keel was the car, on which a 35 h.p. petrol motor was mounted, driving two double-bladed screws. The motor, though far from perfect, was suitable for the work, and I can fix the year 1902 as the time from which the practicable airship dates. It may be called the Year One in aerial navigation.

The Lebaudy vessel made close on fifty trips between October, 1902, and November, 1903, her longest run being sixty-two miles in $2\frac{3}{4}$ hours, average speed twenty-two miles an hour. She was wrecked in November, 1903, through colliding with a tree when landing during a high wind. Satisfied with the design and encouraged by the French military authorities, the Lebaudys built a second vessel by 1904, which was longer than the first ship and had a greater gas volume. Various planes were added to increase the stability. In the following year (1905) the French Minister of War carried out various tests ere adopting the vessel, and after numerous short flights a voyage in three stages was planned from the factory at Moisson to Chalons, the total distance being 130 miles. The first day's run of fifty-nine miles was done in 2 hours 35 minutes, at an average speed of twenty-two miles an hour; the second day's run of ten and a half miles occupied 47 minutes; whilst the third day's run of sixty-one miles took 3 hours 21 minutes to accomplish, the wind being rather troublesome. It was a triumphant journey, but once again a cruel fate spoiled the performance, for in coming to earth the vessel was dashed into a tree and the envelope damaged. In fact, here attention may be drawn to the fact that almost all the airship disasters have occurred when landing, this being due to the circumstance that ships were being built before harbours were ready for them.



THE FIRST BRITISH MILITARY AIRSHIP

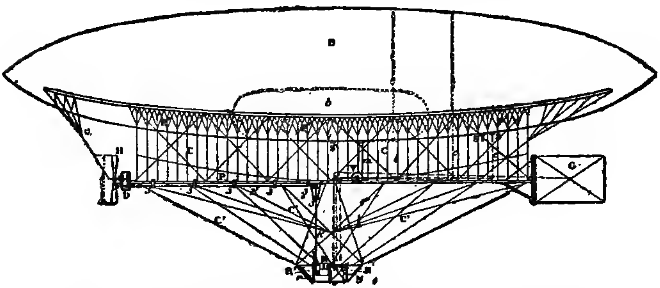
The Lebaudy was speedily repaired, however, and in October of 1905 the French Minister of War made a trip in the vessel after over seventy journeys had been accomplished, and the ship was definitely taken over by the French nation—the first military airship put into commission.

This vessel now became the parent type for the French aerial navy, and a definite programme was laid down. The little town of Moisson, where all the Lebaudy ships have been built, developed to an important aeronautical centre, and here, under military supervision, other vessels were laid down. The first launched was the *Patrie* in 1906, a swift, graceful vessel, which speeds up to twenty-five miles an hour. She made many remarkable trips, manœuvred with the troops, and finally, in the autumn of 1907, attempted the record journey from Paris to Verdun, from the capital to the frontier, where she was to take up her station. This distance of 150 miles was done with a strong cross wind blowing, and occupied 6 hours 45 minutes, the average speed being 22¼ miles per hour.

But once again misfortune came. The craft had no adequate harbour at Verdun. Some little time later (November, 1907) a storm burst, and ere the *Patrie* could be got to shelter she was wrenched from her moorings, dashed high in the air, and soared across France, England and

Wales, the Irish Sea, careered over part of Ireland, and then was carried out to her doom in the North Atlantic.

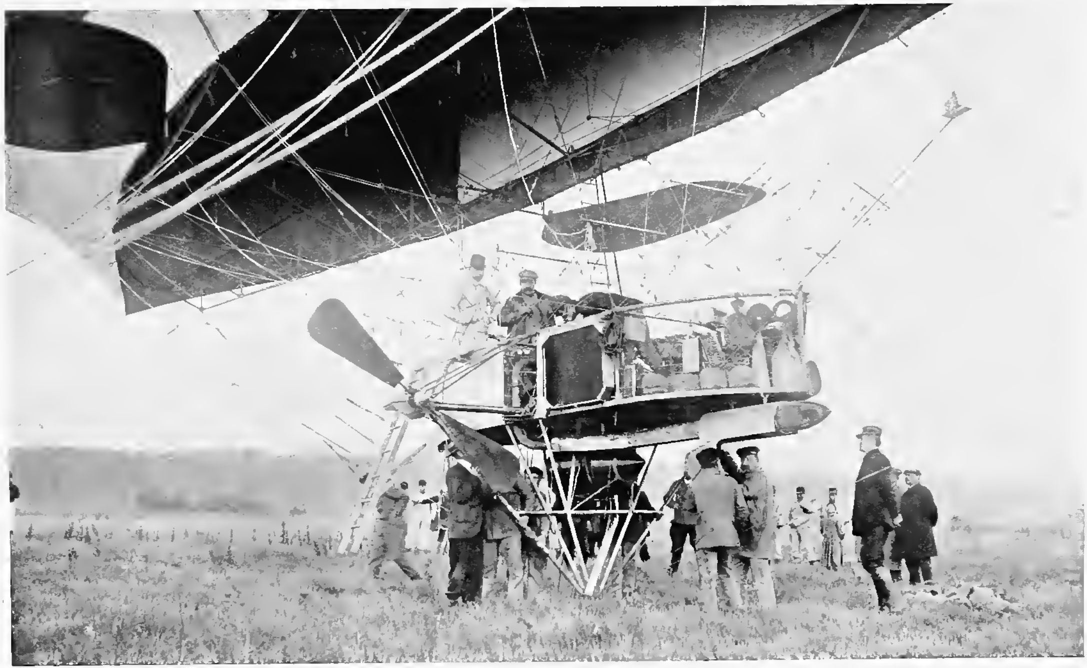
The loss cast all France into grief, but there were two devoted citizens who at the moment had good airships, and of these the *Ville de Paris* of M. Henri Deutsch de la Meurthe was accepted by the French military authorities, while



DIAGRAMMATIC SKETCH OF THE DE LA VAULX AIRSHIP

B, balloon; b, air balloonet for regulating altitude, etc.; C C, suspension cables; P, main frame; H, propeller; G, rudder; N, car; M, motor; J, propeller shaft; V, fan by which air is pumped into balloonet.

their new ship *République* was building. M. Deutsch's vessel is one of the largest of the semi-rigid type yet built, and amongst its novel features are the cylindrical gas-bags at the stern, which increase the stability. Its best performance was accomplished in January, 1908, when it made a run of 147 miles in 7 hours 6 minutes, showing an average speed of twenty-one miles an hour. The



PREPARING FOR A TRIAL TRIP OF THE "REPUBLIQUE"

(The propellers are gear driven, and deliver a strong current of air against the engine's water cooler, which may be seen at the side of the car. The whole structure rests on an inverted conical base)

other vessel offered to the French Government was Count de la Vaulx's airship, an interesting vessel of which I append a diagram.

Reverting now to Germany, we find that in 1905 Count Zeppelin had completed his second vessel which embodied many improvements. It was tested early in 1906 and showed high speed. Several defects manifested themselves, however, and ere they could be remedied the vessel was wrecked by a storm. In the same year Major Parseval, another famous German aeronaut, built his first non-rigid vessel, and this though crude in many respects showed much promise.

In 1907 England, after a great show of secrecy, launched her first airship, a blunt-nosed, sausage-shaped, non-rigid vessel, very crude in its details, but representing an amount of patient work under disheartening circumstances which merits admiration. The gas-bag was many years old, solidly built in the British way from gold-beaters' skin, but quite antiquated by the time it was launched. The mechanical equipment was open to improvement also, and soon led to trouble. The vessel had insufficient power or speed, and in October, 1907, after a few fairly successful circular trips, it was prematurely taken on a straight-away run from Aldershot to London on a favouring breeze, which enabled it to run about eight miles an hour. The inevitable happened when the return journey had to be made. The ship could make no headway against the breeze, and it was forced to descend at the Crystal Palace. There it lay for days waiting for a calm, or a friendly wind. Its top hamper became sodden, the wind remained obstinate and gradually grew in strength, and finally, to prevent disaster during a strong wind, the vessel had to be ripped up, deflated, and carted back to Aldershot.

In the same year Zeppelin on his new airship circled for ten hours over Lake Constance, and covered two hundred miles at an average speed of twenty miles an hour, thus showing the enormous distance he was ahead of England in airship design. This vessel was soon to be followed by another and yet more powerful one. By June, 1908, the new ship *Zeppelin IV*, was ready, and this marked the type which the famous aeronaut had built to qualify for the German Government's test. On his own suggestion, it should be capable of travelling for twenty-four hours, of making a safe descent on land or water, and of fulfilling many other secret requirements, and if satisfactory would be taken over by the nation for £100,000.

With some sixteen passengers on board, the new ship set out from its harbour at Friedrichshafen on June 13th, and journeyed over the Alps to Lucerne. Steering in amongst the mountains,

THE "GROSS" (UPPER) AND "PARSEVAL" (LOWER) AIRSHIPS, TWO OTHER TYPES OF GERMAN MILITARY VESSELS

it encountered eddies and cross currents, and ran through a hail-storm. Lucerne was safely reached, and the return journey was made in triumph. For twelve hours the vessel had remained in the air, and during that time had travelled 270 miles at an average speed of twenty-two miles an hour. This voyage beat all existing records, and in itself proved the feasibility of the airship.

Encouraged by the trial trip, Count Zeppelin made two attempts on the twenty-four hours record in July, but exasperating (though minor) mishaps checked him at the outset, and the public, ever ready to be carried away by their ill-balanced judgment, became pessimistic as to the possibility of the feat being accomplished.

July, 1908, also saw the launch of the beautiful *République*, and during that month she gave many proofs of her speed, reliability, and handiness. The new French vessel is a superb piece of workmanship, can carry six to nine men comfortably, and has shown speeds up to thirty-five miles an hour.

Almost at the same time England launched her old ship in a new shape. The gas envelope had been made longer and more trim, though still not quite the best shape. A covering of silk was an improvement, and the disposition of the planes was better. The mechanical arrangements, however, were still defective. The car only took three people at most, a number of little use for military work. The propellers were worked by belts—quite the worst and most antiquated form of transmission possible for an airship. One of these belts broke in the trial trip, and the vessel came down helpless, and had to be towed home. The cooling arrangements for the engine were inadequate, and in many other details errors were observable. Later in the year the vessel, after a very brief career, was dismantled, and the plucky builders set out on their task anew. The experimental work all through has been starved for lack of funds, and under the circumstances better results were impossible. The British Treasury estimate for the total expenditure on military aeronautical work for 1908–9 was £13,750—*a lower expenditure than in any year since 1902.* As a single well-equipped dirigible costs about £20,000, the British Balloon Department could not turn out such a vessel when they were allowed only £13,750 for the working of the whole establishment in connection with ordinary balloons, etc. Fortunately public opinion in England stirred the Government to action later in the year.

July, 1908, was a memorable month in aeronautics, as both the French and German vessels were tested. The *République** (210 feet long; 80

* Totally wrecked, September, 1909.

THE GERMAN MILITARY AIRSHIP "PARSEVAL" LEAVING ITS SHED

h.p. motor) travelled from Moisson to Chalais-Meudon, and showed a speed of just thirty miles an hour. She was not as superior in speed to the *Patrie* as might have been hoped, but she had a range of action of 500 miles, as against 300 miles of the former vessel, could take a crew of nine men, and carry a total weight of 3000 lbs. *Zeppelin IV*, the German vessel, was 446 feet long (or more than double the *République*), had two Mercédès motors of 120 h.p. each, carried a crew of eighteen, and had a carrying power of 4600 lbs. Her estimated range of action was 800 miles. There were sixteen independent gas-bags within the aluminium envelope.

Two unfortunate attempts were made by Count Zeppelin to carry out his twenty-four hours' test in July, and in the first the journey had to be speedily abandoned owing to engine trouble. A few days later the second attempt was made, but the motor boat employed to tow the airship from its shed appears to have made an error in steering, and the huge craft, ere clear of the shed, was carried against it by a squall. Several panels of the envelope were torn, and the damage was considerable. Intense disappointment was caused all over South Germany at the mishap.

Repairs were quickly made, and early in August all was ready. This time Count Zeppelin resolved to announce no date beforehand for his trip, and, indeed, was determined to make some unofficial trials ere attempting the Government test. On August 4th, at 6.45 a.m., Zeppelin set out from Friedrichshafen on what was destined to prove the most eventful voyage yet recorded. Making splendid progress, Constance was passed at 7 a.m., Basle at 9.30, and Strasburg was reached almost at noon. The running was now slower, Mannheim not being passed until 2.50, and Darmstadt at 4.30. Almost at 6 p.m., or all but twelve hours after starting, a descent was made at Oppenheim, and we can well believe that many a weak point in the hard-worked machinery had then to be attended to. Nevertheless, the average speed for the 11¼ hours was just twenty-four miles an hour, a distance of 270 miles having been covered. Mayence, the turning-point, was reached at 11 p.m., but trouble came thick and fast to the overstrained machinery. The speed dropped to twelve miles an hour, and on Wednesday morning, after Stuttgart had been passed, a descent had to be made at the village of Echterdingen, about 8 a.m. Nearly nine hours had been taken to travel the ninety-five miles, and loss of buoyancy due to gas leakage added to the troubles.

Whilst the vessel lay at temporary moorings there a violent thunderstorm swept over the place, and a gale which had been in pursuit of the

THE WRECK OF "ZEPPELIN IV"
(This illustration gives a good idea of the aluminium girder work of the frame)

Zeppelin struck it. In the inevitable confusion the vessel was torn from its moorings, some gas caught fire and speedily ignited the gas envelopes. Some reports attribute the damage to lightning, but, on weighing up all the factors, I have come to the conclusion that the injury was caused through the vessel becoming charged with electricity whilst in the air, and on being blown to the ground by the gale it made contact and discharged the current, thus creating a spark which ignited either petrol or hydrogen. A metallic conducting cable thrown out to make contact with the earth might have averted the mishap, which was as rare as it was unfortunate. The ignorance of the ordinary newspaper reporters and their love of distorting matters led to all kinds of absurd statements being made. The real contributory cause was that when a compulsory stop had to be made the harbourage was not good—and Count Zeppelin and the German Government had yet to learn that contemporaneously with the building of airships they must build airship harbours. Could a well-equipped aerial harbour have been made at any time on that Wednesday morning the vessel would probably never have been lost.

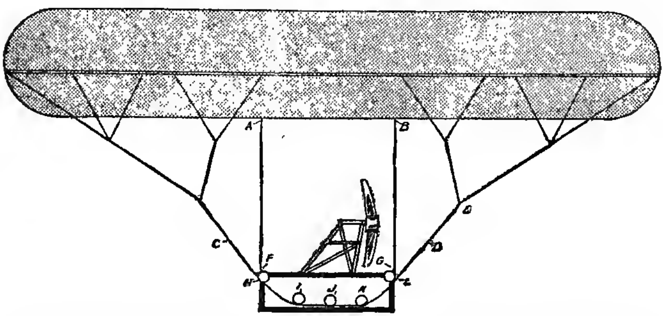
The disaster was a cruel blow to Count Zeppelin, and the venerable hero quite broke down at the sight of his wrecked vessel. But in his mind was doubtless the conviction that it was only a temporary check, such as is inevitable in every new movement. Battleships are lost from time to time, ripe though the experience is of builders and navigators, and in every form of locomotion there is latent risk. Fortunately for him the German nation once again betrayed its great anxiety to establish an aerial fleet, and ere his vessel had ceased burning he had the assurance from State and people that he would have funds to continue his work. Within twenty-four hours a Government grant of £25,000 had been made, and public subscriptions brought the sum to over £100,000. By October, 1908, the total sum had amounted to £300,000 and with this Count Zeppelin has formed an airship-building company. A site of over 300 acres was secured at Friedrichshafen, and here enormous works are being laid down. Wharves, docks, hydrogen factory, aluminium foundry and all the plant necessary for working on a large scale are being provided, so that Germany can turn out from eight to ten mammoth airships per annum.

During September the *Gross* dirigible attached to the German army established a new record by remaining aloft for over thirteen hours. The distance travelled was over 190 miles, and altitudes of 4000 feet were attained. Some days later another German dirigible, *Parseval II*, made a twelve hours' trip, and thus qualified for

THE SECOND BRITISH MILITARY AIRSHIP

purchase by the Government. Later in September both vessels were summoned to appear before the German Emperor on a day of high wind. Neither craft could make headway against the strong air currrent. The *Gross*, which is a semi-rigid vessel, returned safely to harbour, but the *Parseval*, which is non-rigid, was practically wrecked on its way thither. It was speedily rebuilt, however, and put in commission again.

Amongst the interesting features of the Parseval airship is the novel method of suspension.



PARSEVAL AIRSHIP AND ITS NOVEL METHOD OF SUSPENSION

A, B, main suspension cables carrying car and rollers H, L; C, D, cables working on rollers H, I, J, K, L.

From the central part of the envelope two main sets of cables A and B are hung, and these support the car. Another double set of cables runs obliquely from one end of the envelope to the other, passing amidships under the rollers H, L on the vertical cables, and also under the rollers I, J, K at the bottom of the car. By this means the car can oscillate longitudinally over the rollers (within certain limits) without disturbing the gas envelope, and similarly the envelope can be tilted without interfering with the car.

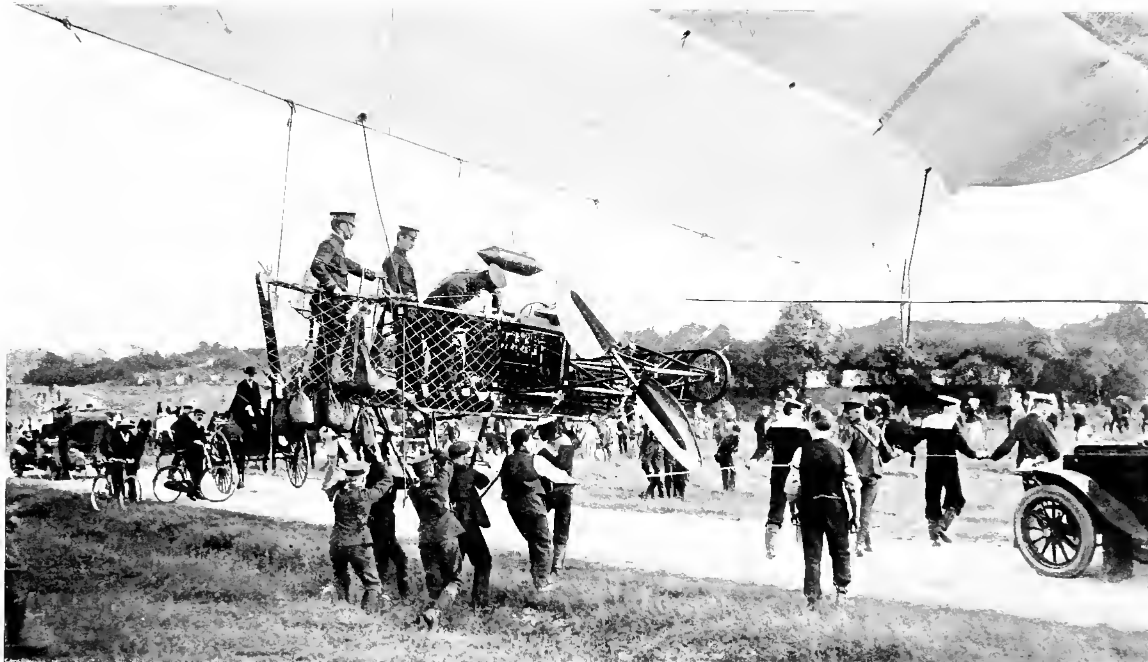
The central roller J is so contrived that it can be pressed down on the oblique cable and so keep it in any desired position, if it is desired to hold car and envelope rigid together.

This suspension is claimed to afford great rigidity whilst at the same time keeping the car at such a distance from the gas envelope that the danger of fire from the motor or other source affecting the envelope is sensibly reduced. The propeller can also be mounted between the envelope and the car in a good position. The general arrangement, it is claimed, gives all the advantages of the car being placed close to the envelope whilst the dangers of this form of construction are avoided.

TYPES OF DIRIGIBLES

The dirigible balloons so far dealt with differ mainly in the mounting of the gas envelope, and they have been classified thus :—

(A) *Rigid*, as the *Zeppelin*, which has an aluminium framework, within which are the gas envelopes in separate compartments.



THE CAR OF THE SECOND BRITISH MILITARY AIRSHIP

(B) *Semi-rigid*, as the French military airships, the gas envelope resting on a keel or bed of metallic tubing.

(C) *Non-rigid*, as the first British military airship, which was merely a stout gas bag from which the car was suspended. The later British vessel was more properly a semi-rigid.

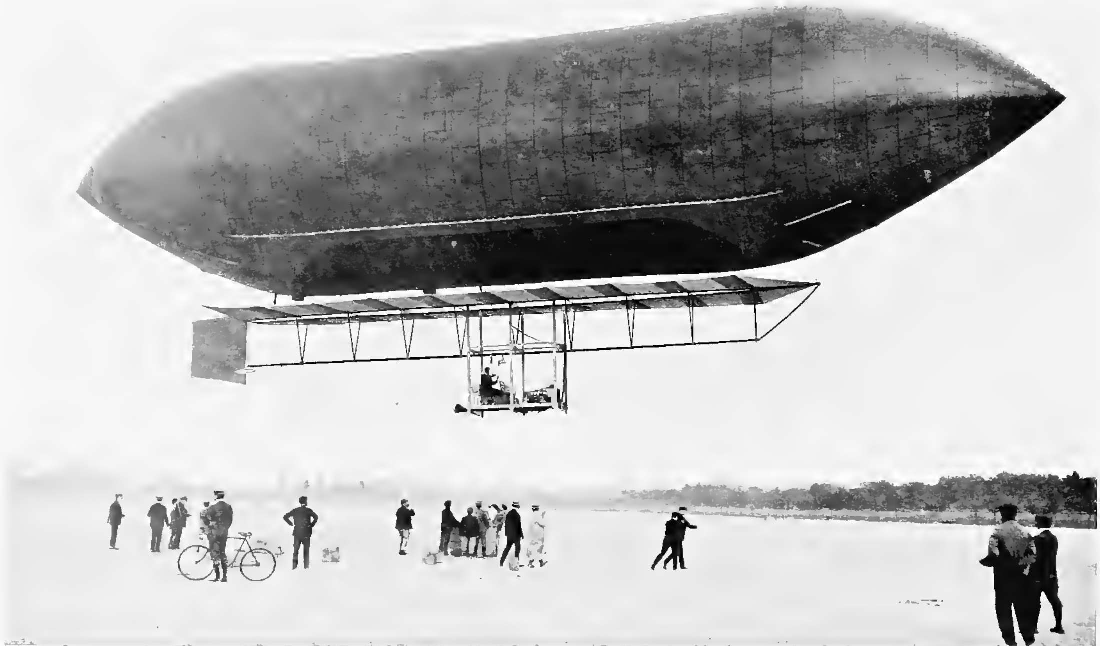
Other differences between the various types are made up of a mass of details, impossible to specify fully. The crude and unsuccessful vessels fail because their designers have not had the practical experience to discover or appreciate these details.

Two other types of airships have yet to be considered, the more remarkable being the Capazza vessel, which was to have been built in 1908. The gas envelope is shaped somewhat in the manner of an oyster-shell, and the edges are joined by a flexible membrane. Every other airship has its gas envelope expanded by the pressure of the gas, but the Capazza oyster-shell can be expanded mechanically, just as a concertina is opened. Hydrogen gas within the envelope prevents the pressure of the outer air being as great as if a vacuum were maintained within.

Capazza's theory is that, when it is required to ascend, the "oyster-shell" is mechanically expanded, and thus, as its volume increases, it gains in buoyancy, and so rises in the air. Height is regulated by the degree to which the "shell" is expanded. When horizontal speed is required in the air the shell is gradually closed, and then the machine acts as an aeroplane.

Should the engines fail, it is only necessary to expand the "shell" again to convert the vessel into a balloon. A descent is accomplished by stopping the engines, and gradually decreasing the volume of the "shell." As it grows smaller it displaces less air, and thus sinks to the ground. The whole idea is but one of the many fantastic and impracticable schemes evolved.

The combined balloon and aeroplane, in which an ordinary cigar-shaped gas envelope is wedded to some form of aeroplane, has been tested by Santos Dumont, and later by Malecot. The theoretical advantages have so far not been altogether attained, and as most dirigible balloons are now being fitted with lifting and stability planes the machines which are more aeroplane than dirigible balloon can claim few special advantages. Nevertheless the latest Malecot vessel has accomplished several satisfactory journeys, and seems to mark a decided improvement over the earlier types. Evolutions have been carried out at heights of about five hundred feet, and as many as four passengers carried.



THE MALECOT "COMBINED" AIRSHIP (DIRIGIBLE AND AEROPLANE)

CHAPTER IV

BALLOONS IN WARFARE

(1) MILITARY BALLOONING

THE application of the balloon to military purposes was first made by France, and the military experts of that nation were quick to realise the utility of a balloon in locating the position of an enemy and directing gun fire. Innumerable projects were considered for utilising the balloon in warfare, and the old prints of the eighteenth and nineteenth centuries show the amount of attention given to the subject. Practical difficulties, however, prevented most of the ideas from being carried out. The first authentic case of a balloon being employed in warfare was by the French at the battle of Fleurus, 1794.

It was somewhat extraordinary that very little use was made of balloons by France in the early stages of the Franco-Prussian War, and the matter perhaps throws a side light on the unreadiness of the French, more especially as over thirty years previous a balloon division had been created. All too late, when Paris was surrounded in 1870, balloons were employed, and by their means hundreds of persons and thousands of despatches were carried over the German lines. In all sixty-eight balloons were used during the siege, and quite an interesting monograph might be written on the adventures and achievements of these vessels.

After the war the matter received much attention, and the French were very desirous of procuring dirigible balloons, but of course at the time this was hopeless. Every effort was then made to render the balloon department as efficient as possible, and the work has never been allowed to slacken. France now possesses, apart from her dirigible balloons, perhaps the best-equipped and most highly trained balloon division of any army in the world.

Ballooning was introduced into the English Army in 1879, and many experiments were carried out. Very little use of balloons was made in the various small campaigns carried on at a great distance from England. In 1882, however, balloons and balloon stores were sent out to Egypt, but as Moedebeck, the German military expert, drily puts it, "they arrived too late to take a part in the military operations." During 1885 excellent work was done in Bechuanaland and the Soudan by the balloon detachments sent out. Very valuable practical lessons were learned from these experiments. In the Boer War (1900), according to Major Moedebeck, the balloon section sent out to Natal was "without material in Ladysmith during the siege, and remained there twenty-nine days in inactivity." Later on excellent service was done by the British balloon section in this war, and especially in directing artillery fire in the attack on Cronje's laager. A single dirigible balloon, however, or a few aeroplanes would, in all probability, have altered the whole campaign, and averted many disasters.

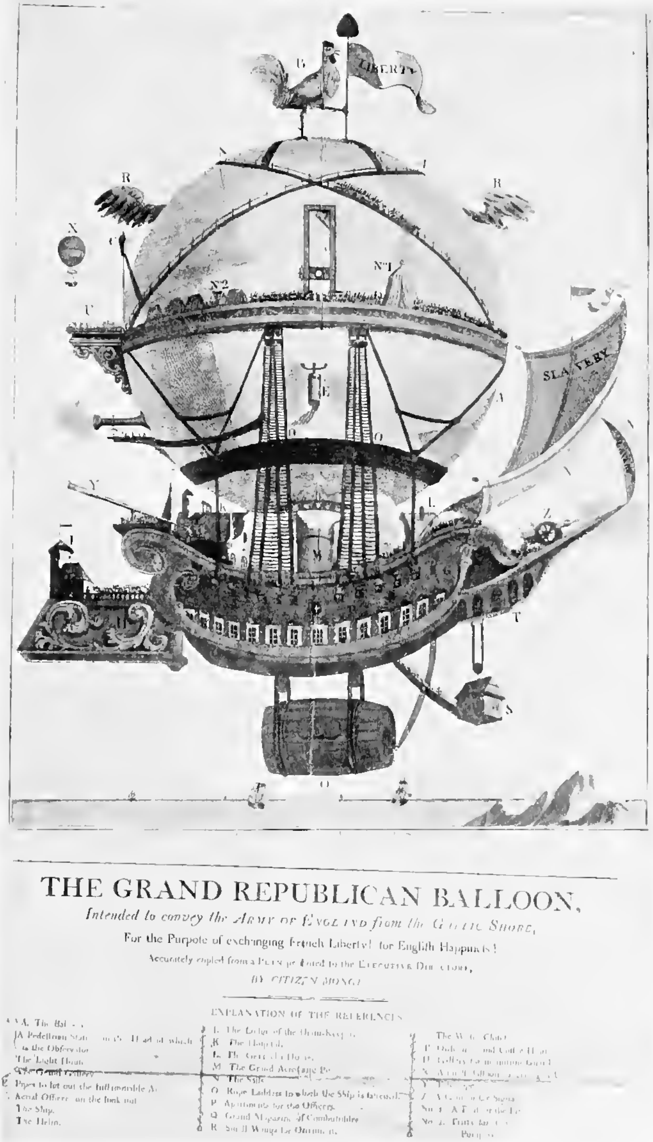
The present constitution of the English balloon section is no doubt hampered for want of funds, this being most felt in regard to experimental work with dirigible balloons; but the staff in their own particular work must be reckoned amongst the most efficient in the world. Handicapped in many ways, the administrators have nevertheless built up a splendid corps; and the British war balloons are, in their own limited sphere of activity, the most suitable for hard work yet constructed. The pity is that the higher authorities attach little importance to military ballooning, and profess to have no anxiety as to the future of the dirigible balloon. The officers of the balloon corps have thus to struggle against apathy and indifference. In effect a new department should be created for airship work.

As in this chapter I deal with the actual work done by the various military balloon corps of the world, I must make mention here of the man-raising kites which have been specialised in by the British balloon corps. Exhaustive experiments have been made by several experts, and remarkable results have been obtained. An observer can be raised to a considerable height; and the plan in time of war could be worked both by the military and navai authorities. These kites are of very limited use, however.

Two English balloons were purchased by the German authorities for use in the campaign of 1870, and were used in the early part of the campaign, though apparently not with much advantage. After the war, on the advice of Moltke, who seemed to have believed strongly in the future of the military airship, various experiments were made with balloons, but no corps was formed until many years later.

In 1884 the German Balloon Division was well established, and from that time they took part in various important manœuvres. In 1896 an interesting development was made by the introduction of the Parseval-Sigsfeld kite-balloon, and German experts hold that this is a far better instrument than the ordinary captive balloon.

The principle of this kite-balloon is ingenious, as the air balloonet devised by Meusnier is



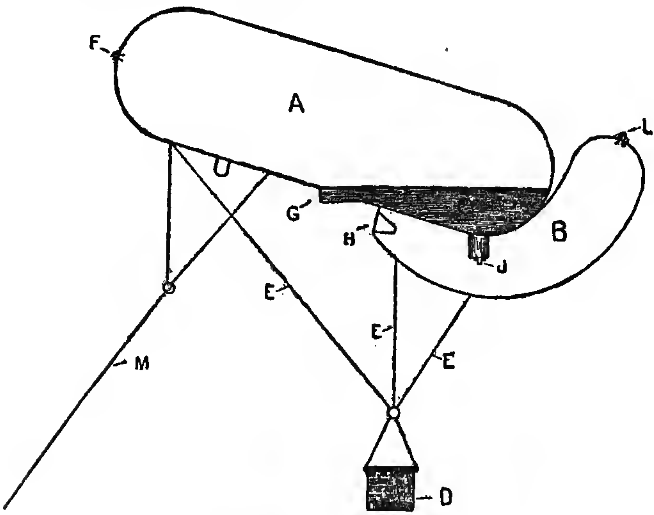
AN EIGHTEENTH CENTURY FANTASY IN ARMY TRANSPORT BY BALLOON

(From an old print dated 1798)

[Owing to the edge of the print having been damaged several of the reference letters are missing. They are: A, " The Balloon" ; B, " A Pedestrian statue," etc. ; C, " The Light House" ; D, " The Grand Galley" ; F, Aerial officers on the look out" ; G, " The Ship" ; H, " The Helm"]

(From Major Baden-Powell's collection)

applied. The kite-balloon consists of three parts, the gas-bag, the balloonet, and the air-bag rudder. The balloonet is curved round one end of the sausage-shaped balloon, and has one opening



THE GERMAN KITE-BALLOON

A, balloon; C, air chamber at base of balloon; G, free air inlet to C; J, valve opening into B; B, air-bag rudder; H, free air inlet to B; L, valve opening out of B; E E, cables holding car D; M, cable leading to ground.

facing the wind, and a smaller opening leading into the air-bag rudder which is fastened beneath it. The air-bag rudder has also two openings, one facing the wind, the other opening to the free air at the leeward side.

When the wind blows strongly, air enters both the balloonet and the gas-bag rudder by the large openings facing the wind: but as the balloon rises the gas in it expands and presses with greater force against the balloonet. This pressure drives most of the air from the balloonet into the gas-bag rudder and so into the open air. If the gas pressure becomes too great the gas-valve of the balloon itself is automatically opened.

This form of kite-balloon operates very well as a captive balloon, has remarkable steadiness in strong winds, and as it has been adopted by most of the Continental powers it would seem to be a very suitable form of instrument for the purposes for which it is designed. The vessel, however, does not find favour with the British experts, who prefer to use man-lifting kites and ordinary spherical balloons, though these seem inferior to the German method.

After the Civil War very little seems to have been done with balloons by the military authorities of the United States, and we find mention of few developments until kites were experimented with in 1897. During the Spanish-American War balloons were used, and although the corps was organised hurriedly it did some very useful work, especially over hilly country, in finding various important positions. At the conclusion of the war it was

THE GERMAN KITE-BALLOON

significant that a German kite-balloon was purchased.

Latterly, the sympathies of the American authorities have been more in the direction of flying machines and dirigible balloons, and the United States War Department has expended a large sum of money in helping the development of the heavier-than-air machine.

The Japanese made good use of the balloon in the war with Russia, and had the latter country employed them extensively much might have been accomplished.

BALLOON CORPS EQUIPMENT

From a review of the balloon corps of the great powers we can draw up a list of the principal instruments now in use irrespective of the airships proper, which I deal with separately :—

Free balloons.
Captive balloons.
Kite balloons.
Kites.

Free balloons.—The principal advantage of the free balloon is that it can make voyages away from its base, *wind permitting*, in order to gain information about the position of an enemy. In times of peace a good deal of secret service work is probably done by military or private balloons manned by spies drifting "by accident" over a neighbour's frontier at points where important fortifications exist. There is as yet no hard and fast rule for dealing with such "accidents," though it is high time an international balloon conference settled the matter.

However, in a few years' time each nation will no doubt have "police" in the form of dirigible balloons, and they will be able to give a friendly tow to a balloon which has crossed the frontier and is drifting towards an important strategic point in a suspicious manner.

Other purposes for which free balloons are usable are for carrying despatches over enemies' lines, but this occupation will soon be taken from them by the airship, as it was a task which the ordinary balloon was hardly fitted for. Various proposals have been made to use free balloons as fighting units, but they have all been impracticable.

Captive balloons.—Though anchored down at one spot, the captive balloon is perhaps of more real utility to a military force than the erratic free balloon. Placed in a suitable position, it affords an excellent view-point from which to watch an enemy's movements, whilst it also serves a very valuable purpose for the officers who direct operations or artillery fire.

As a signalling station both by day and night it is also of much value, especially since wireless telegraphy has become practicable; but even when this fails, the balloon still has many advantages as a manual signalling station, and with the aid of long-distance or telephoto lenses balloon photography has been made a most important branch of military aeronautics.

Altogether, the captive balloon—and especially the captive kite-balloon—is the most useful type of non-dirigible for military purposes, and it has now been brought to a high state of utility. Indeed, it has practically reached the limit of development.

Of the dirigible balloons I shall treat elsewhere, as their present and prospective advantages quite outweigh all those that can be derived from non-dirigibles of all types, and but for their existence this book need not be written.

Kites.—As regards kites, they have been experimented with mainly by England and America, and men-lifting machines have been devised.

The man-lifting kite has been most developed in the British Army and Navy, and very good results have been obtained on many occasions. Its main defect as compared with the kite-balloon is that it requires a strong wind to raise it. On the other hand, it is simple to operate, very cheap and compact, and can be easily transported in the field of operations, whereas any form of balloon is troublesome owing to the difficulty of providing gas cylinders. A system of defence by kites against airships has been elaborated by Major Baden-Powell, who would have explosive kites flown to a great height, and there be electrically discharged. The employment of rival airships is a far better plan.

(2) NAVAL BALLOONING

In naval work ballooning has never played an important part, and it requires little demonstration to show that the free balloon, unsteerable and unpropellable as it is, cannot be used with any degree of safety at sea or even in harbour. The ordinary balloon is not made with a floating basket, and if the wind carries it out to sea and the vessel sinks to the surface of the water it will soon founder. Floating balloons have frequently been made, but even so they cannot be safely used in naval work unless the wind is blowing towards the land, or unless an oversea course is possible in which land can be soon reached. These conditions are not prevalent or reliable enough to justify the extensive use of free balloons by ships, or even at naval stations.

The captive balloon is of more utility, and though as yet not extensively employed, it can fill many important duties, which in brief are:—

(1) General observation work.
(2) Signal station.
(3) Gun-fire direction station.
(4) Observation point for detecting submarine attack.

The ordinary captive balloon is difficult in the strong wind which usually prevails near the sea, but the German kite-balloon would be more satisfactory in this respect, though so far it has hardly been employed in naval work.

Through a mistaken administrative idea balloons have always been attached to the military forces, and comparatively few naval men have kept well in touch with development in this direction. In my opinion there should be both naval and military balloon sections, or one main section with men drawn both from the army and navy. In many respects the sailor is peculiarly suited for such work, and now that the dirigible balloon calls for mechanical and engineering skill, the sailor would perhaps in many cases prove a better man for the work than even a soldier taken from the ordinary balloon corps.

To sea powers such as England the matter is one of vital importance. Unless the Navy are familiar with the working and manœuvres of airships they may not be able to adequately cope with an attack of such a nature should it occur, and in a subsequent chapter I shall endeavour to show that airships may prove a menace to seaships under many circumstances. The British naval authorities have, I believe, already given serious attention to the matter of man-raising observation kites, and these should be quite workable from ships. Considerations of space will, I think, prevent any form of captive balloon being operated from a warship, and for this reason the kite should be preferable until the aeroplanes supersede it.

The French have acquired most data as regards the use of balloons to discover the movements of submarines, and as this work will in future fall most to the duty of airships, it can best be considered in the chapters wherein I treat of these vessels as applied to the naval service. But here it may be mentioned that from a balloon when travelling over water a most extraordinarily clear view can be obtained of objects well under the surface, and according to the French experiments the submarines were very easy to detect from balloons. With dirigibles they can be hunted almost as a sea-bird chases fish.

M. HENRI DEUTSCH DE LA MEURTHE, OWNER OF THE "VILLE DE PARIS," AND ONE OF THE GRAND PATRONS OF AERONAUTICS

CHAPTER V

FEASIBILITY OF AIRSHIPS

AT this time of day it might seem to the intelligent man that a chapter in proof of the applicability of the airship to warfare need not be written. But a little observation will show that many governments, many military and naval experts, and a great mass of the educated public are yet sceptical, not alone as to the present readiness of the airship for warlike purposes, but as to the possibility of aerial vessels ever proving useful in warfare. At most they promise to keep an eye upon future developments.

I must, therefore, bring up some of the evidence which has convinced aeronautical experts and students, and through them has in a few progressive countries eventually won adherents amongst important personages. To the illogical mind perhaps the strongest argument in favour of a movement would be the evidence that some rival, some highly intelligent person, or some powerful state, had adopted an idea, but I prefer to set forth the scientific reasons which exist apart from any such patronage.

The flight of birds has ever been proof in itself that aerial navigation was feasible by creatures such as man. Then with the discovery of light gases and their application to balloons, men-carrying machines actually made voyages in the air. True, these were mere drifting machines, but as such they have established many marvellous records as to the distance travelled and height and speed attained. I enumerate a few.

BALLOON RECORDS

DISTANCE—

1200 miles (Count de la Vaulx and Count Castillion de Saint-Victor), Paris to Kovostycheff, Russia, October, 1900.

HEIGHT—

34,000 feet—or over six miles—(Dr. Berson and Herr Suering), July, 1901.

37,000 feet (Glaisher). Some doubt is cast on this record by German scientists.

SPEED—

68 miles per hour (M. Faure), London to Paris, 1905.

125 miles per hour (Sigsfeld and Linke), Berlin to Antwerp.

Claims have been made of speeds up to 150 miles an hour. As a balloon travels at the speed of the wind, and as air currents are known to attain speeds of well over 150 miles an hour, these estimates are not fantastic, though few of the records have been carefully timed.

DURATION OF VOYAGE—

52 hours (Dr. Wegener), April, 1906.

THE "VILLE DE PARIS" IN FLIGHT

ON THE DECK OF THE "VILLE DE PARIS"

Now turning to steerable and power-propelled aerial vessels we find a still more convincing set of records, since they illustrate performances in which the aeronaut has been able to reach a certain objective, or has the power to reach this. In most cases the journeys have been made with favouring winds, or in the face of very light breezes, but as may be seen from the chapter on aerial navigation, the factor of wind power becomes less of an obstacle as the actual speed of the vessel increases.

DIRIGIBLE BALLOON RECORDS

DISTANCE—

160 miles, Paris to Verdun (French military airship *Patrie*), October, 1907.

200 miles, Lake Constance circuit (Count Zeppelin), October, 1907.

270 miles, Friedrichshafen to Lucerne and back (Count Zeppelin), July, 1908.

360 miles, Friedrichshafen to Mayence and back to Echterdingen (Count Zeppelin), August, 1908.

190 miles, Tegel to Magdeburg and back (Major Gross), September, 1908.

840 miles, Friedrichshafen to Bitterfeld and back (Goppingen), May, 1909.

480 miles, Friedrichshafen to Berlin, September, 1909.

The *Zeppelin* vessel on its trip to Lucerne ran for twelve hours, and had to battle with many cross winds and aerial disturbances when crossing the Alps. In point of distance it was beaten by the later but less successful run to Mayence.

SPEED—

30 miles an hour, *République* (France).
26 „ „ *Zeppelin* (Germany).
12 „ „ *Dirigible II* (England).

Accurate returns as to still-air speeds are not available, and these estimates are probably a little too high.

HEIGHT—

Few available records, but the French military airships are claimed to be able to rise 6000 feet. The *Patrie* on several occasions rose to over 4500 feet. *Zeppelin II* (of 1909) has risen to 5200 feet.

DURATION OF FLIGHT—

7 hours, *Ville de Paris*, January, 1908.
12 „ (Count Zeppelin), July, 1908.
19 „ „ August, 1908.
13 „ (Major Gross), September, 1908.
57 „ (Count Zeppelin), August, 1909.

The journeys of Count Zeppelin were not continuous, as several descents were made.

AEROPLANE RECORDS

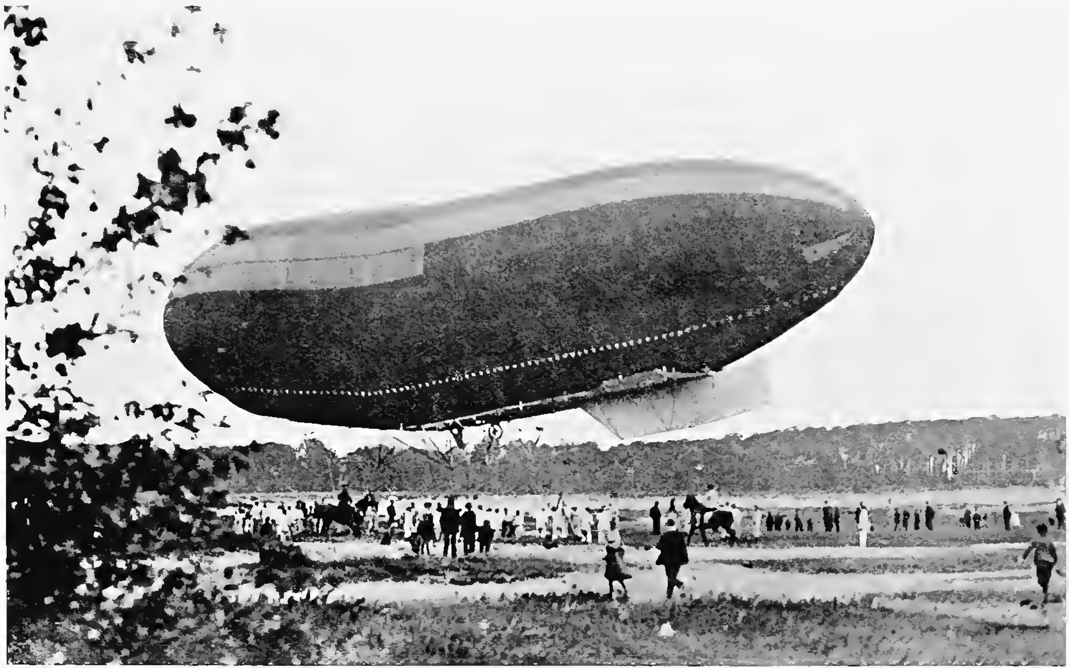
DISTANCE—

24⅕ miles, Dayton, Ohio (Wright Brothers), October, 1905.
56 miles, Auvours, France (Wilbur Wright), September, 1908.
112 miles, Rheims (Henry Farman), August, 1909.

SPEED—

40 miles an hour (M. Blériot).
46½ „ „ (Glenn Curtiss).
47 „ „ (Orville Wright).
55 „ „ (Santos Dumont).
75 „ „ (H. Latham, in a gale).

Many of these records are unofficial.



THE GROSS GERMAN MILITARY AIRSHIP

HEIGHT—

100 feet (Esnault-Pelterie), June, 1908.
150 feet (Wilbur Wright), September, 1908.
645 feet (Rougier), September, 1909.
1500 feet (Orville Wright), October, 1909.
1300 feet (Comte de Lambert), October, 1909.

Latham is estimated to have risen to 1000 feet on several occasions on his Antoinette monoplane. Orville Wright believes that heights up to 3000 or 5000 feet are possible.

DURATION OF FLIGHT—

38 minutes (Wright Brothers), October, 1905.
163 „ (Wilbur Wright), December, 1908.
184 „ (H. Farman), August, 1909.

From these returns we may deduce that the maximum attainments of dirigibles and aeroplanes up to the present can thus be summarised :—

	Distance.	Duration.	Speed.	Height attained.
	miles.	hours.	miles per hour.	feet.
Dirigible balloon .	840	57	30	5200
Aeroplane . .	112	3	47	1500

Eliminating the ordinary balloon as of accepted utility, since it is already employed in every first-class army, and dealing with the merits of the dirigible balloon, we can set them forth thus :—

Distance records are sufficient to guarantee an effective range of action.

There is every prospect of this range being immensely increased, as it mainly turns on the question of fuel supply and engine reliability.

Speed records already place the airship in the front rank of military and naval modes of locomotion.

Altitude records indicate that the vessels can rise to a height at which gun-fire is hardly effective.

The air is a new and untrammelled domain. It gives the aeronaut command of both land and sea.

It allows a "bee-line," that is, the most direct route, to almost any point on land or water.

The position of the airship affords unrivalled scope for observation and for signalling.

It can be used over land or sea.

It affords the only safe and reliable method of locating mines and submarines.

It also has unique facilities for attacking by night or day.

It cannot be adequately guarded against; observation by day is not dependable, and by night, even with the aid of searchlights, is quite untrustworthy.

An efficient airship can be made for about £15,000, and thus an aerial fleet can be built up cheaply and quickly once a successful parent vessel has been evolved.

I treat the matter more fully in subsequent chapters, but these few arguments, one would think, might have been sufficient to induce all the big powers to take up the matter seriously many years ago, since as far back as 1902 there was sufficient evidence that the airship was feasible, and that its development would be rapid. Yet there are many nations and war experts still unconvinced, and they have adopted the foolish policy of allowing other countries to acquire the lead.

As a matter of historical interest I set out in extenso a semi-official pronouncement which appeared in the *Daily Mail* of July 23rd, 1908. This I have every reason to believe the accuracy of, as showing the official attitude of England to airships at that time, and "for a long time." On that pronouncement the British military authorities will have to be judged, if in future years a national inquiry be made as to why in the year 1908 they did not take warning of what had been going on in France and Germany for years previous, and as to why in that year of grace England had no efficient training ship, and no trained crews.*

* Some months after the first edition of this book appeared, a marked change came over the attitude of the British Government towards aeronautics. The results are referred to elsewhere.

WAR AIRSHIPS

"NOTHING TO BE FEARED FOR A LONG TIME"

OFFICIAL VIEW

In the highest military circles in Great Britain it is accepted that so far airships are a failure.

The military authorities have had experts employed in watching the flights of the various airships and aeroplanes, and the impression is that for a long time to come there is nothing to be feared from them.

The Government has not stinted the necessary funds for experiments at Aldershot and elsewhere, but the Royal Engineers, on whom has devolved the task of finding at least a dirigible balloon, are contenting themselves with cautious experiments. From time to time reports are received of the performances of various airships and aeroplanes on the Continent, and in every case details of mechanism and construction have been available. The Army Council is therefore thoroughly aware of all that is taking place both on the Continent and in America in aerostatics.

Consultations have been held at the War Office with expert artillerists as to how airship attacks can be best met, and the plan of campaign, in which the principal feature will be the use of high-angle fire with high-explosive shells, has been evolved.

The military authorities point to the fact that nowhere has any machine designed for flight in the air proved effective. Our own airship, *Dirigible No. 1*, broke down under stress of weather. Count Zeppelin's airship, when it was put to a serious test, involving no less a sum than £100,000, promptly broke down. Mr. Farman's aeroplane was to have been tried in this country, but no place was found suitable for his experiments because of the presence of trees, telegraph wires, and so on. All this points to a lack of practical working in the various designs of which so much has been made in the Continental Press. When it is possible to cross the Channel, say, with a party of excursionists, and land at any fixed point the War Office may be prepared to regard recent experiments seriously.—*Daily Mail*, July 23rd, 1908.

The second paragraph of the report is rather amusing. Our "experts," it seems, have been watching the flights of foreign airships, and assert that nothing is to be feared from them. In the tests of the continental ships the "experts" must have seen very little, judging by the poor assistance they were able to give the builders of the British ships. Indeed, as we have no expert who has had any practical experience in building or working really successful airships, we have to rely on the opinion of theorists.

Still more amusing is the statement in the following paragraph that "in every case details of the mechanism and construction have been available." Why, then, were we not able to build an airship like the *Patrie* or the *Zeppelin?* Why at the date when that report appeared were we without a practical vessel, our engineers "contenting themselves with cautious experiments," whilst the Germans had made runs in the open up to 270 miles? Why were our two experimental vessels inferior to the French and German craft in well-nigh every essential? Does not all this disprove the statement that our Government knows all that is going on?

"The Army Council is thoroughly aware of all that is taking place both on the Continent and in America," says the report. If that is an official pronouncement, or if it voices the opinion of the British Army Council, it shows that our authorities desire to leave no loophole for themselves. They are prepared for failure, and long-continued failure on the part of airships.

The last paragraph is, I hope, an unofficial view, for it is quite erroneous in stating that "nowhere has any machine designed for flight in the air proved effective." The *Patrie* was successful, the *République* is successful, and the *Zeppelin* with its 12 and 19 hours' records was successful. The only real failure has been the British airship No. 1.

The concluding statement is delightful, if it is a semi-official view. Count Zeppelin's ship, three French ships, and a Wright aeroplane had then covered far greater distances than that involved in a cross-Channel journey. For a foreign military ship to undertake such a voyage would be a gross breach of international etiquette, and would in effect be quite contrary to the policy of its owners. If they embark on that voyage it will be for a very serious enterprise, and no one has any doubt but that if it occurred "the War Office would be prepared to regard recent experiments seriously"! But that would not help the country when foreign airships hovered over London or Portsmouth and threatened their destruction. It would then be too late in the day for England to think of establishing an aerial fleet.

The English Government holds the erroneous view that they can start building successful airships at any time, and they intimate that they will therefore wait until these vessels have been proved thoroughly effective. They forget that they have absolutely no past experience in such work, and thus lack the power and the means to carry it out quickly. France and Germany are spending hundreds of thousands of pounds, and have been making practical efforts for years. They have thus acquired a staff of men with unique and invaluable experience. Mere "cautious experiments" with an old balloon shut up in a shed will teach us nothing, and the stern fact stares us that we have let our great neighbours get over five years' start of us in acquiring that skill in building and operating vessels which is only to be gained in the same way that they have gained it.

It may be that luck will save English officialdom for some years from the consequences of their conservatism, but the fact cannot be got away from that whenever the need is forced upon us of building airships, we will be very far behind our rivals. Our "experts" have so far evolved two vessels which, despite all their observation of foreign ships, were vastly inferior in a number of vital respects. What guarantee have we that our future vessels will not be as far behind the times if the plucky little staff of our balloon corps is so handicapped by want of funds and official encouragement?

The arguments I have already advanced in favour of the airship for warlike purposes must be kept in parallel with the English official view for a few years to fully test the incorrectness of the latter. Meantime it may suit the policy of rival nations to alternately blow hot and cold, and let it finally appear that airships are of little real use in warfare. A few judicious "failures" would also produce the desired effect on the British mind.

So much for the state of affairs at the end of 1908. By 1909 it had been materially altered, for the former attitude of the British authorities had been made ridiculous.

CHAPTER VI

APPLICATIONS AND LIMITATIONS

HAVING enumerated the various types of aerial vessels now in use and their present or possible applications to military and naval work, we have now to take up the main theme of the book, and inquire into the methods of using such vessels in actual warfare, and the limitations which exist. We have no actual data to go upon, since the airship has scarcely been seriously considered by military writers, and no such engine has yet been used in war.

To the student this circumstance allows greater latitude of treatment, but there is the danger that he may be tempted to carry his enthusiasm to absurd lengths. Already many sensational works have brought much ridicule on the science of aeronautics. In the chapter on Aerial Navigation I have tried in a dispassionate way to mark out the limitations which affect the use of airships, but I have indicated how careful one must be not to set up too narrow limits, for as aerial navigation is but in its infancy we have yet to await many startling developments and revolutionary changes.

There are, however, certain fundamental facts which must be borne in mind, and especially when treating of the subject from the point of view necessary to take up in this book. Mere theories are given scant attention by the naval or military expert: he seeks for actualities, well knowing that a system must be thoroughly tested and quite practicable before it can be applied to the rough usage of war-time. The dirigible and the aeroplane have become actualities with such suddenness that there has hardly been time for them to be taken into serious consideration by these writers, and it is notable that nearly all the designers of successful airships have been amateurs outside the services, the famous ex-soldier Count Zeppelin being one of the few exceptions. So, too, it will fall to the lay writer first to deal with those new problems and theories which arise from a study of aerial navigation, and later on the service expert will, for the benefit of his country, take any practical hints he may from those, whilst rejecting the many extraneous and hypothetical matters which will be considered useless in a strictly technical work.

In a book such as mine, which I have designed to appeal to the intelligent public, I have taken a wider field of observation than the military or naval expert would be permitted, since he would by his very training make a more conservative estimate of things, and would be careful not to go outside the bounds of actuality. His work will, needless to say, be of more use to the services he writes for than a work such as mine; but as aeronautics develop so rapidly he runs the greater risk of having his limited views affected, and his conservative conclusions disturbed by new discoveries which may be made even while his book is in the press.

For these reasons I have tried to steer a medium course, giving full credit to every actuality, and here and there allowing myself to wander into speculations as to the future so as to provide for eventualities. Many conclusions based on these premises will doubtless prove to be wrong, but this is unavoidable in a subject of which so much is yet concealed from us. I have, however, avoided those absurd and sensational conclusions advanced by writers who have given unbridled play to their imaginations, and who have taken little trouble to study the problem, and are seemingly quite ignorant of the fundamental laws.

In this chapter it will be sufficient for me to touch on the applications of the airship to warfare, and develop the theme subsequently. If we accept the axiom that strategy is one of the most important factors in modern warfare, we must admit that the airship will revolutionise the fighting art, and may be used to such an extent as to make strategy impossible. Surprise attacks, feints, secret marches, concealed movements, and such-like operations will all lose their value against an enemy whose airships observe every movement and report it at once. All this will be in addition to the raiding and attacking work which they can also accomplish.

We can thus summarise the applications of airships to warfare :—

(*a*) To gain information in peace time respecting harbours, fortifications, etc.

(*b*) Patrols and frontier guards.

(*c*) For reconnaissance and photographic work.

(*d*) Despatch work.

(*e*) Checking an enemy's reconnaissance on land or sea.

(*f*) Signalling and wireless telegraph stations.

(*g*) Directing artillery fire and drawing enemy's fire.

(*h*) Destroying the enemy's aerial fleet.

(*i*) Attacking an enemy's base line, destroying stores, etc.

(*j*) Destroying railways and other communications.

(*k*) Raiding the capital of the enemy's country.

(*l*) Making night or surprise attacks on field forces, using explosives or poisonous gas-bombs.

A STRIKING PICTURE OF THE "REPUBLIQUE" IN FULL FLIGHT

(*m*) Raiding harbours and naval bases.
(*n*) Carrying out over-sea raids.
(*o*) Locating and capturing or destroying submarines.
(*p*) Locating mines.
(*q*) Following up a victory by land or sea and completing the rout.

Reverting now to those fundamental limitations which may be laid down, we must bear in mind that the gaseous sea called the atmosphere has sundry disadvantages as a medium of locomotion. If a body is to float in the air it must be of enormous bulk in proportion to its weight, and thus in every form of dirigible balloon we must provide huge ships if any useful burden is to be borne. With aeroplanes and heavier-than-air machines weight must also be kept very low in proportion to volume, and the available useful load that can be taken is very small. We may put down the factors thus:—

(1) The aerial sea is unsuitable for the carriage of heavy loads, and is quite unfitted for the transport of the large bodies of men and stores requisite in modern warfare.

(2) The mobility of the air renders it subject to many and violent fluctuations, and these disturb or prevent aerial navigation.

(3) The duration of time during which a vessel can keep in the air is limited by (*a*)

fuel supply, (*b*) gas supply—in the case of dirigible balloons—and (*c*) food supply, and these are affected by the fact that a heavy load cannot be taken.

(4) The duration of time which a vessel can keep in the air is consequently far less than that of a vessel at sea, as it is affected both by the aerial conditions and the limitations set out in the previous paragraph.

All these factors may be lessened to varying degrees by the improvements which are certain to be effected in the vessels and in their handling, but to a considerable extent they must be regarded as inherent limitations to aerial navigation as applied to naval or military service.

In warfare it may be regarded as a very serious defect in an arm that it can only be used under certain conditions. The very essence of efficiency is that a force be ready under all circumstances wherein any enemy could operate. Violent disturbances of nature are practically the only checks to land and sea forces operating nowadays, and these are only of a very temporary character. Once beyond their maximum intensity such disturbances may, in fact, be used as a cover for his movements by a daring leader on land or sea.

Consequent on the spread of railways and the improvement in roads and road locomotion, and the increased size, power, and reliability of vessels at sea, military and naval operations have been brought to a high pitch of reliability and what I may call "weather-proofness."

But at present all aerial vessels are almost fair-weather craft, and for some time to come this condition will limit their usefulness for warlike operations. Improvements in various respects will increase this usefulness, but we must always allow for a greater limiting factor in aerial navigation than in locomotion either by land or sea. Nevertheless, we must not build hopes that opportune storms will scatter every aerial armada, or that a continuance of bad weather will be so prolonged as to put the issue of a campaign beyond doubt ere aerial operations can be instituted.

On the contrary, the leaders of all the great nations must be prepared for a startlingly rapid improvement in aerial vessels, and nothing but a long course of practical experiment and training will fit their aeronauts to quickly avail of these developments. In any form of land or naval war no nation can now hold a decided advantage very long through some secret improvement, since there has been such a levelling-up in the art of gun-making, the chemistry of explosives, steam-engine design, and shipbuilding that all the leading nations can quickly equalise.

But in building military airships there is no common fund of experience, and few skilled advisers or designers. Each nation has to build up its own school of aeronautics, and train its men in the practical side of the work ere they can appreciate or understand what is being done elsewhere. This was plainly proved in 1907 when England launched its first dirigible. Though it was said that her experts had studied all the continental models and had the details of their mechanism available, the first British ship was out of date in almost every respect, and in some ways was inferior to the Renard airship of 1884. It was wrong in shape, poor in equipment, hopelessly slow, and its failure was a foregone conclusion. The builders did their best, and were cruelly handicapped through want of funds; but they had to learn their lesson from the very beginning, and unfortunately they delayed their progress by fondly believing that they had evolved some new and wonderful design which should be kept quite secret. The writers in the British Press created the idea that England had an airship superior to all others, and this preliminary boasting made the failure of the vessel all the more humiliating, when after months of dramatic secrecy the vessel was taken into the open.

The moral of all this is that every nation will have to serve a long and arduous apprenticeship in the new art, establish practical schools, build many experimental vessels, encourage amateur talent, enlist the aid of aeronauts and engineers, and spend considerable sums spread over a number of years. Success may then come quite rapidly, but it never can be had at a moment's notice by spending a large sum of money at the moment of emergency, as seems to be the policy of the British authorities, who draw a false analogy from what England can do in shipbuilding or gun-making in a crisis.

CHAPTER VII

AERIAL FLEETS

THE composition of aerial fleets promises to be as varied almost as those which sail the seas, but time will effect many changes, though hardly in the way of reducing the number of varieties. Even now we might set out the list in this wise:—

(1) Balloons, free and captive.
(2) Kites.
(3) Dirigible balloons of the non-rigid, semi-rigid, and rigid types.
(4) Aeroplanes.
(5) Helicopteres.
(6) Combined balloons and aeroplanes, or combined balloons and helicopteres.

BALLOONS

The equipment of most nations is yet confined to ordinary balloons, but these will, in a very great measure, be displaced by dirigibles. The spherical captive balloons and the kite-balloons will, however, be always useful to some degree

A PROPHETIC VISION OF AERIAL ARMIES, FROM AN OLD PRINT PUBLISHED IN 1792.
(From Major Baden-Powell's collection)

for observation purposes, and by their ease of transport and simplicity of operation will commend themselves to a field force. But with the advent of airships (by which I mean every type of steerable and propelled aerial vessel) the military balloons will run greatly increased risk, for they will be practically defenceless against attacks from such vessels. A single airship could sweep down on a number of balloons and speedily put them out of action.

KITES

Kites, especially those of the man-carrying type, may take the place of captive balloons in many cases, and they seem well suited for naval work. They may also be adopted for defensive work against airships, but the protection afforded will be very uncertain.

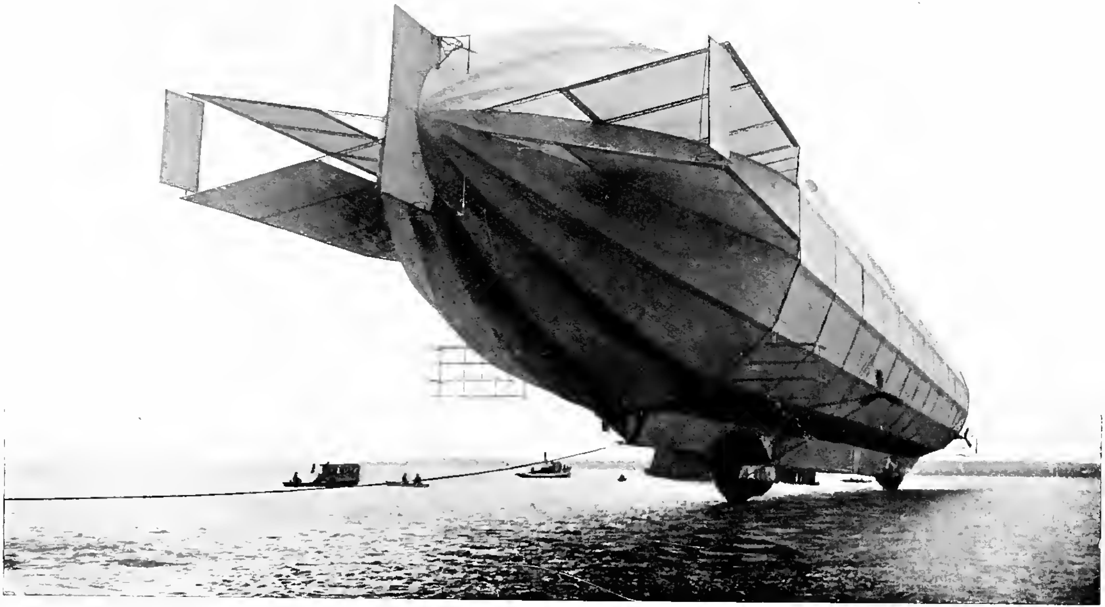
DIRIGIBLES

In dirigible balloons we may have ultimately more than the three types which I have arranged, according to their framework. The non-rigid, consisting of a cigar-shaped gas envelope from which the car is slung, has already almost given way to the other types, as these, by their rigid construction, are better fitted for high speeds and hard work.

Dreadnoughts.—Judging by present conditions, the dirigibles will fall into two main classes, one the "Dreadnoughts," huge vessels of the rigid-frame Zeppelin type, and the other the "cruisers," of the French semi-rigid type. The big ships will not have such speed or ascensive power as the smaller, but will have a wider range of action and more carrying capacity.

They will be veritable battleships of the air, and, fitted with pneumatic or other guns, aerial torpedo dischargers, and a good stock of explosives, they will be intended for making destructive raids of a nature impossible for small ships. Wireless telegraphy will keep them in touch with head-quarters, the supply of fuel and stores will permit long voyages, and the vessels will be capable of coming down either on sea or land. We have not sufficient experience yet to state what the limit may be as to the size of such vessels, but that they will exceed the latest Zeppelin (446 feet long) is tolerably certain.

Further improvements in designing and building will enable weight to be saved in many respects, and we may anticipate many important improvements in the power installation and the propelling devices. All these will tend to give great range of action, and higher speed and efficiency. Improvements in the generation and storage of hydrogen or other gases used for filling will also enable such a vessel to keep the air for almost an indefinite period, for it is quite possible that fresh



STERN VIEW OF "ZEPPELIN IV," SHOWING THE PLANES AND RUDDERS. THE PROPELLERS ON THE RIGHT SIDE CAN ALSO BE SEEN

gas can be generated on board to make up for any losses.

A big airship with all these properties could ride out a storm, running before the gale until the speed of the wind abated, and using very little fuel meantime. It could then have enough fuel to take it back to its base, even if that were many hundred miles away. With improved anchoring methods, and the existence of aerial harbours, it could shelter safely without going far out of its course. Such a vessel would be rigid enough to stand considerable side strains, and it would have ascensive power enough to take it to a higher altitude, there to find, perhaps, a less adverse wind.

This factor of changing altitude is most important in aerial navigation, since the direction and intensity of winds vary to an amazing degree according to altitude. Thus a skilfully handled vessel would often have an opportunity of getting out of an unfavourable wind by changing its altitude, and this factor will make for increased security. Neither in land or sea travel are such changes possible, and as our knowledge of the upper air is still very limited we cannot yet sum up how great the advantage will be of having the choice of a number of different aerial currents.

The control of aerial Dreadnoughts will be a work calling for immense skill owing to the number of new conditions that have to be studied and experimented with. If it be premised that such vessels are essential in an aerial fleet, then the need is obvious of prompt efforts being made to acquire the necessary experience. But Germany so far is the only country to design such craft, and she alone has gained any experience in the work. She can best appreciate the advantage of this.

Critics of the large rigid airship urge many objections, and some of these are of importance. Owing to its method of construction such an airship has but little lifting power of its own, independent of that obtained by the lifting planes. Other types of airships derive considerable lifting power from their gas envelopes, and can rise without the assistance of their engines. In warfare quick ascensive power is essential in getting away from gun fire, whilst a small airship might destroy a large one if it rose above it.

But the Dreadnought will try to provide against these emergencies. Her guns and aerial torpedoes will avert the necessity of having to come close to the enemy on land or sea, whilst she will eventually be attended by "mosquito craft," either small dirigibles or aeroplanes, which will ward off the overhead attack of any aerial enemy.

The landing of a huge airship of this type will, however, always be a difficult operation owing to her great bulk and her rigid frame. The slightest hitch may bring about severe collision with the ground or objects upon it, and cause much damage to the ship. The work of manœuvring the giant craft close to the earth will be fraught with danger when getting it into its harbour. In rough weather this would be well-nigh impossible under present conditions.

Count Zeppelin very soon found the necessity of landing his vessels on the water to avoid the destructive shocks incident upon landing on the earth, and though improvements may be made which will permit aerial Dreadnoughts to alight safely on the ground in fine weather, the probability is that most such vessels will be harboured on the coast or over some sheet of water. At such places the risk of being blown against buildings, trees, etc. can be avoided and a safe descent made.

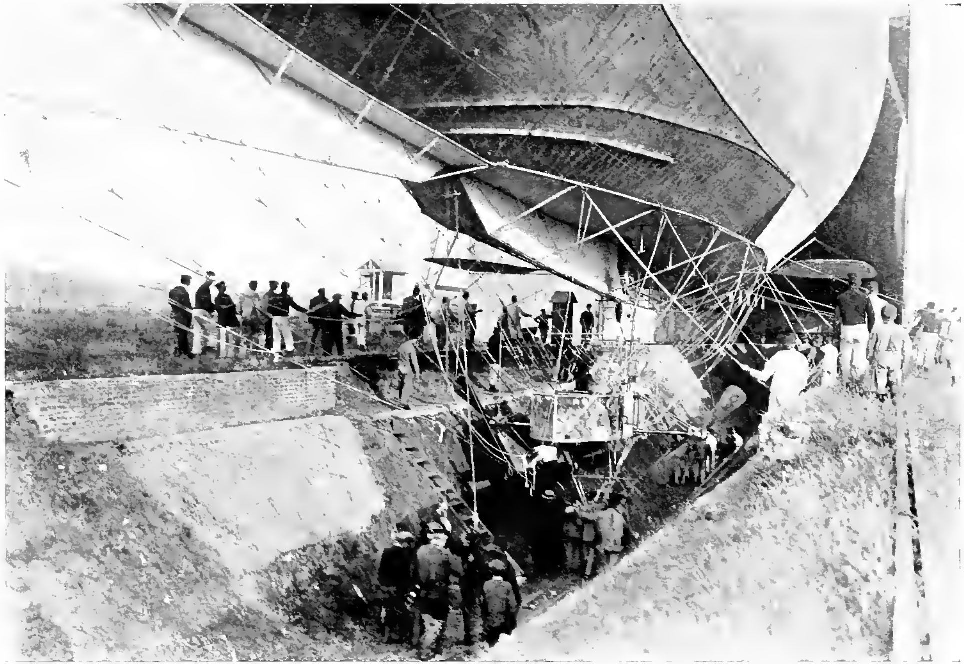
AERIAL HARBOURS

Aerial harbours will soon demand much attention from aeronautical experts, and doubtless great improvements will be effected. Natural and artificial shelters will be availed of to give airships safe berthing-places and protect them from the wind when they are close to the ground. Just as land is most dangerous to a ship when a storm rages, so the airship runs most risk when close to the earth and subjected to the cross winds and squalls which may prevail there. Over water the ship could contend better with the breeze, and might anchor safely with its nose to the wind.

The aerial sea is a most treacherous one, and very probably we shall have to pay heavy toll in human lives ere we acquire the necessary skill in sailing aerial craft; but the dangers will not deter men from taking the risk now that they feel assured that aerial navigation is feasible.

Perhaps before the various nations lay down plans for their airships they will give the matter of aerial harbours more attention, as otherwise many a good ship may be lost for lack of a shelter. In insular countries like Great Britain this is a most important matter, since a new ship may be caught in a strong wind blowing out to sea. If natural shelter points were mapped, and a few artificial ones erected at various points, a vessel would be able to make for one of these in an emergency, and so effect a safe landing without loss of gas.

Cruisers.—The French school is the best exponent of the light medium-sized airship of the semi-rigid type. These may be classed as cruisers, and for the special purposes of France are perhaps the handiest types of vessel possible at present. Craft of the "République" type can take a crew of about six or eight men, have a range of action of about 500 miles, and are



NEW EARTH DOCK CONSTRUCTED FOR THE "REPUBLIQUE" AT MOISSON

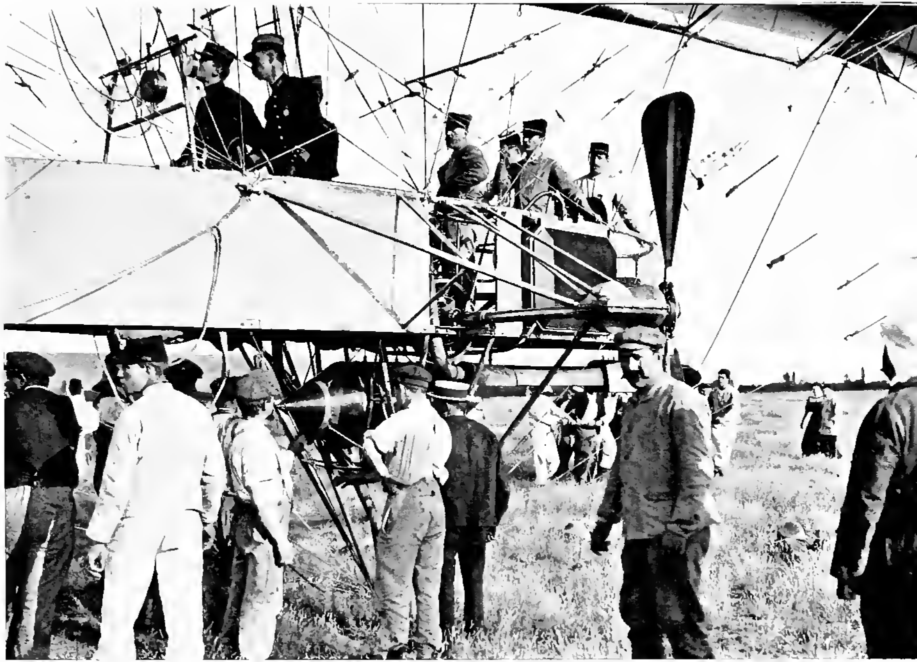
characterised by their speed and power of manœuvring. I do not think that smaller vessels are of much avail in aerial warfare, and the slow, sausage-shaped vessels hitherto built by England, and carrying only three men, would be of little use if pitted against the Zeppelins or the French vessels.

In one respect at least the French vessels are superior to the German, viz. ascensive power, and this negatives many of the advantages possessed by the Teutonic fleet. At the same time France has made a mistake in confining her vessels to one type, whilst Germany has now representatives of practically all the approved forms. The French ships by their speed and handiness could generally be reckoned upon to out-manœuvre the Zeppelins, and escape from them if necessary. Their great ascensive power, too, would give them facilities for attacking these vessels by rising high above them in the air and shelling them from the commanding position.

Neither in land or sea fighting can mere position give so much advantage to two fairly equal forces as that conferred by the upper place in aerial conflict. A land force posted in a great fortress has obvious advantages, but these are conferred by the fortifications, and are hardly to be taken into consideration here. But forces on land or sea meeting in the open could not secure such an overwhelming advantage by mere manœuvring for position as that which will be secured by the airship which can quickly rise to the greater height.

This point has not been given much attention to by many designers, and possibly the advantage gained by the French design has been in a measure accidental, and has not been attained in the endeavour to construct a craft which would be able to contend with a heavy ship of the Zeppelin type.

Be that as it may, the characteristic of high ascensive power secured by aerostatic means (that is, from the buoyancy of the gas envelope) will be a strong point in favour of the cruiser type of airship, and for land operations over the frontier area the French vessels seem very well suited. Their high speed would enable them to get over the whole region very quickly, and would enable them to battle against stronger winds than a slow-paced rival. Their handiness in manœuvring and in coming down at practically any point would permit them to work away from their base for extended periods, and thus would fit them admirably for staff and observation purposes. Then in emergency, when a raid by the Dreadnoughts of an enemy was threatened, a few of the cruisers could be specially lightened and speeded up so as to attempt with



THE DECK OF THE "REPUBLIQUE"
(The general arrangement is almost ideal for a cruiser)

best hope of success what I may call the "hawk attack."

Rising vertically by its buoyant power, and ranging still higher by the aid of its engines, such a vessel would be ready to attack the enemy's largest ship, rain explosives upon it while hovering vertically above, and thus attempt the destruction of a vessel, which if it could ward off such an aerial attack would of a certainty do much damage to the land forces. The manœuvring to obtain the "hawk" position and to utilise it with quick and terrible effectiveness will be amongst the most dramatic evolutions in aerial warfare.

But though at present the French type of cruiser is best adapted for this manœuvre, I think France has adopted a mistaken policy in adhering to one type of airship, and in this opinion I am supported by Count Henri de la Vaulx, one of the most experienced aeronauts in the world. Germany is working on the right lines, since she is simultaneously testing vessels of several types, and can at any time build up a fleet in which they will all be represented. No amount of testing in time of peace can definitely decide which is the best type for the varied purposes of warfare. Nor can it be laid down that any one class of vessel can fulfil all the functions that airships will be capable of.

FLYING MACHINES

From the military point of view there seems to be a great future before the heavier-than-air flying machine, and it would be unwise in the highest degree to limit the sphere of usefulness of this class of airship. One cannot yet estimate the maximum speed possible for an aeroplane. Already it is superior to the dirigible in this respect, and it needs little demonstration to show that it will always maintain this superiority. The bulky gas envelope of the dirigible prevents really high speeds against the wind, and its maximum in calm air will probably never exceed fifty miles an hour. The aeroplane under similar conditions may soon be capable of speeds up to eighty or even a hundred miles an hour. To these speeds the speed of the wind must be added when it is behind the vessel.

If the maximum speed of a dirigible in calm air is forty miles an hour, it is plain that it cannot make direct headway against a wind blowing at, say, forty-two miles an hour. A high-speed aeroplane, however, will probably be able to face winds up to sixty and seventy miles an hour, that is, of course, provided that in all other respects it is fitted for such work.

Though so far the duration of time that an aeroplane can remain aloft does not exceed

WILBUR WRIGHT AND A PASSENGER ON THE WRIGHT AEROPLANE

(This illustration gives a good idea of the disposition of the engine, the steering levers, etc. The right hand grasps the lever for warping the planes and actuating the rear rudder: the left hand operates the front planes which give the vessel upward or downward motion)

four hours, very rapid improvement is being made in this respect, and in theory the machine should be able to keep aloft as long as its fuel supply holds out. Mr. F. W. Lanchester estimates that the limit of flight for an aeroplane with a modern engine will be 1000 miles.

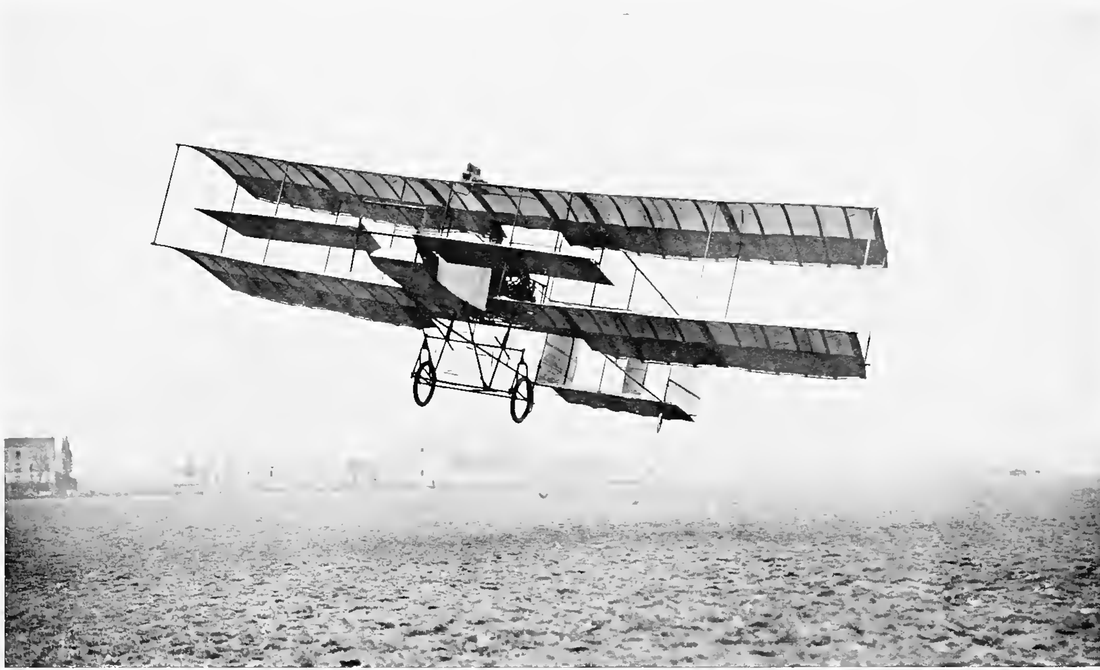
The aeroplane keeps in the air through the fact that it is being driven at speed against a mass of air and derives upward pressure therefrom. Once having acquired momentum, it can soar or glide for various distances ere coming down, but it has not the property of remaining motionless in the air for long periods like the dirigible. In effect it gains and secures its position by mechanical means dependent upon the working of the propellers. If the engine fails, the machine must inevitably come down, but not necessarily with dangerous suddenness.

This limitation of time and its dependence upon a single mechanical factor are two serious drawbacks from the military point of view. At a critical moment when an aeroplane has soared over an enemy's country the engine might stop or the propellers cease to act. A descent would then be compulsory, and escape would hardly be possible. When a stoppage occurs to the driving machinery of a dirigible balloon the aerostatic properties of the vessel will be able to keep it aloft, and availing of the wind it may be able to make good its escape from the zone of danger. This consideration emphasises the importance of all dirigibles having sufficient ascensive power to keep at a safe height even when the engines fail. In other words, the aerostatic properties of the balloon must not be too much encroached upon in the desire to carry heavy loads or fit heavy power installations.

Duplication of the engines and propelling gear will minimise the risk of failure on both aeroplane and dirigible, but it will add to the dead weight, and will never wholly obviate the risk of failure. At the same time we may expect a steady improvement in all mechanical features which will tend to reduce failure, and the reliability of the modern high-grade motor-car is an index to the efficiency which will be attained.

Another matter for consideration when dealing with aeroplanes is the small carrying capacity they possess. The great majority of the machines now in use take only one person, and he is fully occupied in the delicate work of steering, balancing, and keeping the engines running. For warlike purposes the machines will have to carry two or more persons.

To carry any greater number on a long journey, in addition to the driver, would call for a much larger and more powerful machine than any yet built, since, if the passengers are to fulfil any



THE FARMAN AEROPLANE IN FLIGHT

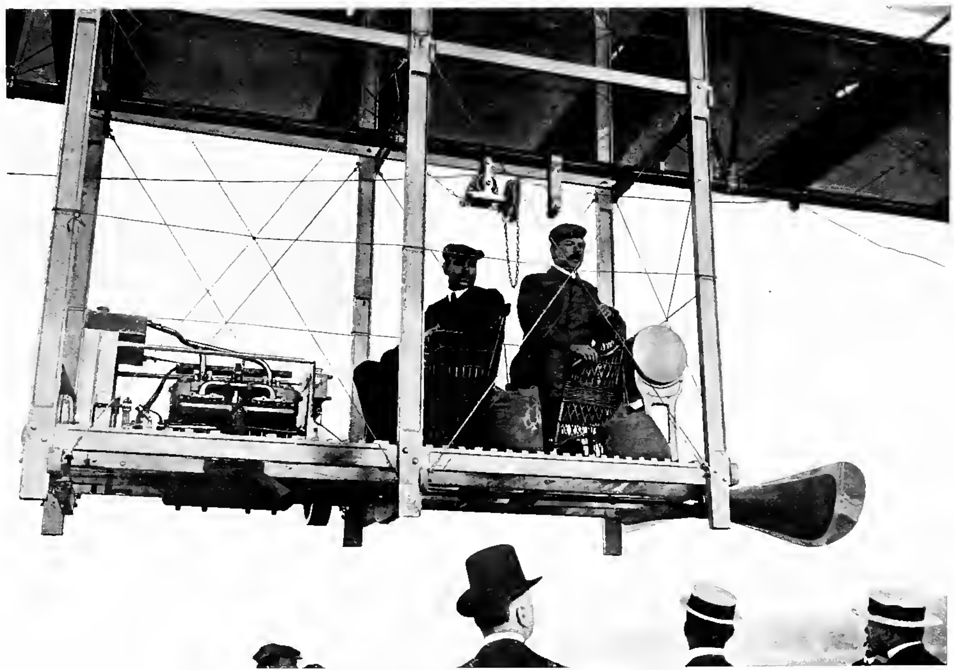
warlike purpose, they must have certain facilities which no present-day type of machine affords. It is questionable if machines can readily be built which will allow many such passengers to be carried in addition to stores of explosives or weapons, nor would the facilities for using these be obvious owing to the fact that the aeroplane could not remain stationary in the air. The facility of rising to great heights is not a marked feature of the aeroplane, especially when carrying passengers and stores, and thus these vessels would run special risks, even though they moved at high speed and presented less bulk than dirigibles.

These have been the main reasons which so far have prevented the military authorities of France and Germany from adding machines of the aeroplane type to their establishments, but they will soon have to alter their tactics. English and American inventors are, on the other hand, sanguine as to the military utility of the aeroplane, and the recent achievements of the Wright Brothers and French aviators have opened up new possibilities.

The future has probably most astounding things in store for aeroplanes, and at any moment epoch-making discoveries may be made which will give new scope to flying machines as distinct from dirigible balloons. To my mind both types of vessels will be needed in an aerial navy. The aeroplanes with their high speeds, up-and-down motion, and small bulk will run little risk from gun-fire, and so will be able to carry out daring reconnaissances and even raids. For despatch work, too, they will be invaluable, and they may be employed by naval as well as by land forces. The dirigibles, on the other hand, will be used for observation purposes by commanding officers, and they will also carry out night attacks and make long voyages for various purposes. Armed with guns and explosives, they will be the main attacking forces in the air. Eventually, in the opinion of some experts, the aeroplane may almost entirely displace the dirigible balloon, but that period is too remote to prevent the dirigible balloon from being steadily developed for war purposes.

COMBINED MACHINES

The combined aeroplane and dirigible balloon has not yet been adopted for military purposes, and attractive though the idea seems in theory, it has not so far proved very successful in practice. Of course, strictly speaking, the Zeppelin vessel is partly an aeroplane, since the plane surfaces fitted to its sides for lifting purposes accomplish the same object as an aeroplane. But what

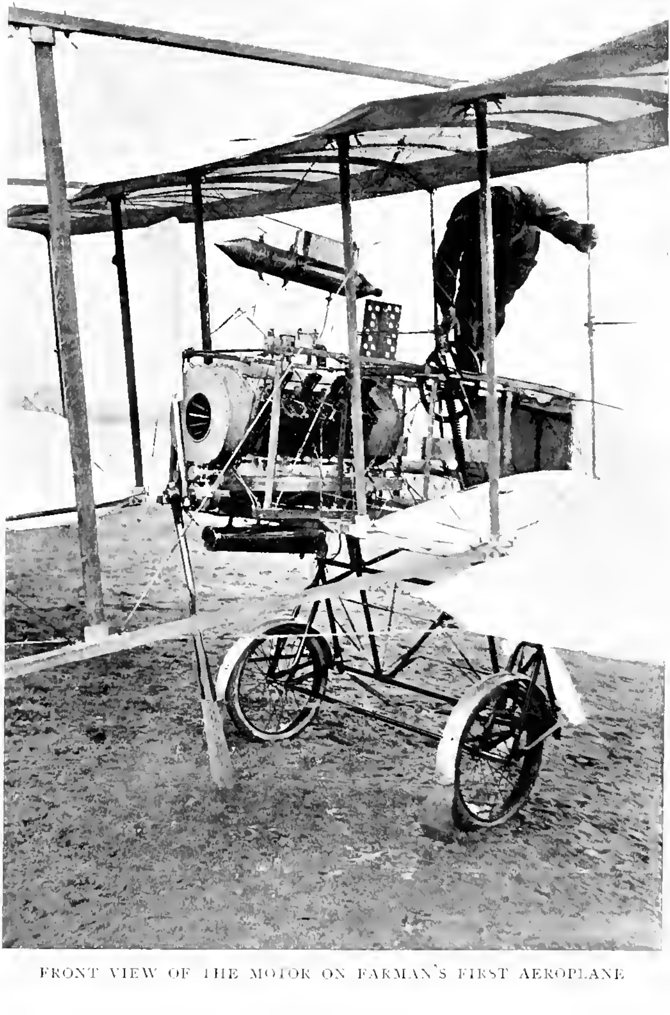


THE CAR OF THE MALECOT COMBINED AEROPLANE AND DIRIGIBLE

aeronauts regard as the genuine "mixed machine" is practically a small dirigible balloon mounted above an aeroplane.

One object of this is to diminish the size of the gas-bag and rely mainly on the aeroplane for lifting purposes, but this is obtained at the sacrifice of various advantages. At the same time it is possible to reduce the size of the aeroplane proper, and there is hope that eventually quite a serviceable type of combined vessel will be evolved which will be of considerable use in warfare. Aerostatic power derived from the buoyancy of the gas envelope is a very valuable feature, as it is akin to the power a ship has of floating on the water. It would be a very risky proceeding to trust too much to vessels which kept afloat on the water only so long as their engines are running—which in effect is the principle governing the aeroplane or heavier-than-air machine. Thus the future vessel may be a compromise between the various types, and perhaps the helicoptere or vertical lift flying machine, as well as the Capazza mechanical expansion vessel, may all be blended in the mammoth ships of the future. Aerostatic vessels of the rigid type with vacuum envelopes have also been suggested, but seem impossible.

Under the conditions that obtain at the time of



FRONT VIEW OF THE MOTOR ON FARMAN'S FIRST AEROPLANE

Kite and ordinary balloons,

Various combinations of these.

Combined aerostatic and aerodynamic vessels of the Kostovitch type. This is a rigid dirigible in which the gas can be taken from the balloon and stored under compression in other chambers. Air is then admitted to the balloon, and the whole vessel becomes heavier than air and acts like a flying machine.

CHAPTER VIII

ARMAMENT

VERY little has been done so far in designing special weapons for airships, but it is evident that there is much scope for ingenuity here. Many points have to be considered in devising suitable armament for airships, and though these limit the choice of weapons in several respects they suggest obvious substitutes. Thus the space available on an airship will always be very limited, and more important still, the vessel is not fitted for the carrying of heavy loads. Furthermore, the use of explosive guns would be attended with great danger, as naked flame cannot be permitted on such a vessel. The gas envelope contains either hydrogen or coal gas, and both of these are highly explosive. Provision must always be allowed for the possibility of leakage, and though the gases by their lightness tend to rise rapidly, too much dependence cannot be placed upon this. The petrol vapour constitutes another serious risk, and perhaps one of the greatest that menaces the safety of the airship.

A list of the principal weapons that suggest themselves for aerial purposes may be set out thus :—

Guns actuated by compressed air, or other gases, liquid air, and also by springs, etc.

Rifles worked by similar means.

Bomb-throwing devices worked by similar means.

Explosive bombs and shells to be cast by hand through rifled tubes.

Petrol, petrol gas, and petroleum bombs and igniters.

Poisonous gas bombs.

Aerial torpedoes.

Aerial mines.

Parachute or drifting bombs.

Javelins and detonating darts for use against other airships and balloons.

Fire-tipped arrows for similar purposes.

For the present we can very well rule out ordinary types of explosive guns as being too dangerous, too heavy, and too bulky; and resort will thus have to be made to pneumatic guns, or those using springs, liquid gases, or other expansive power which does not produce a flame. These types of weapons will not give the long ranges which ordinary guns afford, but for an airship this is not a very important consideration. The force of gravity can be utilised with much advantage, and in many cases only a slight horizontal velocity need be given to a projectile delivered from an airship high in the sky to attain its object. Mere vertical dropping of shells, etc., can be resorted to in most cases, provided the vessel has an ascensive power which keeps it at a safe distance from the guns of the enemy on the earth, or accomplishes its work at night. Vertical shooting from the ground, or any firing at high angles against a moving object in the zenith, is exceedingly difficult, and I have had the practical opinion of a Boer marksman as to the uncertain work of shooting at balloons in the South African War. The light, the position to be taken up, and the fact that the target (in the case of a dirigible balloon) is a quickly moving one, tend to make the task very difficult, though under certain circumstances artillery can make very good practice against ordinary balloons. Most important of all is the fact that *airships can have both vertical and horizontal motion simultaneously*, whilst any target on land or sea has but horizontal motion. This factor will render accurate shooting at them very difficult.

It is certain that the airship will be enabled to take up almost a vertical position over its object on many occasions, and thus will have merely to use the force of gravity to bring destruction down upon its objective. Training and calculation will soon enable the aeronauts to allow for the drift of wind and vessel, etc. For casting out such explosives an airship will be much more reliable than an aeroplane, as it can remain almost stationary at the moment of taking aim, whilst the flying machine will always have to keep up motion.

Thus, on the whole, powerful guns will not be needed on aerial vessels, and where any horizontal velocity has to be imparted to a projectile compressed air or other gas, or even a spring contrivance, will be found adequate.

Bomb-throwing devices need not be specially considered, since the foregoing remarks apply to them in the main. It is obvious, however, that the airship offers unique possibilities for the discharge of explosive, fire-producing, or poisonous gas bombs over a large area unreachable by land or sea forces. Enormous destruction could be wrought by these, and the poison gas bombs could render a whole district practically untenable by troops.

Rifles and small-bore weapons will be needed mainly for war between airships before coming to close quarters. The Dreadnought type of ship will have to rely mainly on her superior range in putting a cruiser out of action ere the latter succeeds in getting to the "hawk" or upper position. Gun-fire will be directed both at the deck and at the gas envelope, and the object will be to keep the smaller vessel at a respectful distance. This firing will be most effective when the two vessels are at about equal altitudes, or else a considerable distance apart. Once the small vessel gets overhead the big ship will be almost doomed.

The enormous gas envelope of the Dreadnought will project well over the car in which the guns are mounted, and thus high-angle fire will not be easy to carry out. Then, again, the under-frame of the overhead cruiser will not be so vulnerable as the gas envelope. Once in the overhead position the small vessel would be able to bring all her destructive agents to bear against the balloon of the Dreadnought, and thus would have many factors in her favour.

The selection of guns both for operations against other airships and against land and sea forces will be a most important point in the development of the aerial warship, and as actual experience alone will determine the best forms to employ it is essential that every up-to-date nation should have its experimental airships in active service, and use these in conjunction with all military and naval operations.

Hand grenades and bombs will be the main equipment of many of the small vessels, and although these will have but a limited range of action they will be able to do enormous damage if the throwers are expert in their work. The velocity acquired by bombs when dropped from great heights would also give them enormous striking power. Such an object dropped 100 feet has a velocity of 80 feet per second (55 miles an hour); dropped from 1000 feet its velocity per second is 254 feet (or 170 miles per hour), whilst from 5000 feet the velocity is 567 feet per second, or over 386 miles per hour. Here, again, the need of long practical training is requisite, for the task of dropping a bomb from a great height on a predetermined spot is by no means as easy as might be supposed, and it can never be safely trusted to scratch crews raised at the last moment. Indeed, the crews of airships will have to be highly trained men with a wide experience in their special work.

Aerial torpedoes have already been designed, I believe, but not for discharge from the decks of airships. There are no serious difficulties in the way of making an efficient projectile of this kind; and used from the airship it would be a fearful menace to any force on land or sea. The aerial torpedo would be some form of miniature airship loaded with high explosives, and perhaps in the perfected state steerable by wireless electric means from the airship itself. Such an instrument of destruction could be directed towards a fleet, a naval harbour, or a fort from a very considerable distance, and though the aerial sea is very changeable, the direction and striking-point of the torpedo could be controlled to a remarkable degree by experts. With the discharge of a series of these from a distance at which an airship would be almost invisible, incalculable damage might be done in a naval harbour or a military station. The little torpedoes will sail through the sky without attracting any notice until close to their objective, and it would be practically impossible to check or alter their course. With airships operating from two quarters the effect would be very puzzling and disastrous for those against whom the torpedoes were aimed. The high-explosive shells which could be used against airships within range would be impracticable against the small and swift-running torpedoes, which would bear down on a fleet of warships from several quarters.

As mine-sowers airships would doubtless be employed also, though of course special types of mines would be needed, and perhaps no very dependable results would be obtained. In this connection it is worth calling attention to the value of airships in assisting or frustrating the work of laying naval mines, and also in detecting submarine evolutions. I believe that the airship of the future will rob the submarine of all its terror, and limit its sphere of activity very considerably.

Even at a considerable height the aeronaut gets a wonderfully clear view through water, and thus the airship is well adapted for discovering the movements of submarines and the position of mines. In hunting for mines an airship would come down to a low level, and skimming over the surface would be able to locate floating mines with absolute safety. It would be quite simple then to "label" each mine with a flag or other device, and they could then be picked up or destroyed by naval vessels.

The submarine working under ordinary conditions would be as helpless almost as a fish when sighted by a diving bird. An explosive could be dropped upon the submarine, or it might be so located that destruction of it would be easy by other means. The slow-going submarine once sighted could hardly escape from its pursuer, which swooping down unexpectedly from a height could smash the observation-tube of the submarine and render its escape impossible. In fact, submarines, unless protected by other vessels, such as cruisers or destroyers, would be at the mercy of airships if they ventured any distance out to sea. Submarine attacks could also be frustrated very effectively.

Petrol bombs would accomplish very destructive effects by the fires they would create, and if dropped on warships, forts, stores, etc., they might in many cases effect results unobtainable with explosives. In case of shortage of fuel on board the airship these bombs would form a reserve supply.

The parachute or drifting bomb is a projectile which would drift down slowly on a favourable wind, and alight within the prescribed area. Teams of these drifting bombs might be linked together, and when any one, or the ropes connecting them, came in contact with a ship's mast or other projection the whole series would be drawn in about the doomed ship with terrifying results. These linked drifters could sweep like the plague over a large area, and all would come into action on any one making contact with a solid object. Lighter types could be floated across large masses of the enemy's troops, and would be contrived to come to the ground without exploding. Sown at night, and lying across railway lines, main routes, etc., they would work considerable damage. They would need to be used with great care, however, or they might be as dangerous to friend as foe; but for raids they could be employed with advantage.

I have by no means exhausted the forms of projectiles and explosives which can be hurled from an airship, and the future will bring many new ones to light; but enough has been said to show the possibilities of the new arm, and to urge laggard powers to make themselves conversant with this form of warfare.

The final type of armament is that peculiarly belonging to aerial warfare, and designed to be used by vessels in the "commanding position." If even a small airship were able to keep vertically above a large vessel, the latter could be destroyed by the former raining down explosives or destructive agents upon its gas envelope. To merely puncture the envelope by mechanical means would be sufficient in many cases, but probably fire or detonators would be employed to explode the envelope if the attacker were a sufficient distance away to be out of reach of damage. The occupants of the attacked vessel could do very little, as the great gas envelope of their ship would be above them, and thus shut out a view of the other vessel. Coming right down over it, the smaller vessel might present its ultimatum, as it would have the power to sink the other craft if this did not strike its colours. With its gas envelope partially punctured and flabby, the attacked Dreadnought would possibly consent to be taken in tow as a capture rather than risk being totally sunk with a suddenness which would render destruction inevitable. Aeroplanes of the larger types which ultimately will prevail will be more immune from attacks of this kind, and for many forms of aerial warfare they may eventually be superior to most types of dirigible balloons.

CHAPTER IX

TERRESTRIAL FORCES AGAINST AIRSHIPS

THE older school of military and naval experts are still strongly opposed to the airship in any shape or form, and their arguments fall under two heads : (1) That the airship is, and will ever be, impracticable for military or naval purposes ; (2) that even if a practicable vessel were built, it could be successfully contended against by the weapons now at the disposal of the land and sea forces of all great powers.

In fairness to these critics I must set forth their present arguments as far as I have been able to collect them, though in kindness to them I have not brought up some of the arguments which were uttered even a few years ago, but which since then have been disproved by facts, and are conveniently forgotten by their authors.

Under section (1) that the airship is, and ever will be, impracticable for military and naval service, the main arguments now adduced are :—

(*a*) No successful airship has yet been built.

(*b*) The difficulties and dangers of aerial navigation render airships impracticable.

The first argument is at best a temporary one. The practicable airship is less than seven years old, and in that time we have arrived at vessels with speeds up to thirty-five miles an hour, and with records of journeys up to 800 miles, and with a theoretical range of action of 1000 miles. No such progress has been made in any other branch of locomotion, and this rapid improvement is still going on, so that not even the most expert aeronaut can foretell the developments that are likely to occur within the next few years. These, needless to say, will first come to the nations which have intelligently worked at the problem, and are prepared to adopt such improvements.

As regards the difficulties and dangers of aerial navigation I have endeavoured to set them out with all fairness in the chapter on aerial navigation, but here again we must bear in mind that every improvement in the vessels will tend to diminish these dangers and difficulties. I have mentioned many defects which the average military and naval expert is unacquainted with, but after making full allowance for these I can safely assert that there is a big and an ever-growing balance in favour of airships being practicable and, indeed, invaluable in warfare. That there will be disasters, that there will be disappointing set-backs, I cannot deny, but who that has studied the history of any branch of locomotion, who that has noted the early struggles of the steam engine, the steamship, the motor-car, and the submarine, and has taken count of all the disasters that they have brought about, can maintain that progress has not been very dearly bought.

For one thing, the airship will always be a very cheap instrument, and the loss of one naval battleship, costing over £1,000,000, will take many airships, at £10,000 or £15,000, to balance it.

Turning now to the arguments of the critics that airships, even if they were practicable, could be successfully contended against by land and sea forces, the first obvious weak point in the statement is that the authors of it (not being students of aeronautics) have only a very hazy idea as to what the practicable airship could accomplish, and probably they would never find out until such vessels had been actually used against their forces by an enemy. As they do not understand the problem, it is fallacious to suppose that they can effectively grapple with it. I can lay it down as a safe axiom that until a nation has successful airships of its own the naval and military experts of that country can have no data upon which to base their line of defence against such vessels, nor can they arrange the scheme of training of their officers and gunners. If they have no special scheme of attack and defence they tacitly admit that they are unprepared for airship attack, and the original assumption is thus negatived by their own line of conduct.

As to actual means of attack and defence, the only suggestions I have seen are the use of rifles and artillery using the ordinary projectiles employed in land or sea service, whilst in special cases high-explosive shells may be used.

The effectiveness of rifle fire against quick-moving objects at a long range and high in the air is not admitted by French and German experts as a result of their tests against balloons, and it is always possible for a vessel to rise high enough to be out of practical range. Save where an airship is in distress through loss of ascensive power, it need fear little damage from rifle fire, even if this were delivered by crack shots of a skill not to be found in the regular army.

With long-range artillery another difficulty crops up, for though projectiles can easily be made to travel the requisite distance it is quite another matter to ensure that they will reach their objective, when this is a quick-moving object necessitating high-angle fire and constant change of vertical and horizontal direction. Long-distance artillery fire, even when directed against stationary targets, is not a very accurate proceeding ordinarily, and with an airship many of the guns would be unable to cope, owing to the high angle required and the rapid aiming at points all over the compass.

The experts forget, too, that if gun-fire has to be changed very rapidly in direction, the possibility of immense damage being done to their own forces will be very great if ordinary projectiles are used. As the guns swing about to follow the course of the airship they would fire shells which would come down perhaps on their own troops and so cause no small destruction and confusion over a very wide area. Aerial tactics would be developed to draw this kind of firing, and a "dummy" airship might lead many an impulsive battery commander to shell his own troops unwittingly.

Nor could naval vessels near land use their big guns against airships unless they sighted the aerial craft far out at sea. Once the airships worked round to landward, even if over a naval base, the ships of the fleet could no longer use their ordinary projectile for fear of the shells dropping down on the harbour works, stores, etc., and for the same reason the fort guns would have to be very circumspect in their firing in a seaward direction for fear of hitting some of the fleet.

In effect the matter settles down to the use of high-explosive shells which will do their work in the air; and, if airships are to be prepared for, every ship and every fort and every artillery regiment must have its stock of these special shells, and must be ready to use them at very short notice from guns giving a high angle of discharge.

The theory of the high-explosive shell is that if it explodes in the air, even some considerable distance from an airship, it will produce such enormous concussion in the air that the gas-bag will burst, or the aeroplane will be shattered to pieces. This theory has been seriously advanced by British experts of high standing, but it has several weak points which show defective knowledge of aeronautics.

Concussion means the displacement of a great mass of air at enormous velocity. In other words it is a kind of artificial squall, but with nothing like the intensity of those which nature can create. If a balloon were *held stationary to the earth*, then the concussion due to an explosion would do it much damage, since the current of air would drive it against the resistance caused by the anchor. The concussion following violent explosions can wreck buildings, but here again we have fixed objects resisting the sudden current of air directed against them.

A free airship in the sky *floats* in the medium disturbed by an explosion. It is powerfully moved by the sudden current or squall created, but since there is no resistance to this beyond its weight (and it is as light as air since it floats there), the effects of the concussion are not very serious. The vessel yields to the sudden blow of the moving air, and the elasticity of the air, the free space in which the energy can be quickly dissipated in all directions, and the ready movement of the ship when struck by the blast, will all tend to minimise the shock. It is a point, however, which deserves to be fully tested in practice. Save at close quarters I doubt if any serious damage would be done.

The real danger will come from the missiles which the shell may contain. That well-aimed, high-explosive shells which scatter missiles over a wide area constitute a very grave danger to airships cannot be denied, but airships run no greater risks than any other objects against which these are directed, and the difficulty of getting correct range and aim against such targets limits the effects of this mode of attack.

Moreover, these shells can only with advantage be used in daylight when the ships are clearly visible. There is nothing to prevent an airship taking advantage of the cover afforded by a cloud or mist, and I have even seen the fanciful suggestion that an airship could make artificial clouds by ejecting steam, etc., or could so colour the gas envelope as to render it almost invisible!

At night whilst the airship is guided by its compass and all the lights on land and water its presence in the air is almost impossible to detect save in strong searchlight or moonlight, and accuracy of range and aim at such a time is well-nigh out of the question.

To the aeronauts the land is mapped out quite clearly as they glide noiselessly through the dark sky, ships' lights, harbour lights, town lights, and many other direction points being there to indicate their objective. At high altitudes they would run little risk from discovery by searchlights, and by attacking from the landward side of a naval base they would quite upset the calculations of the designers of these forts and of the defenders.

The potency of land and sea attack against airships is thus practically confined to the use of a special type of gun and a special projectile. Crack shots would be needed to carry out such attacks, and they should be available at every important point where airships might be feared. Can any army or navy guarantee such a defensive service at all points by land and sea?

CHAPTER X

WAR IN THE AIR

THE inclination is strong to conjure up for the reader a striking series of pictures illustrating the course of an aerial war. But, as I have written all along in a more or less practical fashion, I will follow the same course in this chapter, though there are inducements to let imagination run riot in describing war in the air, so novel and varied are the situations that suggest themselves.

It has always seemed to me that most so-called graphic descriptions of warfare are very far from the truth; and even the realists convey very erroneous impressions. The killing business can be dull as well as mean; but grim, grisly horror is the prevailing feature, I think, when it comes to be coldly analysed. Warfare, in fact, does not bear calm analysis. Its glory and its fascination—and these are as real as its cruelty and its horror—exist only for the supreme period of the struggle, when man barters with man for his life, when the blood is hot, and that oldest and strongest human passion is fully roused.

Civilisation and science have tended to place the combatants at greater striking distance, and perhaps have altered in some degree the psychological condition of the participants by rendering the affair more impersonal. Though the destructiveness is greater, it is more carefully restricted to the combatants, and humaneness is shown to every soldier once he is stricken down. Specialisation has been carried to a high degree in the making of the modern fighter, and the combatants are under better control, with the result that the cruel and wanton destruction of children, women, and non-combatants has been lessened. The wide range of action, however, in modern battles has threatened to interfere with this, since in artillery duels, for instance, a vast area of country is endangered, and stray shots cause much useless destruction of life and property.

The use of airships will have the effect of reducing this accidental destruction, since better surveys can be made of an enemy's position and gun-fire can be more accurately directed. Thus in one respect airships will be beneficial in that they will tend to keep the destructiveness of long-range artillery fire within bounds, and whilst rendering it more effective against the enemy will diminish the unnecessary damage caused hitherto. If only as a scouting agent and a director of artillery fire, the airship fills duties important enough to compel its immediate adoption by every great power.

In fact the airship should have a most revolutionary effect on warfare, since it well-nigh destroys strategy and those surprise movements which have been developed to such a science in modern warfare. Practically no move can escape the aerial scouts, and reports to head-quarters will be made with astonishing rapidity. Thus even the development of airships as scouting machines will cause the whole war game to be remodelled. The appended table will give an idea of the value of the airship for scouting and observation purposes :—

Height of airship.	Distance up to which objects can be sighted.
50 feet	9 miles.
100 „	13 „
200 „	18 „
300 „	22 „
500 „	29 „
1000 „	33 „
5280 „ (1 mile)	96 „

But the possibility is now clear that the airship may prove a terrible instrument of destruction in itself by discharging explosives, aerial torpedoes, etc.; and here again it can confine its operations to the actual enemy owing to the commanding position it will have. To get maximum results such a vessel should poise almost vertically over the ship, fort, or other object it seeks to destroy, and then rain down explosives. On the other hand, the high-angle firing from the attacked party may wreak considerable damage in the neighbourhood unless special projectiles are used which will explode in the air.

As I will now proceed to show, the application of airships to warfare will "speed up" the operations, will wreak more terrible destruction amongst combatants, and may lead to such rapid and extraordinary developments that nations will be deterred from rushing hastily into war owing to the unknown dangers which threaten from this new arm.

Thus the development of the airship may be looked upon as beneficial to the cause of peace, for in our modern materialistic times the strongest deterrents of war are those practical arguments which touch the security or the wealth of nations. Every new and unknown factor that increases the risk of war for a nation, and increases the amount of damage it may incur, will help to prolong peace; and of the airship it may be said, that it will one day entirely alter the science of warfare, and spoil many a fondly matured plan of campaign.

LAND OPERATIONS

Where we take two warring powers with a common frontier line, and each possessed of large armies, we may omit the consideration of the naval applications of airships, and take the two cases:—

(1) A having an aerial fleet, B having none.

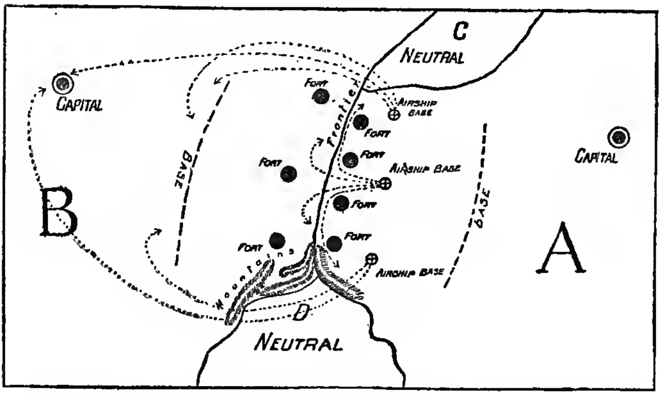
(2) A and B having aerial fleets fairly equal numerically, but more or less different in their types.

Case 1.—That A would derive many advantages from its aerial fleet when B had nothing better than the ordinary observation balloons is very obvious. A could, by patrolling the frontier, keep a very close watch on all B's movements, and could choose his striking-points with a nicety impossible to arrive at by ordinary espionage and observation.

The country with the aerial fleet would detach part of this for a daring raid timed to be almost simultaneous with the declaration of war; and if A forced matters so as to open hostilities at a suitable time, his airships could dash over the frontier at night and be in position to wreak enormous damage on forts, forces in the field, or on the bases where mobilisation movements were in full swing. No artillery or searchlights could protect B against these night movements.

With a numerous fleet of airships one section could attack on the frontier line, making a feint, or actually opening a way for troops. The moral effect of a few airships raining down explosives from a great height would be very serious on B's forces, especially at night or early morning, and if timed to occur very quickly after the declaration of war.

Before effective artillery could be opened up enormous damage might be done, and B's army be sadly shattered at an important strategic point. The airships could cross the frontier at any place,



War between two continental nations, A and B; the former employing airships. (The dotted lines show the courses of A's airships.)

and special high-angle guns with high-explosive shells could not be provided for them at all points. If necessary, they could even make detours at night over neutral countries, and thus come up from the most unexpected quarters.

Meantime another section of A's fleet would have flown very high, or by a devious route, to swoop down at B's mobilising points or bases. Here the preparations for repelling aerial invaders would conceivably not be so ready as at the front, and a cleverly planned aerial attack might cause inextricable confusion in a portion of the army which at the outbreak of hostilities is quite immune from all ordinary attack. It is to be presumed, of course, that since B's army has no airships the authorities, the nation, and the army in general do not believe in the utility of these vessels, and consequently they would not have any great fear of such craft when hostilities opened, nor would they have taken any elaborate precautions against warding off raids on the bases and lines of communication. Thus if A's ships appeared over the mobilising points or other important places at the rear of the fighting lines it can be imagined that the confusion would be terrible, and that the airships could do enormous damage ere they could be seriously attacked.

A regular panic might be created amongst a portion of the reserve troops when thus unexpectedly attacked from the skies. And in addition to the destruction of life and war stores many important railway stations, bridges, and other communications leading to the front might be wrecked far more thoroughly than by any raid made on land. Indeed, such an attack timed with a similar attack by another portion of the aerial fleet on the frontier would give B a very staggering blow at the very outset, and perhaps put the final issue of the campaign beyond doubt.

Even if A's aerial fleet were almost entirely destroyed in delivering these blows the material and moral effects would more than justify the expenditure of lives and ships. Certainly on a well-guarded frontier no other form of attack could accomplish so much, be carried out at such small cost in lives or fighting appliances, or be delivered with such frightful speed. The airship will almost invariably be able to get in the first blow, and it can hit very hard. Within a few hours of the declaration of war both attacks could have been made and their effects gauged, and the initial success would give A's forces the confidence of victors.

Still more daring and quite as feasible would it be for another portion of A's fleet to make a dash on B's capital, and even if this happened to be one or two hundred miles away from the frontier, it could possibly be reached on the same day that war was declared. Picture a great capital in the feverish excitement incident upon a declaration of war, picture the enthusiasm of the populace, the streets crowded with the frenzied populace as they clustered round the newspaper offices and public buildings, or cheered regiments on their way to the points of departure. And then imagine amidst all this excitement and enthusiasm a flock of strange bodies appearing suddenly in the sky, and growing rapidly in size as they approached.

"Airships!"—What an awful meaning the word would convey to the crowd suddenly struck dumb in their martial rejoicings! Who can describe the horror that would seize their hearts as they helplessly gazed at the strange monsters in the sky, and then realised for the first time that, through their conservatism, their scepticism, their stupidity, they had neglected to build an aerial fleet? What would be the feelings, too, of the military experts who, years or months previous, had solemnly assured the nation that nothing was to be feared from airships?

Ere the populace could find words the airships, with a few well-directed shells, would have wrecked the Parliament house, where perhaps at that moment the head of the military department was complacently assuring the listeners and the nation that their plan of campaign was superior to the enemy's, and that everything promised success! Lucky for him if the ruin of the Parliament house brought him death, for assuredly he and his experts who for years had pooh-poohed the value of airships, and had advised the government to spend no money on such rash experiments, would be given short shrift by the maddened crowd after the aerial attack had been delivered on the capital.

This is not a fanciful state of affairs: under the conditions that A had a well-trained aerial fleet and B not a single ship, it would be quite feasible. The distance of B's capital from the frontier (let us say two hundred miles) has already been actually covered by French and German airships, and the journey could be made up to speeds of forty miles an hour, that is in five hours. The ships could carry explosives, they could escape detection until almost over the capital, and then everything would be at their mercy. There is thus nothing at all impracticable about it even at the present moment.

Of course it would be only a demonstration: the houses of Parliament would be wrecked as well as those of the head of the state and his chief officers: a few railway stations might be rendered unusable for some time, and perhaps some barracks, magazines, and other army buildings destroyed. If intent on much destruction a few explosives amongst the various regiments of soldiers to be picked out, or amongst the dense masses of people in the principal streets, would give results as sanguinary as a long siege.

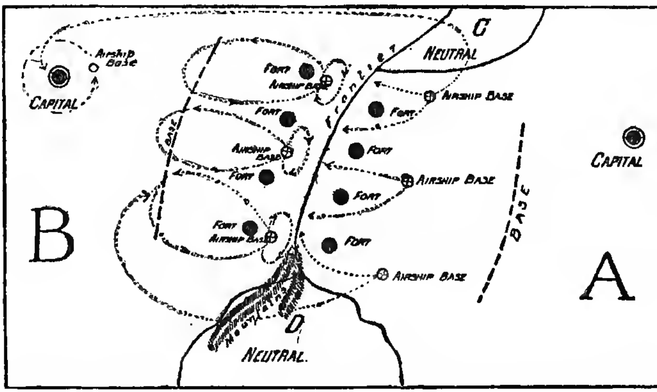
The moral effect of an enemy's aerial fleet merely appearing over B's capital within some hours of war being declared would in itself be so disastrous and so heartbreaking when known at the front that victory should be easy for A. But the raiders would assuredly attempt destruction of government buildings, magazines, ordnance works, military stores, railways, telegraph stations, food supplies, and even the national treasury and the banks would be endangered. There would hardly be a special gun or a well-trained gun crew to attack them, and certainly at such a moment no effective defence could be made against such an unexpected raid.

Here, again, we have the advent of aerial warships upsetting all preconceived notions as regards immunity from attack, and yet very many military experts will not admit the possibility of such things happening, and they hold doggedly to the idea that the airship has no value as a fighting force. If no airship had flown more than twenty miles, if the speeds were never more than a few miles an hour, if the cost of construction was enormous, and the risks of operation sufficient to deter any but a few foolhardy persons, then for the present such opinions might hold.

But the long-distance, high-speed airship is already in existence, it is practicable, though necessarily crude for the moment in several details, and it can be made at a price which compares very favourably indeed with any other form of locomotive used in warfare. But all this will not convince; and it will take an actual war with experiences similar to those which I have sketched to bring conviction to a large section of the public, and to many heads of nations, government officials, and military and naval experts.

The airship has, in fact, developed so rapidly that many people have not had time yet to accept its existence, and their natural scepticism and conservatism will prevent them from believing in its utility even after they have allowed that airships exist, and can travel through the air, and carry things—and can drop these things! The only conceivable factor to prevent or hamper the aerial fleet in its work would be stormy weather at the opening of the campaign, but this would be a very poor factor to rely upon, and the nation with the airships would by diplomatic means engineer the declaration of war to occur at a favourable time.

Case 2.—Now to turn to the second case where A and B have aerial fleets, and we presume both to be fairly equal at the outset in numbers. Much will depend on the types used, the manner in which they are employed, and the skill of the crews and commanders. Nothing but actual experience from such a campaign will settle the relative merits of the numerous classes of aerial war vessels that might be employed. But the nation with the longer experience may usually hope to have the better ships and the better men. The frontier would be carefully patrolled on both sides previous to hostilities, and here the first idea would be got as to superiority. If A's fleet were faster and had better ascensive power it is evident that it could outmanœuvre B, all other things being equal. But two well-matched and neigh-



War between two continental nations, A and B; both employing airships.

bouring powers would each probably have its fast cruisers in addition to the more powerful but slower vessels of the Dreadnought type.

Presuming, however, that A pinned its faith to Dreadnoughts and B to cruisers, an interesting case arises. The aim of A would be to get its big ships quickly over the forts or the base lines of B, or even to make a long-distance raid on B's capital. The B fleet of swift and high-rising vessels would act on the defensive as far as not crossing A's frontier to any extent. They would endeavour to get the "hawk position" on each of A's Dreadnoughts which crossed the frontier, and they would hope by their speed and rising power to be able to keep out of his clutches. The big vessel would probably carry pneumatic or other guns of far greater range than those the B cruisers could mount, and thus under many conditions it could destroy or put these cruisers out of action. The fictional idea of airships drawn up on the level like a fleet, and pounding away at each other, is hardly correct, as the ships are far more likely to take advantage of their aerostatic powers and manœuvre for the best altitudes.

The cruisers if well handled, and if sufficiently superior to the Dreadnoughts in speed and rising power, should be able to offer a very sturdy resistance, and perhaps defeat the attackers. They should in effect be able to guard the frontiers and lines of communication, but they would still have to be fast and numerous enough to guard against flank and rear attacks, which the Dreadnoughts could make, owing to their wider range of action.

Free to roam through the upper air in all directions, whether over neutral countries or the enemy's land, a section of A's Dreadnoughts might make a long detour over sea or some neighbouring state, and so arrive over B's capital to make a demonstration or a night attack; or else come up to the battle area from the rear and deliver an attack on the base or the lines of communication. The air will be a wonderful place for surprise attacks from all quarters, and the vessels capable of long-distance runs can make detours impossible for smaller vessels.

In theory, thus A's Dreadnoughts could best assume the rôle of attacker, whilst B's cruisers would keep to the defensive, and within their own territory, to guard against the many possible surprises. If ships could be spared, a swift raid might be made by the B cruisers as soon as all the units of A's fleet were located. The cruiser raid should not be for a long distance, nor could big supplies of explosives be carried, and thus the expeditions would hardly be so destructive as those possible for big ships. A's capital, unless fairly close to the scene of operations, would also be less liable to a raid than B's, owing to the small range of action of the cruisers.

From these considerations it would seem that an aerial fleet should comprise both Dreadnoughts and cruisers, and then the battle between rival powers would be settled by the relative merits of the ships, plus the element of luck.

Allowance must now be made for the use of aeroplanes, though as yet few of these instruments have been adapted for military work. Flying machines carrying two people would make admirable scouts along the frontier, as they would be very much faster than airships, and would attract less attention. As despatch carriers, too, they would easily outdistance even the swiftest motor-cars. It is within the bounds of possibility also that aeroplanes can eventually be employed for purposes of attack and defence, but as such they would work over restricted areas. They could repel airship raids somewhat in the manner of torpedo boats in naval warfare.

Circling high round the points to be protected, a few aeroplanes manned with bomb-throwers might be able to ward off the attack of a Dreadnought for a time, and perhaps "sink" her. The mosquito craft would not be easy marks for the Dreadnought, and their operators might be daring enough to dash for the big vessel and blow her up by collision, or rip up the gas envelope by the action of a pointed prow.

As aeroplanes so far depend on the working of their engines to keep aloft, their time is necessarily limited, nor is fuel supply the only thing militating against prolonged flight. The constant motion necessitated will also hamper the accurate aiming of projectiles against an enemy, for even from a slowly drifting balloon or dirigible this task is by no means easy.

Nevertheless, I attach the utmost importance to the development of the flying machine, and of all heavier-than-air machines, as at the present juncture it is quite impossible to determine their limits of utility.

The combined aeroplane and dirigible vessels also may play an important part in warfare, and as my interest in aeronautics is purely a scientific one, I hope that every form and type of machine will be developed to its utmost in order that we may arrive at the best selection.

It has been fancifully suggested by one writer that small aeroplanes may be carried on the large dirigible balloons, and the idea cannot be dismissed as impossible, though for some considerable time to come the plan will hardly be within the range of practical politics, and need not be further considered here.

CHAPTER XI

OVER-SEA OPERATIONS

I ENTER with some diffidence upon this chapter because the theme is so novel that so far it has scarcely been touched upon, and certainly no naval writer has given serious thought to the possibility of airships being employed in sea fighting, or of their attacks being directed against sea fleets in harbour. As far back as the Napoleonic days there were suggestions of balloons being utilised to convey troops across the Channel when the way was clear; and the fantastic notion has even in this year of grace found publicity in the daily Press that Germany has planned a huge fleet of airships to land a big force of men and arms upon the English coast. Once and for all it may be definitely laid down that airships are quite unfitted for the transport of the men, arms, horses, and stores necessary for any form of military expedition, and the notion may be dismissed as absurd.

But a more daring rôle may be played by airships in actually fighting ships on the sea, or crippling them in surprise attacks. I will again take the case of two rival powers, in this case separated by a stretch of high sea, with

(1) Y having an aerial fleet, X having none;

(2) X and Y having aerial fleets.

Case 1.—In the first case we will assume that X has a very large navy, and relies upon this mainly for the defence of his coast and shipping. Y, on the contrary, has a relatively small navy, but a very large army, sufficient to overwhelm X if a landing could be effected. Through good fortune or enterprise Y has built up an aerial fleet of such speed and range of action that the vessels are considered capable of crossing the intervening sea space between the two countries, and of returning to their bases without replenishing fuel or supplies. Store ships at sea would also furnish other bases of supply.

We will also assume that X is westward of Y, and that the bee-line distance between the most contiguous points of X and Y is three hundred miles, and owing to the conformation of the two countries Y's airships can attack with favouring winds over half the compass; that is to say, Y can avail of northerly, easterly, and southerly winds to reach X, according to the stations which the airships are despatched from. Or, on the other hand, with a strong *west* wind blowing, Y can still attack from the north or south with only a side wind to hamper progress.

Finally, we must postulate that as X has no airships designed for naval work his naval experts do not anticipate any real danger from airship attack, and have taken no special precautions, fitted no special guns, or built any aerial observation stations. In a word, they expect attack only from ships on the sea, and concentrate all their efforts in preparing for this.

The policy of Y with its small navy will be to lead a secret and desperate aerial attack on the naval bases where X's navy mobilises. It may cloak its intention by preparing for a naval raid also, but the real object will be to sacrifice a portion of the aerial fleet in an attempt to reduce the preponderance of X's navy at one or more points, and thus make an opening which would allow the landing of an expeditionary force ere the remainder of X's navy could concentrate to prevent it.

The questions which every naval expert should ask himself are, Can this be done now? or, *Can it ever be done?* In our hypothetical case X's naval advisers have laughed the two questions to scorn.

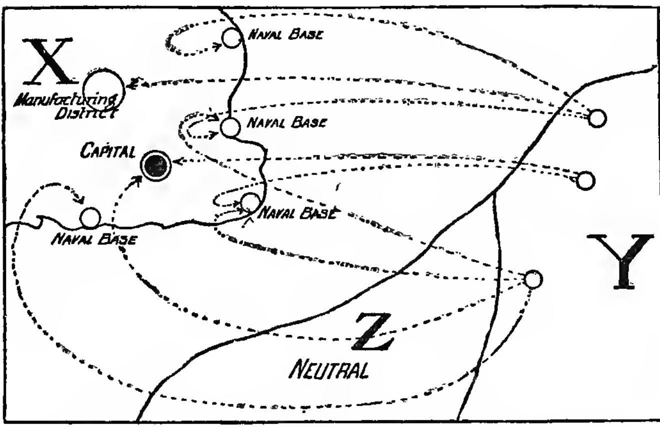
As the nation to derive most advantage from a sudden attack opportunely timed, Y's diplomats will take the decisive step at a period when the aerial raid can best be attempted, and X, disdainful of danger therefrom, may not seek to checkmate them in this respect since they profess to have their navy always ready. Even if X forces matters to an issue rather prematurely it will be for reasons other than those affecting the operations of an aerial fleet. In any case, however, the airships will be ready, and some hours before the actual declaration of hostilities they can steal out in absolute secrecy, and by devious ways make for "certain places" off X's coast.

The weather element will be the only uncertain factor, but if Y's airships can stem direct winds up to speeds of thirty miles an hour, and have points, say, due east, north-east, and south-east of X to start from, nothing short of a very fierce westerly gale could absolutely prevent Y's airships from reaching X's coast. A well equipped and high-speed aerial vessel skilfully navigated could make almost any point of the compass during most days of the year, though I will not maintain that an airship can ever be so weatherworthy as seaships.

Nevertheless, a nation without airships must not place too much dependence on meteorological conditions preventing an enemy's aerial armada from reaching its shores; and as rapid progress is being made in engines, propellers, etc., it may be naturally expected that in the next few years airships will be able to take the air on far more days than at present.

If we even take the very erroneous estimate of an airship being able to reach its objective for fifty per cent of the year, or on 182 days out of 365, there is sufficient margin to justify the building of such vessels when only a distance of two or three hundred miles separates two rival countries. As time goes on the percentage of days on which an airship can be used in over-sea operations may rise as high as eighty or ninety per cent, and indeed we cannot set the ultimate limit.

Certainly, if a campaign opened in the summer months Y's aerial fleet might in all reasonableness hope to find at least one day in the first week of the operations on which to make a raid. They could bide their time, as they could never be blockaded or checked in their over-sea journey. Assuming the distance between X and Y to be three hundred miles, the airships could reach their objective in ten or twelve hours and do their work within the next hour or so. To Y it would be a comparatively minor point about their return. The object of the raid would be to cripple some part of X's naval power at all costs. Thus Y's aerial fleet would need only a favourable half-day on which to attempt their enterprise, and assuredly they would, if necessary, be prepared to take some weather risks rather than delay the work unduly. Moreover, as they could attack from the north, east, or south, and as the fleet would set out in sections from two or three points perhaps a hundred miles apart, and each with special points on X's east or south coast as objectives, the chance of some part of the fleet attaining its object would be very favourable.



War between a continental nation, Y, and an insular power, X; the former using airships.

Various schemes would suggest themselves to Y as to the conduct of his aerial raid. With X's four great naval bases, say, three hundred miles apart (or about fifteen hours for warships to cover the space) he would possibly seek to cripple one or more of them, and then operate his own sea fleet to cover a landing of troops on X's territory ere the remainder of X's fleet could prevent this. With four naval bases to work against, and these, say, to the north-west, the west, and the south-west of Y, he would have a wide choice of weather conditions, since the air current which impeded progress towards one of X's bases would favour a rapid journey to another.

In fair weather Y would probably manœuvre to deliver a smashing blow almost simultaneous with the declaration of war, and I will show how this is feasible with an airship flotilla. Some six or eight hours before hostilities opened, and when it was seen that war was inevitable, Y's aerial fleet would secretly set out for "certain places" over the open sea perhaps one hundred miles from X's coast, but on the way to the naval bases on which attack was to be made. They would meet secret service or other vessels and take in fresh supplies of fuel, and then travel to within fifty miles of the enemy's coast. The ships would soar very high and endeavour to keep quite out of sight of X's observers. Or an over-night journey inland might be made to some hilly and almost uninhabited part of X, well to the rear of the naval stations, if information were received that X's naval scouts were so far out to sea that the sea station was unsuitable for the airships.

Remembering that X disdained airship attacks it should not be impossible for Y to act on one of these plans to get its airships within two hours' run (fifty or sixty miles) of the naval bases, and to keep them undetected in the air until a wireless message to strike had been received from headquarters. The fact that attack could come from the land side as well as from the sea, and that the airships could make a raid on the base from almost any point of the compass, would quite upset all preconceived notions of the defenders of the base, especially if they had so despised aerial navigation as never to have seriously studied its possibilities.

The land attack on X's naval base might be a tragic surprise for it, as most naval bases are not planned to resist bombardment from the land side. Something like consternation would reign when within two hours after the declaration of war a strange airship sailed over the naval harbour from the landward side, and, ere a gun could be trained on it, rained down a terrible shower of explosives. The attack might take place in the evening, the early morning, or even at night; for at any time the experts in the airship aided by their secret service guides and pilots would be able to locate X's great naval harbours. By the fortune of war, the major part of the fleet might escape damage, but assuredly enormous destruction could be wrought by well-aimed explosives and petrol bombs rained down on the stores, the forts, magazines, telegraph stations, the reserve portion of the fleet, and the harbour defences, and at the same time invaluable information could be wired back to Y's head-quarters as to the disposition of X's fleet.

A night attack would be feasible under many conditions, and too much trust could not be placed upon the searchlights at the naval base discovering an airship at a high altitude when an attack might be feared either from the land or sea side. Indeed, if the authorities relied only upon the ordinary defence arrangements, the onslaught of the airships would produce a most disastrous effect; and even if only a slight demonstration were made the moral effect would be tremendous. In brief, if X disdained airships and possessed none of them, it would have few, if any, of the appliances useful in fighting against them, and would hardly have evolved special tactics to cope with them. Thus, taken more or less by surprise, the defence made against aerial attack would hardly be very effective, and the airships of Y would have an excellent chance of doing considerable damage.

Apart from the surprise occasioned by such an attack on a naval base with a section of the fleet stationed there, one must allow for the possibility of the high-angle firing from the forts, and likewise the shots from the fleet, causing destruction on land or water, unless provision were made of special ammunition for use against airships. But if a nation lays itself out to prepare special defences against aerial attack, and prepares for the possibility of such in its scheme of operations, it will have intelligence enough to take the further obvious step of building and using airships of its own, and thus providing the only adequate defence against an enemy's aerial attack.

But as we have presumed X to be too conservative to do this, it must suffer the inevitable consequences of letting Y secure the benefit of its many years of careful work and preparation. If four aerial attacks were made on X's four naval bases, or if four successive attacks were made on one of the bases, it can be presumed that X's fleet would be weakened seriously if not destroyed at one strategic point. This would be Y's opportunity, as it would have twelve or fifteen hours in which to force a landing near such a point ere X's fleets from the other three naval bases (each fifteen hours away) could come up and prevent it. Possibly a message might reach these bases some hours before the destruction of the attacked base was completed, and so I allow that X's remaining fleets might come up in twelve hours.

In far less time than that Y should have been able to make a move with its seaships and effected a landing, since we have taken it for granted that Y's main object is to fling a portion of his enormous army on the shores of X. All this, be it remembered, takes place within the first twenty-four hours of war being declared, since Y has manœuvred its airships to attack within the first two hours of the declaration, and at such a time we may presume that each of X's fleets will be in the neighbourhood of its naval bases, and naval feints by Y may encourage them to remain there. The concentrated attack on the central one of X's stations would perhaps be most effective, since the full fleet of airships acting over docks and roadstead would be able to do widespread damage in a very brief period before a proper defence could be set up. There would be more likelihood of confusion, too, amongst the defenders when attacked by such unexpected enemies from all quarters.

Meantime Y's whole available navy would be advancing, a reserve airship keeping it in touch with the progress of the fight. If all went well with the attack, it would be safe to push forward the sea fleet and the transports so as to effect a landing ere the remaining fleets of X could combine.

Of course Y's airships might have to contend with a combination of X's fleets, as it would be open for X to group its ships in various ways on war being imminent. But the probability is that X would work on the old naval tactics in which it would have to fight the sea-power of Y. Therefore an aerial fleet would have an opportunity of completely upsetting the effectiveness of this. The airships by their superior power, their absolute secrecy of movement, and most of all by reason of the disregard paid to them by X, could strike any point within two hours of war being declared, and high up in the air would be decided the policy which was to be put in force against X according to the actual disposition of its fleets.

According to its old traditions X would have its fleet ready to meet the navy of Y, and to beat him by weight of numbers. But even a sudden diversion created at a well-chosen point by the airships would greatly mar these plans, and large though X's navy was it would find great difficulty in coping with the difficulties which would thus unexpectedly arise.

Even if I take the extreme case that Y's airships were afraid to attack any part of X's fleet or any one of its naval bases, we have still to reckon many other possibilities. The airship, it is true, cannot land men, but it can conduct the most destructive raids over any part of *land or sea* that may be chosen. We have seen in our premises that X depending for security on its enormous and excellent navy has very small land forces, and perhaps has not kept them up to date in training and equipment. Thus there is little or no coast defence save at important points such as naval bases and ports.

This circumstance will render it quite feasible for Y to send its airships over X's capital within a few hours of war being declared, and nothing imaginable can strike such cold terror into the heart of a nation as to have an enemy hovering above its metropolis just at the moment when it is exulting in its great and unconquerable power. I have already tried to describe the panic which an airship raid would produce in the case of a continental capital; much worse would the effect be in the case of an island capital, which boasted complete immunity from all enemies owing to its watchful and all-powerful navy, and thus had few land defences. Little or no defence could be made by X since its army is small and defectively trained, and since its capital is without defensive works of any kind from which an attack could be made on the raiding airships.

The few soldiers would be quite unable to prevent the enemy wrecking the sovereign's palace, the houses of Parliament, the national treasury, exploding the gas works, destroying the electric light and water supplies, the railway stations, the Admiralty wireless stations, the War Office, and the various other important points which would be so well known to those on board the vessels. The nation could be struck at its heart, and would lie helpless and bleeding whilst its navy watched the shores for the enemy that did not come. Of what avail would the great fleet be at such a moment? What an empty mockery would its sea-power be!

Nor does the terrible tale end here. Similar raids could be made all over the provinces, destroying the great manufacturing towns, the collieries, the mercantile shipping centres, and all internal communications, until eventually the splendid navy of X would be guarding a mangled and dying nation, which might be driven at length to sue for peace ere its navy fired a shot, so helpless would it be under the rain of explosives hurled down from the sky. X's food supply from over-sea, and its shipping upon the various seas, could be raided also, and many a good cargo might be sent to the bottom before a war-ship could come to the rescue. The airship could go in every direction, steer a bee-line to well-nigh any point, and the merchant ships pursuing their tortuous courses would be wholly at their mercy. X's fleet would be holding the strategic points which would prevent Y's navy from operating, but sooner or later the aerial raids might cause such a change of tactics that Y's navy could eventually find an opening for effecting a landing of troops on X. That would be the end.

Perhaps the reader will declare all this too fanciful, but let him hark back to the accomplishments of the comparatively crude airships now in existence, and let him make all due allowance for rough weather, and then can he totally deny that a few years hence the state of affairs I have set out is impossible or even improbable? Let him remember that the practical airship has not been seven years in existence, and yet it has higher speed than any naval vessel, and almost day by day is being improved in reliability and range of action. We have reached almost the limit in speed of vessels on the sea: we are only at the beginning of aerial development.

Case 2.—It is a more pleasing task to weigh up the chances of X and Y, when both in addition to fleets on the sea have vessels in the air. As in Case 1 we assume that Y has a small but growing and effective navy, and further we will assume that it has a much larger and more up-to-date aerial force than X, the latter country having built only a few more or less experimental vessels. As before, Y's plan will be to strike the first blow with its well-trained aerial fleet. This is of the over-sea type, whilst X, owing to conservatism, treasury niggardliness, etc., has only small ships, with limited range of action, and not fast enough for over-sea work. They belong to the military organisation, and have found small favour with the naval authorities.

At the outbreak of war X would furbish up his airships, and being a trifle afraid of Y's airships, since it has seen what its own crude vessels could do, would send its aerial fleet to the naval stations. At once Y would have to alter its tactics, and the task of a surprise would be rendered very difficult. Indeed, a very good scheme of defence could be carried out by X's airships if they were at all well handled. In the first place these vessels must be destroyed by Y, and this operation would give the fleet and forts some little time to make their preparations. Indeed, a surprise attack on the naval bases might be obviated by the presence of X's aerial fleet, especially if combined training had been carried out by X's airships, fleet, and forts.

Y's airships would ultimately destroy X's, as we have taken them to be inferior in number, fighting power, speed, and equipment. But they would have gained breathing-time for the nation, and with a few distributed at the naval bases, the capital, and the provincial centres, at least a humiliating defeat would be avoided. In addition, X's army and navy might have studied the powers and possibilities of its airships, and intelligent commanders in both services would assuredly have devised special modes of defence and attack. In a word, the nation would be prepared to some degree for aerial attack, and a very stubborn defence might be made. But granting Y the advantage which it would deserve to gain by having given many years of work to its aerial fleet ere X made any move in this direction; and granting that it had vastly superior vessels, and outnumbered X, we can assume that under normal circumstances: (1) Y would destroy X's aerial fleet; (2) Y could then raid X's capital, manufacturing and shipping centres; (3) attack his mercantile fleet at sea; (4) and finally choose an opportune moment for a desperate attack on X's naval bases or a section of its fleet, with an aim to clear a way for Y's main fleet to operate.

So far it has been presumed that Y's navy played a waiting game, but it would be strong enough to take an offensive part at any opportune moment, or else create diversions which would scatter X's forces. It can never be assumed that airships can fight a navy, and Y could not decrease its naval power because it was also building airships. An aerial force comes as a new factor in the war game: it displaces none of the old factors, but it makes new developments. It is quite fallacious to hope that a nation can conquer by means of her airships alone: she must have an army and a navy to follow up the blow struck by the aerial craft.

If this point were more generally allowed, perhaps there would be less prejudice against airships amongst military and naval men.

In an actual naval engagement between Y and X the superior airships of the former would be capable of lending assistance. They would be effective scouts, they could prove useful in directing gun-fire, and they would help also in watching the operations of submarines, as a surprisingly good view of objects in the water is obtained from aerial vessels. Indeed, submarines away from the main fleet would be at the mercy of airships. Mines also could be located with ease and without danger.

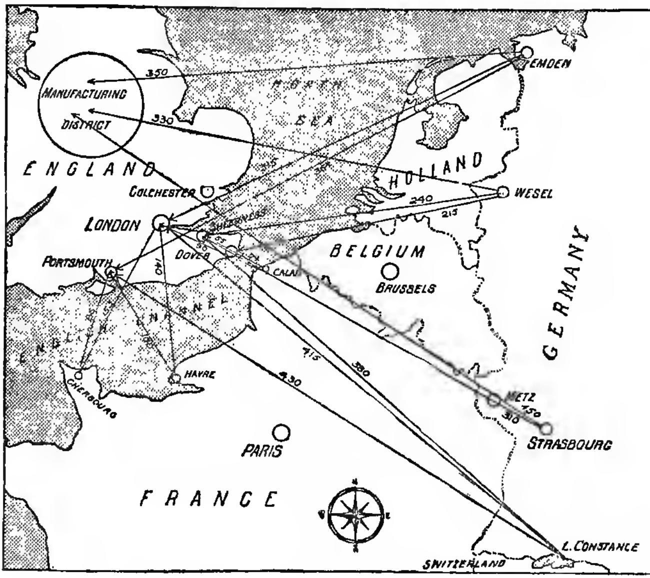
CHAPTER XII

CAN ENGLAND BE RAIDED?

TO the military or naval expert every other nation than his own must be regarded as a possible enemy; and, to provide for eventualities, plans of campaign have to be prepared and kept up-to-date, no matter how favourable the political relations of the nations may be at the time. It will not be necessary in this book to consider all these plans so far as they affect England, but as showing the potentialities of aerial warfare it will be of interest to take some typical examples, and I have selected the three following for study: (*a*) War between England and Germany; (*b*) War between England and France; (*c*) War between England and a Franco-German combination. Two of the powers concerned have given much attention to airships, and thus it may serve a useful purpose if I indicate how this new force might be used by them against England, presuming, for the sake of argument, that England maintains its present official attitude towards airships.

Can England be Raided?

It has become a settled idea that as we are an island power we can only be attacked by sea, and as long as our navy comes up to a certain standard of strength, we are to believe that all is well. Britishers as yet have no confidence in



Map showing distances from the principal strategic points of France and Germany to the English capital and naval bases.

aerial locomotion. In fact, the average Britisher is badly educated in aeronautics, and hardly gives the subject any serious consideration. In England we have some balloon displays per annum: our military authorities have made a not altogether happy attempt to evolve an airship: and at a few shows in the country there have been parachute descents and an occasional accident. This was, up to September, 1909, about the sum total of our work to navigate the air.

No wonder that little thought is given to the naval and military possibilities of aerial navigation. When John Bull reads of French and German experiments he smiles in contempt at them, just as in the early days of motoring. His conservatism as regards motoring cost him millions of money, which was paid to foreign manufacturers when he found that motor-cars were necessary things, and when he discovered that the enterprising continental nations had got their motor factories in working order some years ahead of him.

The realisation that we have been outstripped in aerial navigation may not be paid for so cheaply, and it is not for nothing that the Germans are now quietly sinking hundreds of thousands of pounds in this work. The fostering care of the French and German Governments, extended over a number of years, will soon give them the plans of well-tried airships, which can be rapidly duplicated once an approved design is arrived at. That period may have been reached already for all we know, but as far as we are concerned years must elapse ere we can draw level, for alas! we have no Count Zeppelin, who has given his life work to his country, no Parseval or Gross, no Lebaudy, Julliot, Deutsch, or de la Vaulx, and the few workers who courageously evolved our first crude airship have had no official encouragement and very little assistance.

(*a*) ENGLAND *v.* GERMANY

In the *Zeppelin* type of vessel Germany has an airship capable of carrying, say, fifteen people, and a large supply of fuel and stores. There is nothing to prevent it mounting wireless telegraphy, and having aerial torpedoes, explosives, and special guns. In fact, she can be made an aerial warship, and she will be supreme in her element. She can run against a thirty-mile-an-hour breeze, and on a favouring wind can show speeds up to fifty or sixty miles an hour. In the new vessels the range of action will probably be over 800 miles, that is, some 400 miles out from the base, and 400 miles back. Theoretically, by utilising suitable winds on the out or home journey, or on both, the ship might be able to travel 1000 miles ere its fuel supply was exhausted. It could also replenish from storeships at sea.

There is no rash surmise about these figures: they depend upon mechanical facts. The lifting power of the vessel is governed by the volume of the balloon, and also in the case of the *Zeppelin* by the power of the engines and the efficiency of the lifting planes. A vessel of this type has already taken up a load of twenty men, and has been manœuvred with ease. Thus we must face the fact that Germany has an airship capable of carrying sufficient men to work her over a long distance, sufficient fuel and supplies, and also no small storage capacity for destructive agents. As to speed, we can reckon thirty miles an hour as a fair average for the latest vessel.

Now, if we glance at the diagram, it will be noted that a straight run of 380 miles would take the *Zeppelin* from Lake Constance to Sheerness, one of our important naval centres, in less than thirteen hours, if an average speed of thirty miles an hour were kept up. If she chose to attack, we have absolutely nothing that could stop her.

She would travel over Germany, France, the Channel, and England during the night without the least fear of detection, and could strike with literally the suddenness of a bolt from the blue. Our forts and warships are not designed to fight aerial attackers. Indeed, without special high-angle guns, worked by specially trained crews, and firing high-explosive shells, we could offer hardly any resistance. And, even if by any good chance such an attacker were brought down eventually, it could certainly get in its blow first.

It could do enormous damage, it could send invaluable wireless messages back to head-quarters, and then, if destroyed by chance, it would mean but the loss of a vessel costing, say, £20,000 and the lives of a few men. A torpedo-boat attack would cost more in lives and cash value of vessels destroyed, and it certainly could not effect so much.

An airship of the modern type is practically an invisible enemy, it has greater speed than any warship, and, as it can pursue almost a straight line, it can get from point to point, over either land or water, more rapidly than any other form of military or naval locomotive. The upper air is free to all, and a German airship could take its line across France or any other country without protest. In fact it would probably never be seen, and this matter of invisible attack is the most terrifying feature of aerial warfare.

There is nothing to prevent a rival's airship travelling at night up to a point a few miles from our shores, and there hovering for the appointed time to strike. In a critical time, before war were declared, an aerial fleet might be massed some forty or fifty miles away from our coasts, and on receiving a wireless message *could strike within two hours of war being declared!* No naval force, of course, could do anything of the kind, nor could as rapid an attack be delivered by a military force on land, since the massing of large numbers of men near a frontier would be noted many hours before an attack could be delivered. Indeed, the more one studies the aerial problem the more one discovers the surprising nature of the work that can be attempted, and the enormous damage that it is possible to effect.

It may be argued that the weather will prevent airships being used in naval attacks. This, however, is but a dwindling factor of safety. The higher the speed of the vessel the stronger the wind it can travel against, and airship speed and power are steadily increasing. The rigid Zeppelin vessel is little subject to the danger of buckling from side currents and squalls, and nothing short of a strong gale could absolutely prevent it from reaching our shores if the journey had to be made. Then again, the geographical relation of Germany to England gives our neighbours a wide choice of wind to work with or against. In process of time the Germans will undoubtedly have aerial stations at various strategical points near the frontier, and for purposes of illustration I have supposed them to be in the neighbourhood of Strasburg, and near Wesel, Emden, and Friedrichshafen.

If we suppose a west or north-west wind blowing over England with a speed of thirty miles an hour, it might be imagined that a thirty-mile-an-hour airship from Germany would be unable to reach us. This might be so if a start were made from a point due east of us, such as Strasburg or Wesel. But it is obvious that if the vessels set out from Kiel or Bremen in the north-east, or Friedrichshafen in the south-east, they would have to fight only against a side wind instead of a head wind; and of course there would be nothing to prevent them making a long sweep round either by the North Sea or across southern France so as to come down on Portsmouth, London, or Sheerness on the westerly wind. As I have said, every path is open to the airship, and even if tacking has to be done lost time can quickly be made up for. Furthermore, as the direction of the wind varies in the most extraordinary way at various altitudes, a vessel by soaring aloft or descending might find a favouring breeze.

Of course in really rough weather the airship, as at present known, could not be used; but in practically every month of the year many days would be suitable for it to go aloft. The great danger lies in coming to earth again, and airships bent on a destructive mission would have no occasion to come down until the work had been carried out. They would be equipped with fuel and stores for a nine hundred or a thousand miles run, and by taking advantage of favouring winds could husband their fuel supply so that they could keep aloft near the enemy for a very considerable time.

Sheerness, Portsmouth, and Rosyth would all be open to land or sea attack, whilst another section of the aerial fleet could make destructive raids on London, the midlands, the manufacturing districts, Liverpool, and other great commercial ports, where no defences exist. Our artillery forces are not large enough to give protection at all these points and at the same time take up the strategic stations that they would have to fill on the outbreak of war. In preparation for a landing of German forces, the bulk of our artillery would be needed near the east and south coasts, and many other important points would have to go unprotected against aerial raids.

The German aerial fleet, by crippling our naval forces at two such points as Sheerness and Portsmouth, would open the way for a German naval raid covering an expeditionary force. The landing of a German army on our shores would be possible in no other way—and it would be the last chapter of the war!

The successful night attacks on Sheerness, or Dover, and Portsmouth, with the consequent crippling of the main portions of the British fleet at these points, would leave our eastern and southern coasts open for several hours, and the German fleet would probably seize the opportunity of escorting its ready-prepared transports to the appointed places. Under the guns of the German fleet this force could land and find protection until it was ready for action. The airships would render the troops assistance on land, and would also watch all the movements of the other sections of the British fleet, which would then be concentrating. Further aerial attacks, followed up by the full force of the German navy, might then prove too much for the British ships; or, at least, prevent them from guarding the coast as effectively as they could have done had no aerial attacks been made in the first instance on Sheerness, Dover, and Portsmouth.

(*b*) ENGLAND *v.* FRANCE

War between France and England would be a foregone conclusion under the conditions which English strategists consider that it would be waged—that is to say, making no allowance for the French aerial fleet. The French navy in northern waters is too feeble to make any stand against the English ships, and even the arrival of the French Mediterranean fleet would hardly alter the situation. The French might do some destruction with their submarines and torpedo flotillas, and might for some time preserve their fleet and harbours. But very soon the British fleet would destroy or capture the whole French naval forces, bombard her principal ports, and completely blockade the country.

The magnificent French army would be useless, or, at most, could merely prevent a landing of an English force, but as this would be unnecessary the English would not attempt it.

For France to carry out a naval raid on England and land a body of men would be impossible also under the assumption that no airships existed: but when we take into consideration that France at present has six well-tried airships, and by the end of the year will have at least eight, we must make allowance for this new factor. We must also reckon on her aeroplanists, and take it that fifty or more flying-machines could be turned out in an emergency with men who could fly at least fifty miles each. If, as is probable, the French Government takes over these flying-machines, we must allow for a little fleet of aeroplanes which at no distant date will be able to fly a hundred miles or so without touching earth. Many of these would be attached to the seaships, and would constitute a new auxiliary to the navy.

Allowing France a fleet of six dirigibles, each with a range of action of 500 miles, and fifty aeroplanes, each able to fly fifty miles without descending, let us see how a clever strategist might employ them. His great aim would be to cripple some section of the British fleet so as to clear the way for a French naval raid escorting a force of the French army big enough to hold its ground in England until fresh reinforcements could be landed. Given a sufficient force of French soldiers in England, with their splendid infantry and unequalled artillery, and it might be safely concluded that the British land forces could not repel them. All the evils of the present system of the English army and its auxiliaries would then be made evident, and the French, with the aid of their remaining airships and aeroplanes, would set British strategy at naught, since every movement of our forces could be watched and reported from the airships. The land campaign under such conditions would be short and decisive, and the French would soon be in possession.

A glance at the map on page 165 will show that on the declaration of war France could quickly carry out an aerial raid. From Calais to Dover is under twenty-four miles, and thus a French airship could be over that port within an hour of war being declared, or even sooner if her commander intelligently anticipated developments. From Calais to Sheerness, the Thames naval base, is but fifty-five miles, and thus within two hours' flight. A night raid on Sheerness by airships from the land side could almost cripple that portion of our fleet stationed there, and very little resistance could be made. Warships would have explosives rained down on them, naval stores and magazines would be destroyed, and merchant shipping in the Thames and Medway would be sunk, thus blocking part of the channels.

Very little defence could be made against this attack from the skies, if carried out at night; and two airships could do almost incalculable damage and seriously injure one important section of our fleet. If part of our warships were massed at Dover similar destruction could be accomplished, and in the meantime two more of the French airships could have sailed the hundred miles between Havre and Portsmouth, and there also made a desperate attack on the fleet. I have already elaborated the results which would arise from a similar attack delivered by a German aerial force, and thus I need not go into details here.

Suffice it to say, that if the French could cripple or disorganise the important sections of the British fleet to be found at Dover, Sheerness, and Portsmouth at the commencement of a war, there would be a splendid opening for a naval raid on some part of the coast which would cover the landing of an expeditionary force. Owing to the short distance between the two shores, the transports might make a double journey, and so land such a big force of the French army that the success of the campaign would be tolerably certain.

If the airships had kept the sea clear for half a day such a raid would be possible, and even if before the declaration of war the British battleships had pushed well out from their bases, the airships could still damage them very severely in a night attack, and make an opening for the raid. The whole French fleet would be intact after the airships had done their work, and they would be encouraged to push home a raid and land troops with all haste. The landing of French troops in England would be the beginning of the end, for it is never seriously considered that the home section of the British army could hold its own against a crack continental army, especially when the latter would be aided by airships and aeroplanes.

In effect, if the aerial raids were successful, and damaged the big ships of the British fleet, and destroyed one or more of the naval bases, France would have every opportunity of landing so many men that our army would certainly be defeated, and as the country is without internal land defences the progress of the French army to the capital would be rapid.

The massing together of the other sections of the British fleet by that time would be too late, since the country would practically be in the hands of the French, and the capital at their mercy. Any British naval victory then would be barren, and the French airships would always be able to keep up communication with France, as well as deliver further attacks on the navy.

Thus with the aid of her aerial fleet France might hope to combat England successfully, whilst without such aid the struggle would be altogether in favour of England.

(*c*) ENGLAND *v.* FRANCE AND GERMANY

In the third case, where we take it that France and Germany have allied against England, the attackers would have some hope of success even without the aid of their airships. With the double fleet of French and German aerial vessels the prospect of victory would be enormously increased. In a war of this nature the naval vessels of France and Germany would endeavour to "draw" a portion of the British ships so that the airships might the more readily destroy them. Any close assembly of British warships at night would be open to destruction by airships, and unless they were protected by aeroplanes and other aerial defences they could make little effective resistance.

The combined Franco-German aerial fleet would be very powerful, and if they elected to steer clear of the British warships they could lay waste all England whilst the helpless navy would patrol the shores.

It is not easy for the British public to accept these possibilities, for the majority of the experts do not yet admit them, and the idea of the invincibility of the "blue-water" policy cannot be knocked out of their heads. But in a very few years the advance in aeronautics will be so evident that these theories will have to be seriously considered by our experts, and perhaps too late in the day they will set about forming a British aerial navy. The inestimable value of the experience which France and Germany are now acquiring will be sadly admitted when our designers make sudden and futile efforts to draw level with their rivals. Not until we have a successful fleet of dirigible balloons and aeroplanes in our military and naval services can it be possible for the authorities to correctly gauge the importance of airships in warfare. No scheme of land or sea defence will be adequate against these vessels, and, as I have endeavoured to sketch, a very real danger will exist of lightning-like raids on our naval bases and capital almost simultaneous with the declaration of war. With the progress of aeronautics a naval force, however large, will be unable to guarantee protection as heretofore. The ships can only guard the sea, as the army can only guard the land. In the air the real danger now exists.

At the time when the second edition of this book goes to press conditions in England have somewhat improved, as the naval authorities are building a rigid type airship, and the army is contemplating the purchase of a French dirigible. But England is still a long way off from having an aerial navy.

CHAPTER XIII

COAST AND COLONIAL DEFENCE, TROPICAL EXPEDITIONS, ETC.

SEVERAL other modes of using airships now present themselves, apart from those considered in war by land or sea between two great powers. Though a large navy be set aside to guard a nation's shores, we must always allow the possibility of a naval raid against it succeeding, and of a force of the enemy securing a landing. Even if there is an adequate military force available to engage with these invaders, it will be admitted that a vessel like an airship would be of immense assistance to the defenders. By its speed it could patrol a large area of coast-line, and could give instant warning both to fleet and land forces should an attacking force be sighted. If well equipped, it could even take a part in the fighting, and possibly help to scare off a naval raiding force, which, seeing that the alarm had been raised, would realise that success was rendered almost impossible. Thus the airship is an important means of defence for every nation.

Aerial raids could also be guarded against much better than by any other form of observation, and a speedy little home fleet of airships, aided perhaps by aeroplanes, could do much to mar the plans of an invading enemy. Of a certainty, the existence of a number of vessels such as these would diminish the work and anxiety of the naval forces when war was impending.

Colonial defence is another problem which will be helped to a solution by the development of airships. Many distant colonies belonging to great powers are at times left in a most defenceless condition owing to movements of the small fleet which can be spared to guard them. With two great powers at war various outlying possessions belonging to one might be exposed to attack from the other. The colonies have a right to protection, but the mother countries would in time of grave danger look to their own interests first. For young colonies to build up a naval fleet of their own is impossible, owing to the enormous cost, and their land defences are oftentimes inadequate to protect them from even a small invading force. Airships will be comparatively inexpensive, and quite serviceable dirigibles can in time be obtainable at from £15,000 to £20,000. Indeed, prices may be brought down to £10,000 for well-equipped vessels, and to £1000 for well-equipped aeroplanes, and the colony which could not afford a number of these hardly deserves to be under the flag of a great nation.

A fleet of these vessels would cost very little in upkeep, would be manned by a small force, and in emergency would be able to tackle the comparatively small force of an enemy's fleet which could be spared to attack a colony.

For the defence of outlying and isolated places, both on the coast and inland, the airship will play a most important part; and in savage lands the moral effect of such an instrument of war is impossible to conceive.

Such an expedition would cost very little, and be appallingly swift in its action; the ordinary punitive expedition is an enormously costly affair in lives and money, and drags on for months.

For land operations over difficult country, as, for instance, on the frontiers of the Indian Empire, the airship would also be invaluable, though it should be of a very high ascensive type to give it good clearance from the hill-tops on which snipers might lurk. The usual punitive expedition has to crawl along at the rate of a few miles a day, and may take months to attain its object, running great risk all the time from the small bands of the enemy who occupy un-get-at-able positions on the hills. An airship with a radius of six hundred miles could make the necessary demonstration in a few days, establishing a convenient base from which to make one swift scour amongst the hills. The most secret valleys, the most secure retreats of the enemy would be opened out beneath the ship, and it would be very quick work to pour shells into points unreachable by any other means. The appearance of the airship would strike terror into the tribes.

For all forms of difficult fighting in every part of the world where at present the progress of land forces is limited to a few miles a day owing to natural difficulties, the airship will in time be indispensable, as by its unrestricted speed in free air it can accomplish in some hours what a large expedition might take months at. Over deserts, malarial regions, mountains, or marshy countries, or in fact wherever land or water transport is difficult, the airship will eventually be of immense use. It will enable an expedition to be made with astounding rapidity, it will create the most terrifying effect on savage races, and the awful wastage of life occasioned to white troops by such expeditionary work would be avoided, whilst the cost would be considerably reduced.

The time will come when assuredly every important outpost of the great empires will have its airship, and each of these will be able to accomplish as effective patrol work inland as the warships of these nations can undertake along the coast. Many good effects will arise from this method of protecting the rights of white men in distant climes, and it is tolerably certain that the saving in human life, the minimising of wanton cruelty, and the protection of innocent non-combatants from accidental injury will be among the humane advantages to result from the new method of warfare. Punishment — sharp, severe, and terrible — can be meted out to offenders, but this punishment can be confined to those actually implicated, instead of injury and damage being spread over a wide area. Coming from the skies, too, this punishment will have a moral effect on uncivilised races which we can hardly conceive.

Indeed, in every branch of warfare, whether between civilised nations on land or sea, or in expeditions against savage races, the airship will make the operations more humane in that non-combatants will be rendered more immune from injury than at present, and I urge this as a very strong point in favour of the general adoption of airships. War will undoubtedly become more terrible by the use of airships, and I have suggested that this will cause nations to pause well before they resort to arms. Until an actual war, the utility of the airship will not be fully known, and each nation may fear that its rival has a better type of vessel than its own, and so may defer making war.

But once a war is entered upon, its progress will be accelerated by the use of airships, and thus a decision will be more quickly arrived at. The rapid and decisive campaign is to be favoured from all points of view, and though there may be appalling loss of life in such a war, both nations will be less weakened than by a long and painfully drawn out struggle.

The airship, in addition to aiding gunners to make more accurate practice against a distant enemy, and thus incidentally diminishing the damage caused to non-combatants and to private property through inaccurate gun fire, will further help to localise the destructive effect of a campaign by the direct manner in which it can attack on its own accord. To reach an important position there will not be the same need as at present to fight a series of engagements and lay waste a great tract of country, with all the misery which this entails. The airships will make a bee-line for their objective, and will concentrate their efforts against this point.

Finally, for great powers like the United States, where it is necessary to keep naval fleets at each side of the continent, the airship will prove an immense advantage. In time of war with a great naval power all the American sea forces might be unable to concentrate on one coast in time to cope with the attackers, and any such concentration would leave the other coast quite open to attack from another section of the enemy's forces. A feint attack or cleverly planned manœuvres might cause the American forces to be misled as to the side from which the enemy would attack, and eventually a plan might be disclosed which would indicate that a large section of coast was undefended. A fleet of airships on each coast, in addition to making valuable scouts, would render immense service to the land forces in checking a naval attack. In time of danger all the airships could quickly concentrate, and they would bear the first brunt of the attack, and probably spoil the enemy's plan.

CHAPTER XIV

AERIAL NAVIGATION

THE two most important matters which govern the successful usage of airships are the mechanical improvement of the vessels themselves, and a better knowledge of the conditions which prevail in the aerial sea. The factors are interrelated, and progress in one will bring about progress in the other. As airships become more efficient and reliable, longer and more adventurous journeys can be undertaken, and from every run valuable experience will be gained.

Ballooning has afforded a certain amount of data, but it has led to the erroneous idea that a skilful pilot of a free balloon is best fitted for handling an airship. Many of the successful builders and users of airships have had little or no experience with ordinary balloons, and the majority of balloonists have given little attention to airships. Any adventurous man may take readily to ballooning, and the manipulation of the vessel will call for hardly as much skill as handling a high-speed motor car. The qualities of the aeronaut are weather knowledge, coolness, boldness, and love of adventure. There is no great call for scientific training, and no need for engineering skill. A few elementary facts about gases and their properties, and a store of experience gained from a few trips, are deemed sufficient in many cases to make an aeronaut.

But once a man endeavours to convert a balloon into a vessel which can be steered and propelled, there opens out before him a whole sea of difficulties. He will have to take some hand in designing the vessel, he will have to select his engine carefully as to power, weight, and suitability, and he will have to make himself thoroughly acquainted with its working, since on this depends the efficiency of the ship. The shape and constitution of the gas envelope and frame, the method of transmitting power, the system of control, and hundreds of other things have to be studied which call for practical engineering skill in many forms. The inventive and resourceful amateur engineer (especially if he has had training in motor-car work), working in collaboration with an aeronaut, make the ideal combination for the production of a successful airship.

Even when the vessel has been finished the difficulty is by no means over, for a new problem has now to be solved, viz. the best method of handling it in the sky. Practical tests of every vital part must be carefully made ere a long flight is attempted, and it will not suffice to make these experiments indoors. As far as possible, each part must be tried under actual working conditions in the open, and the operators must gain practical skill at their work.

Many considerations have to be taken into account in launching an airship, keeping it in the air, and bringing it back to its harbour again, and we must have happy collaboration between the various members of the crew. Santos Dumont worked his little airships unaided, but the military ship must have several operators, each specialising in his own department, and all under the command of one man who knows every branch of the work. The engine or engines will need one or two men; the lifting planes, ballast, and other aerostatic work will require, at least, another man, whilst the captain can hold the steering wheel, and be in communication with the engineers and the aerostatic staff, so as to control speed and altitude. So, too, with aeroplanes we must have machines which hold two or more people, and long training will be needed ere the necessary skill is obtained.

After securing skill and confidence in working the various parts, free air trips may be made both of the circular and end-to-end type, and if these are carefully graded as to difficulties, the power of the vessel can be nicely gauged with a minimum of danger. Then the operators will really begin to learn the peculiarities of aerial navigation.

The air sea is estimated to be nearly one hundred miles high or deep, and airships move in the lower strata close to the bottom. The air is usually most dense close to the surface of the globe, and balloons have greater buoyancy there. As higher altitudes are reached, the density becomes less, until a level is reached beyond which the vessel cannot rise, other conditions being equal. The most authentic record as to height attained is that of 30,000 feet, which was reached in a balloon by Berson, and life cannot be long sustained there. Airships, owing to their greater weight, cannot aspire to such heights, nor is this desirable, since the cold and the rarefied state of the atmosphere are not favourable to life in the upper regions. Thus it may be taken that airships will keep to much lower levels, and will generally move between heights of 100 and 10,000 feet. The heavier vessels of the rigid type will scarcely be able to reach more than 5000 feet, and unless more attention is given to this point vessels will be launched which will be unable to rise more than perhaps 1000 feet. Good ascensive power, however, is an essential in an aerial warship for the reasons I have already elaborated, viz. escape from gun-fire and from overhead attack from lighter craft. Aeroplanes so far have not risen above 1500 feet, but the Wrights believe that they can rise to 3000 or even 5000 feet.

The air, through its gaseous state and the many influences it is subjected to, is a most treacherous medium in which to travel, and everyone is conversant with its quick changes and mobility. On the condition of the aerial sea depends the weather, and, with all our scientific research, we are yet unable to forecast the state of the weather with much reliability. By the aid of telegraphy, and especially wireless telegraphy, a central station may now be kept in touch with the changes at other stations over a wide area, and thus we are able to map out the course of many aerial changes, but much remains to be done ere our knowledge of the aerial sea will be made reasonably accurate, and the aid of airships is awaited.

Moreover, the present observations, as a rule, concern the movements of the lower strata, and thus we are in ignorance of the counter movements which may be going on at higher levels. The air is made up of a most conflicting series of currents and eddies, and from tests made at various altitudes, as well as from the experience of aeronauts, it is known that the direction of the wind changes many times as various levels are reached. The average direction of the change is clock-wise, and the speed of the wind also varies considerably, generally becoming higher as we go upward; and density and temperature also change. We have thus several important variable factors which have to be provided for in aerial navigation:

(1) Direction of the wind (changing at various altitudes, and generally in the direction of the hands of a clock).

(2) Speed of the wind (usually increasing with altitude).

(3) Density of the air.

(4) Temperature of the air.

(5) General atmospheric conditions.

A ship on the sea floats on the surface of the water, and the navigators are concerned only with the direction and speed of the wind at their level, and with the state of the water at the surface. The airship, however, must range through several levels, and whilst this in one way is an advantage, since it allows a choice of wind direction and "weather," so to speak, it has its drawbacks since every condition is unstable; and it is not always easy for a vessel to keep to the same level, or move in the same current.

Engine power is the most vital item after buoyancy, since on this depends the ability of the vessel to make its course. In dealing with airship speed we have two forms:

(*a*) Still air or independent speed—the actual speed which the vessel can travel at in a dead calm.

(*b*) Actual speed. This depends on the still air speed and the speed and direction of the wind.

Travelling *with the wind*, the actual speed of the vessel is measured by the formula

$$V + W = \text{actual speed};$$

where V is the still air or independent speed of the ship, and W the velocity of the wind.

Travelling *against the wind*, the actual speed is:

$$V - W = \text{actual speed}.$$

If the wind is equal to the independent speed no headway is made; if greater, the vessel is blown back if running straight into the wind.

But even if the wind is almost as speedy as the pace of the vessel, an airship can reach points over a certain area by steering at an angle to the wind, such angle being determined by various considerations.

Moedebeck, the celebrated German expert, has in his excellent "Pocket Book of Aeronautics" worked out the angle of action over which an airship can travel under varying conditions. Even where the wind speed is greater than the independent speed of the vessel, he shows that points within a certain area may be reached by steering at an angle to the wind. No point in the teeth of the wind can, of course, be reached since the ship is driven back in each moment a greater distance than it can move forward.

In airship practice high speed is thus most essential, since the ship must be superior to the average force of the wind in a region to enable it to be used over a wide area.

Where the speed of the wind and the independent velocity of the vessel are equal, the ship can touch at most points within an angle of 180 degrees, and thus its range of action is very much increased.

Finally, in the case where the independent velocity exceeds that of the wind, any point within the complete circle of 360 degrees can be attained, those with the wind at a speed proportionate to the combined speed of wind and vessel, those against the wind at a pace proportionate to the difference between the independent speed and the velocity of the wind.

I must refer the reader to Major Moedebeck's book for other interesting details which sketch out the manner in which aerial navigation may be carried out. The work of navigating an airship with good engine power and a plentiful supply of fuel can soon be reduced to an exact science as long as the weather is clear, since many marks will be available on land or sea; and by the compass, aerial log, chronometer, etc., both speed and direction can be judged with no small degree of accuracy.

Even night journeys in clear weather will not present great difficulty with a vessel which has an independent velocity greater than the average wind. Slow vessels, owing to the indirect courses they will have to take, will run more risk, as the voyage will be of longer duration, and the risk of using up too much fuel will be feared.

From an airship at night there is an extensive view, and the aerial pilot who knows the coast-lines of adjoining countries will be able to make long over-sea voyages, provided his ship has sufficient speed.

An independent velocity of thirty miles an hour, which speed is claimed for the French vessels, and of twenty-five miles an hour for the Zeppelin craft, would enable voyages to be taken on a good many days in the year, as allowance must be made for days in which the wind would be blowing from a favourable quarter as well as for those days in which its opposing velocity would be lower than that of the ship's speed.

The statement so often made that any strong wind would prevent the progress of an aerial fleet is quite erroneous, as may be gleaned from the foregoing, and moreover it must be remembered that as the winds vary in speed and direction according to the altitude, an airship may have a variety of currents to select from.

Thus it may be said that an independent velocity of not less than twenty miles an hour will enable a vessel to be used on many occasions for both land and over-sea work in Europe, or indeed most parts of the globe. Nevertheless designers must work for a far better speed, and thirty miles an hour would be a far safer rate to fix in setting up a standard for war purposes. Speed, indeed, is a vital point in the airship, as it determines the number of days on which a vessel can be worked, its range of action, its ability to outdistance other vessels, and its general safety.

So far we have assumed that the vessel has been navigated in clear weather by day and night, the light of the moon or the position of the stars, as well as lights on the earth, giving the necessary navigating data in the latter case. But though the aerial navigator may not be so much troubled with fogs as the navigator at sea, he will have to contend with banks of clouds which may completely shut out the earth from him.

In war operations these clouds may, however, serve a very useful purpose, and one which the artillerists and the critics of aerial navigation do not allow for. It often happens that an aerial vessel travels serenely above a bank of low-lying clouds which shut it off from earth, and thus hides it from observation. The sky above the ship may be quite clear at such a time, and a skilful navigator may be able to make a correct course for a considerable time without dropping below the clouds which hide him from terrestrial observation. The sun, moon, or stars will give him the necessary guidance by day or night, and in future years many a stolen march will no doubt be taken under such circumstances. Von Sigsfeld devised a form of artificial horizon to assist the aerial navigator in calculations at such a time, and he will have many other aids.

It will also happen, of course, that an airship may be quite surrounded by mist or cloud, and will be unable to get bearings either from the earth below or the sky above. Here the vessel's power to alter its altitude will serve a good purpose, as it will cast about up and down until a clearer space is reached in which some landmark or skymark (to coin a phrase) will be found.

Many special difficulties will have to be considered, such as the various phenomena which will disturb accurate observation, the constantly varying power, direction, and temperature of the air currents in which the vessel moves, etc., but these will soon be as well understood as those which the sea navigator has to cope with.

That many dangers will be incurred, and that ever and anon lives and ships will pay the penalty for men's invasion of the air goes without saying; but on the whole there is no need why, under special conditions, the aerial sea cannot be used as a medium of travel, especially in the urgent work of war, or rather that of preserving peace. The nation which first builds a successful aerial navy will have an immense advantage over other nations, and though no secret can be permanently retained in regard to aerial locomotion, the country with the most experience and best ships will be able to hold its lead much longer than it could by any new type of seaship, or by any improvement in tactics, artillery, explosives, etc.

I must give attention to the special dangers which aerial navies will run, and for brevity's sake I will tabulate them :—

(1) Storms, fogs, mists, etc.
(2) Fire.
(3) Explosion.
(4) Lightning.
(5) Loss of gas.
(6) Disablement of engine or propelling or steering gear.
(7) Loss of fuel.
(8) Collision.

It is a popular fallacy that airships cannot remain in the air during a storm. Balloons have been caught in gales, and have run in them at speeds up to 125 miles an hour. Keeping well aloft in a more or less direct aerial current of this kind, an airship moves smoothly along, as it is travelling at the same speed as the wind. In storms on land or sea the wind blows against objects not travelling in it, and they are torn between two forces. In an airship drifting on the wind there is no sense of motion, and even in a high-speed current there is nothing suggestive of the wild movements which occur on land and sea during a gale. Aerial eddies, circular storms of great intensity, and such-like disturbances may constitute dangers, but of these we know very little yet. An airship can run with a gale just as a balloon, use little or no fuel, and harbour her resources to make the return journey when the storm abates, or when a favouring current at another altitude may be found. In this respect the airship has the advantage over the balloon in that if blown out to sea it can find a way back if it has carefully reserved its power and its fuel.

I have already touched on fogs and mists and their dangers. In over-sea work there is the added risk of the moist air condensing on the vessel and seriously affecting its buoyancy. One critic has stated that dirigibles are useless for over-sea work on this account, but that is absurd, and the defect can be got over by a specially designed envelope.

Fire is a serious danger on an airship, since the presence of the large gas-bag filled with such an explosive agent as hydrogen is a constant menace unless the utmost care is exercised. Fortunately the gas tends to float aloft owing to its lightness, and thus quickly clears away. But the petrol motor in itself is a danger, since even on land motor-cars take fire from time to time. Fire is to be feared either from an electric spark igniting waste petrol due to a leakage, or to the flames from the exhaust pipe from the engine causing accidental ignition. Terrible though this danger is, several military airships have been sent up on trial trips with open exhaust pipes instead of being fitted with silencers or chambers in which any flames could be guarded! Improved silencers, too, will help to deaden the sound of the motor, which on modern airships is needlessly noisy. The improved airship will travel in absolute silence. Extreme care must be taken with all the fuel tanks, connections, carburetter, engine exhaust pipe, etc., so as to obviate the risk of petrol fires. Any fire on board an airship is to be dreaded, since the flames may get near enough to the gas envelope to ignite the hydrogen, and then a terrible disaster may be feared. Ultimately, however, some form of dirigible may be feasible, in which this danger will be eliminated.

Explosion of the gas envelope is most to be feared from fire, but it might result from a failure of the devices which regulate the pressure of the gas. This latter cause, however, is very rare, and in a properly worked airship need cause little misgiving.

Quite an interesting monograph might be written on the effects of aerial electricity on balloons, and the possible effect on airships. There are records of balloons having been struck by lightning, and many aeronauts relate extraordinary experiences of phenomena which they witnessed when amidst electrically charged clouds. That the amount of electricity increases according to altitude seems to be well established, but we know very little as to its characteristics or how it will behave towards airships which have a good deal of metal-work. To my mind this is one of the most serious risks the airship will be subjected to, though perhaps investigation may prove that airships will be almost immune from electrical dangers save where they actually get in the vicinity of a lightning discharge. (This chapter was written before the disaster to *Zeppelin IV*, which most probably was caused by the vessel being highly charged with aerial electricity, and then "earthing" the current through being driven to the ground by a storm. Conducting cables will possibly obviate the trouble in future.)

Most of the other dangers, such as loss of gas, loss of fuel, and mechanical disablement, are preventable to a high degree, and although they will lead to distressing accidents from time to time, when reasonable precautions are neglected they do not call for special comment. Duplication of engines will probably be needed on aeroplanes and other machines which have no natural buoyancy.

Collisions may be of two kinds, viz. the meeting of two airships, or the dashing of an airship into some object on land or sea. Even greater than the lightning risk is the danger incurred by an airship of running into some object on land or water. This will usually occur when the vessel is at a very low level and is making for its harbour. Then the engine speed will be reduced to a minimum, and the ship runs the risk of being caught by a gust of wind and dashed out of its course. The stationary airship is like a great feather, and is as much the sport of the wind unless kept under control. Side winds are most to be feared, and they have led to many disasters.

But with the designing of proper aerial harbours most of this danger will disappear. Perhaps it may be possible to have aerial break-winds which can be swung round on pivots, and thus give shelter to a vessel from any quarter. There is much scope for ingenuity in the designing of aerial harbours, and the need for efficient means of protection for the ship when close to the ground is very pressing. The attention of inventors should be called to this point, as when once the danger of making harbour is lessened, airships will be free to carry out many experimental trips which are now deemed dangerous. In fact, good harbours are needed before airships are launched.

CHAPTER XV

AERIAL LAW

A MATTER of urgency is the drawing up of international laws on the subject of private and government airships. Various regulations and unwritten laws prevail with regard to balloons, and these are not always adhered to, since it is recognised that the free balloon is more or less an irresponsible agent and not fully controllable as regards direction or speed. Advantage has been taken of this by military spies and secret service agents in various countries to drift "accidentally" over the frontier lines of adjacent nations, and quite by chance (!) travel on a wind which takes them within sight of important fortifications at a time perhaps when various alterations were being made.

Every nation is compelled to employ spies and secret service agents, and their nefarious work must go on as long as war is a business; but to prevent unfair advantage being taken of prevailing winds and other circumstances a code should be drawn up as regards the employment of balloons and airships. It is a nice point to determine to what height a country can claim right in the aerial sea above it. If the limit were set above 30,000 feet, for example, it would mean that no foreign airship could cross a country, as life is unbearable above that height, and even when over 20,000 feet an aeronaut needs oxygen to prevent his becoming unconscious. Then, again, how are the people in one country to determine what altitude the airship of another nation is at if it crosses the frontier? The old Russian rule in regard to all balloons not flying the proper flag was to open fire on them, but this method would hardly be feasible in other countries.

Now unless some limits or restrictions are made it can and will happen that the military or private airships of one country will by accident or design, or by a combination of both, sail over other countries, and important military and naval secrets may thus be discovered. An airship may break down when conveniently near the frontier, and plead this excuse for drifting across on a favourable wind. Hours later when the "repair" is made the ship will steer homewards again with perhaps very valuable information for the military or naval authorities.

In time of war, no doubt, a country would openly send its airships across neutral countries, claiming its right to the free use of the upper air; and even if the point were disputed there would be the risk of unscrupulous commanders making such trips by night if any advantage were to be gained.

I therefore think that we must have two distinct sets of conditions which I can thus formulate:—

(1) In peace-time no foreign military or private airship may cross a frontier line without special permission.

(2) In time of war the air is to be deemed "open" above a height of 1000 feet.

(3) Any landing of a military airship in a neutral country during war time will necessitate its surrender to that country.

As to a general code of rules for aerial vessels in peace-time I would suggest the following:—

(1) Every war airship must bear a special flag which will indicate its nationality, and show that it is attached to the war service.

(2) No war airship will cross a frontier line without giving preliminary notice of its intention, stating the route selected, and obtaining the permission of the authorities of the country in question.

(3) In case of disablement near the frontier a war airship will descend as soon as possible

should it be unable to follow the original route.

(4) Every war airship will agree to an international code of signals, and conform to any instructions signalled to it when over another country.

(5) Every private airship shall be enrolled upon an international register, and carry a special flag which will denote its nationality, distinguish it from war vessels, and if possible denote its number on the international roll.

(6) Every private airship will carry papers and credentials.

(7) Exchange of flags or papers between war and private vessels, or any falsification of credentials, will be subject to a fine and the removal of the vessel from the international register, and forfeiture of international rights.

(8) Airships, whether private or military, crossing a frontier without showing a flag or giving the necessary notice, will incur the risk of being subjected to gun-fire or arrest by a military airship of that country.

(9) International "open routes" will be mapped out by an international congress, designating routes which under normal conditions may be freely used by all private airships, and under certain conditions by warships.

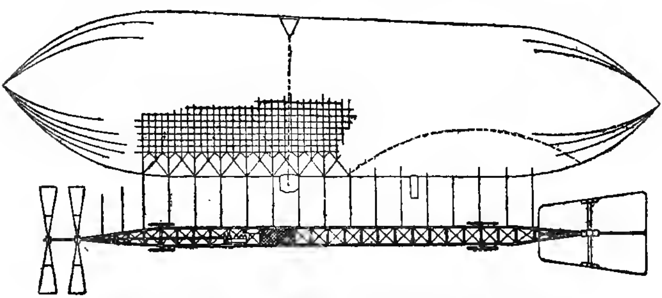
All the foregoing suggestions require little explanation save the last. My idea would be to have several international highways mapped out which would establish communication between the important countries, and at the same time prevent the military and naval secrets of the various nations being discovered. The routes would be so planned as to avoid as much as possible strategic points, and military and naval stations. Thus we could have one grand international route running from London via Brighton and Boulogne to Paris, and so by one route to Nice, and over-sea to Italy, and by another to Bordeaux and Spain.

From Berlin a great route would run via Brussels, Liége, and Lille to Paris. This city would be the international centre, and from it another route would lead via Dijon to Geneva, Italy, Austria, and Russia. The various trunk routes would be perhaps a mile wide to allow for errors and deviations, and beyond a halt at the frontiers, vessels would be able to visit most of the European capitals without trouble. The main principle would be to lead the routes over such small and neutral countries as Belgium and Switzerland when possible instead of crossing the Franco-German, or Frano-Italian frontiers. Sporting and experimental voyages would not be interfered with, and all the confusion, underhand work, and misunderstandings which will arise out of the present chaotic state of affairs would be avoided. Airships are developing rapidly, and the authorities ought to be prepared for eventualities.

APPENDIX I

THE AMERICAN ARMY AIRSHIP

THE first American army airship is the *Baldwin*, which, after a series of tests, was taken over by the United States Government in 1908. In many respects the American vessel is novel. The gas-bag is only 100 feet long with a



THE FIRST AMERICAN MILITARY AIRSHIP

major diameter of 16 feet and a minor diameter of 14 feet. The entire envelope is encased in linen netting. This suspension is so designed that when the vessel is on an even keel the forward end will have an upward tendency, causing the pressure of the gas to be strongest where it is met with the greatest resistance. The netting is so adjusted that in case of collapse of the envelope it would form a parachute, and thus allow of a safe descent.

A 25 h.p. motor is employed, driving two propellers. The vessel is estimated to have a still-air speed of twenty-two miles an hour. On each side of the frame are planes for changing the altitude of the craft. These are said to show great efficiency, thus enabling the vessel to be very readily controlled as to altitude. The *Baldwin* is the smallest military airship yet built, and its handiness and ease of working are two important features. The efficiency which this little vessel obtains from its small engine power is quite remarkable.

THE CAR OF THE "PARSEVAL" AIRSHIP
(Note the collapsible blades of the propeller, and the air pump for filling the ballonet)

APPENDIX II

AN AERIAL DEFENCE LEAGUE

TO state that France and Germany are fully five years ahead of us in the construction and usage of airships for warlike purposes is quite a conservative estimate, but it will suffice to prove the urgency of great efforts on the part of the British nation. This start of five precious years is not to be wiped out by a mere expenditure of money, for it means that our neighbours have amassed priceless experience and a number of valuable secrets, have fully tested countless plans and contrivances, and have the services of men of mature experience in the building and handling of airships.

We cannot lay claim to any of this, since we have never had a really successful airship, either amateur or military. It is obvious that we cannot have experienced builders and operators of airships until we have evolved a thoroughly successful type of vessel. France has already expended over £150,000 on airship work, according to a well-known Germany authority; and Germany, when she acquires the new Zeppelin dirigible, will have spent well over £200,000 on the work, whilst a fund of £300,000 is in hand for further work to be carried on by Zeppelin. If memory serves me rightly, our total expenditure in similar work was under £10,000 up to 1908.

It was largely due to the personal efforts of Colonel Capper that any move was made to build an experimental airship for the British Army, and he and his staff of the Balloon Department had a severe struggle to produce the ship owing to lack of funds. To expect under the little better circumstances now prevailing that our dirigible balloon department will draw level with France and Germany is hopeless on the face of it, since we lack almost every essential.

For this and sundry other reasons I think the time is ripe for a popular movement which would take some such form as the establishment of an Aerial Defence League. Similar leagues already exist in France and Germany, and are doing invaluable work. When it is pointed out that the foundations of the French and German aerial fleets have been laid by the work of enthusiastic amateurs, the need of similar help would be apparent in our own case, even if we had not such leeway to make up.

But when our authorities have been outstripped to such a degree, and when our rivals are redoubling their efforts to increase their lead, the situation is one of no small gravity. It must be confessed that our amateur aeronauts have given all their attention to balloon sport, and they have lacked the enterprise which impelled French and German aeronauts to design airships. Count Zeppelin has made it his life-work to give Germany an aerial fleet, and for France the Brothers Lebaudy, Count de la Vaulx, and M. Henri Deutsch de la Meurthe have rendered noble service. When the French military airship *Patrie* was lost M. Deutsch was able to step forward and place at the service of his country another magnificent airship; and it is that England should imitate such work that I would propose the Aerial Defence League.

Before dilating on the merits of such an organisation I may set out in brief the main objects which I think should be achieved by such a body. These are:—

To encourage the building and use of airships by amateurs and the military and naval authorities.

To band together all interested in the subject; prepare reports, and encourage research and experimental work.

To organise a fund for the construction of an airship, and offer prizes for the best British design.

To fully test this vessel and, if successful, present it to the nation.

To form a society amongst balloonists to encourage them to take up work in the building and handling of airships, and thus form a corps of expert amateurs who, in case of a national crisis, could lend their assistance.

To send a commission to study continental practice as far as possible, prepare a report on the subject of military airships, and present this report to Parliament.

Many other aims and objects could be set down, and naturally suggest themselves, but at present my intention is to arouse interest in the main idea. I do not see why our wealthy sportsmen, our numerous skilled balloonists, and the many retired Service men should not join in this work and form a powerful society which, at least, would fully inquire into the merits of the military airship.

If such a body after very careful and unbiased research arrive at the conclusion that our military or naval forces need fear no danger from continental progress in airship design, then everybody would be rendered easier in mind than they are likely to be if the present uncertain state of affairs continues; and no more money need be spent in building military airships. If, on the other hand, the League came to the conclusion that we ought to keep on a par with our neighbours in the building and usage of military dirigibles, the work could be put in hand on a bigger scale than the Government is likely to attempt under present circumstances.

The labours of the League would in a sense be independent of those carried out by the military authorities, but the existence of the tormer body would be most helpful to the latter. The civilian organisation, with larger funds, a more elastic scheme of working, and less hampering from red-tapeism, would be able to test every promising idea, and hand over to the military balloon department any device which their experts recommended. The authorities would thus have the services of an expert body of festers, and would be saved the waste of time and money now involved in separating the useless suggestions and inventions from those with a germ of usefulness.

In the designing of the first national airship a league such as I have suggested would be able to obtain a certain amount of assistance from friendly nations, and just at present we need skilled assistance of this nature. With the help of many well-wishers the work could be pushed on very rapidly, and then if the League had the assistance of our numerous skilled balloonists they would have the finest material in the world from which to establish a corps of skilled captains of airships.

Our amateur balloonists have nothing to learn from other nations in manipulating the ordinary non-steerable balloons, and owing to their experience in such vessels, coupled with the fact that most of them are enthusiastic motorists as well, they could very soon be trained in the working of airships. They would, no doubt, form amongst themselves a corps of Aero Volunteers, and would be able to perform splendid work in a national emergency.

No good has been done to the cause of aeronautics by the absurdly sensational articles which have appeared in various journals on the subject of the military airship and its uses. Perhaps the most grotesque is the idea of a huge fleet of aerial vessels transporting an army of men to our shores. An aerial League would put an end to all these ridiculous statements, as it would educate the public to a proper appreciation of what might be expected from airships. In effect, the aerial warship can never be regarded as displacing any form of the military or naval establishment, but rather as a new auxiliary.

On the other hand, some influential body of recognised authority is needed to combat the scepticism with which the British public and British officialdom generally regard aerial navigation. That our present apathetic attitude towards the subject is fraught with danger will be admitted by every intelligent man who has analysed all that has been achieved already in France and Germany. The development of the airship is a menace both to our naval and military forces if we make no adequate efforts to prepare for it.

It can be laid down as a sound dictum that airship must fight airship, and assuredly when we find our astute neighbours sinking so much money in the work we must be alert also. It must not be forgotten that we are quite beginners in this new art of navigating the air, and perhaps not until we have acquired all the data possessed by France and Germany will the utility of the new locomotion be apparent to our naval and military advisers. Our scoffing and scepticism are largely born of ignorance on the subject. If will be sheer, and almost undeserved luck, it unforeseen causes prevent for the moment a rude awakening being forced upon us.

An authoritative body could quickly remove all this prejudice, and by vigorous propaganda could stir up the nation and the authorities to action. [*In* 1909 *The Aerial League of the British Empire was established by a body of influential naval and military men.* Its president is Lord Esher.]

APPENDIX III

AERIAL PHOTOGRAPHY

A SPECIAL volume would be needed to deal fully with aerial photography, and so far most of the scientific work in this branch has been done by Germany and France. English amateur balloonists have compiled many excellent photographic records, and we may expect that when airships are available in this country that our naval and military men will develop the art of aerial photography to a very high degree.

From the point of view of picturesqueness and also from the scientific standpoint, aerial pictures have an interest all their own, but the work has only recently become of real value for military purposes. Improvements in cameras and plates, and most important of all the development of the telephoto or long-distance lens, have opened out a new field of usefulness for aerial photography as applied to warfare.

By means of the telephoto lens a detailed photograph can be taken of a very distant object, which if rendered by an ordinary lens would be very minute. Enlargement of the ordinary negative would not give a satisfactory result, and thus the long-distance lens is requisite. Very striking records have been made by this lens, and it will prove invaluable to observation forces. A clever camera operator in an airship would be able to take detailed views of harbours, fortifications, etc. at a range which would keep him out of danger, and telephoto pictures of ships, field forces, etc. would show up an amazing amount of detail. Of course the object covered by the telephoto lens is not so great as that embraced by an ordinary lens, as the former magnifies a small area so to speak, but this matter can readily be remedied by the military photographer taking a series of views; and improvements in the lenses will also help to give a wider area.

One of our leading British firms of lens makers, Messrs. Ross, Ltd., Clapham Common, London, S.W., have very kindly placed at my disposal a mass of information concerning telephoto lenses, and I append extracts which will afford the military aeronaut some useful hints :—

In all branches of photography lenses of different foci are necessary, according to the distance of the objects to be photographed and the size of images required. A telephotographic lens is simply a combination affording, by means of alterations in the separation of the components, a variety of foci extending over a very wide range.

Lenses of long focus usually necessitate cameras of long extension; but the normal extension of camera, when using the high powers of the telephoto combination, does not require to be materially increased. This renders it possible to employ such long foci as could not be provided for under ordinary circumstances.

The combination consists essentially of a positive and a negative element, of which the former may be the lens in everyday use, while the latter is a lens specially corrected to afford the best results in combination with it.

If we have a good anastigmat of, say, 6-in. focus, that gives at a certain distance from an object an image of it one ½ in. diameter, and in conjunction with a negative lens an image of 4 in. from the same position, the extension of camera bellows will be about 12 in. This means that we work with the equivalent of 48-in. focus and a camera of ordinary bellows extension. Increasing the separation of the positive and negative lenses until the image is reduced to, say, 3 in., the extension to focussing screen will be only about 9 in., while the focus of the combination will be equal to a 36-in. focus lens.

The immediate gain is that we can photograph very distant objects with an abundance of detail as though they were close at hand. They are rendered the same as are pictures with very long focus lenses. Enlargements of photographs taken from the same position with a lens of short focus do not give equal results, as not only is the detail wanting, but the grain of the plate is enlarged with the picture itself, doing away with definition, and veiling the image.

The telephotographic lens is invaluable for portions of architectural structure that are not near enough to obtain a sufficiently large image in the ordinary way; for distant and inaccessible views, such as mountain scenery or buildings at considerable distance; for obtaining photographs of wild and timid animals; for heads and busts, in or out of the studio, that show distortion when approached too closely with a short-focus lens; and for obtaining pictures of various size from the same standpoint.

To carry the lenses and afford the necessary adjustments, a racked tubular setting, which adapts itself to the camera front as an ordinary lens setting, is provided with screws to receive the positive lens in front and the negative at the back. This attachment has two engraved scales, one showing the separation of the optical elements in tenths of an inch, and the other the approximate magnifications, that is, the increased size of the image at various extensions over that produced by the positive lens alone.

The actual amount of subject in the image remains the same under all magnifications, but the circle of illumination, and consequently the plate covered, is proportionately larger or smaller. When greater covering at the same magnification is desired, a negative lens of longer focus should be employed.

The Approximate Extensions from negative lens to focussing screen are as follows :—

For Magnifications.	5	6	7	8
Negative Lenses of $1\frac{3}{4}$ in. focus ...	7	$8\frac{3}{4}$	$10\frac{1}{2}$	$12\frac{1}{4}$
" " $2\frac{1}{4}$ " ...	9	$11\frac{1}{4}$	$13\frac{1}{2}$	$15\frac{3}{4}$
" " 3 " ...	12	15	18	21

Extensions for lower or higher magnifications are proportionate to the above, and they are calculated by multiplying the focal length of the negative lens by the magnification, less one.

To find the Magnification. — Divide the camera extension by the focal length of the negative lens and add one.

To determine Equivalent Focus. — Multiply focal length of positive lens by the magnification; or, multiply focal length of positive by that of negative, and divide the product by the separation, which can be easily read off scale in tenths of an inch.

The Exposure is that necessary for the positive lens multiplied by square of magnification, e.g. 2 secs., 5 mag^{n}., $2 \times 25 = 50$ secs.

As regards a photographic outfit for aerial work Messrs. Ross recommend the following:—

½-plate Square Bellows Camera, with Telephotographic Objective consisting of No. 5 Series II f/5.6 Homocentric Lens, No. 4 Setting, with rack and pinion adjustment, and 3-in. Tele-negative Lens; or No. 5 Series III Homocentric Lens, No. 3 Setting, and 3-in. Tele-negative Lens. This outfit would be found very useful for all work done in connection with moving forces.

A larger camera might be thought necessary in the case of sieges, and the extra weight would probably not greatly matter. An 8½ in. by 6½ in., or even 12 in. by 10 in. camera might be used, and a Positive Lens of correspondingly longer focus employed.

For balloon and airship photography the most useful camera would be a Reflex. The same Telephoto Objectives would answer for this camera as for the Square Bellows pattern, ½-plate size. If a smaller camera be preferred, say for 5 in. by 4 in. or 4¼ in. by 3¼ in., then the most useful Telephoto Negative Lens would be that of 2¼-in. focus, or even the 3-in.

APPENDIX IV

AIRSHIPS UNDER FIRE

THE utmost diversity of opinion prevails as to the risk which airships will run during warfare in being shot down by the enemy. Some critics hold that no airship can be of any practical value, from the fact that it can be brought down so easily by either rifle or big gun fire; but others assert that aerial vessels, by their speed, altitude, and ever varying vertical and horizontal movement, will almost completely baffle the most expert marksman; whilst from the rank and file of soldiery, whose bad shooting is notorious even against fixed targets on the level, nothing at all need be feared.

So far we have very little data to go upon, but from available reports in the Boer War and the Russo-Japanese War it would seem that even captive balloons formed most elusive marks for sharpshooters. Nothing is definitely known as to how the airship would behave under fire, and we must take with extreme

caution the statements of artillerists and others who assert that high-angle fire and high-explosive shells will check all aerial work by day or night.

Discussing the relative merits of dirigibles and aeroplanes, it must be admitted that the latter do not make such bulky targets; but, on the other hand, the dirigibles will probably be able to rise higher and keep further away from attackers. One of the best articles I have seen on the subject of aeroplanes under fire appeared in the *Scientific American* recently, and I append some extracts from it:—

"The army tests of aeroplanes at Fort Myer are naturally bringing the question of the military value of the airship into marked prominence. Our esteemed contemporary *Engineering News*, in the course of a thoughtful article upon this subject, is evidently less enthusiastic over the military possibilities of the airship as a future means of obtaining full information of an enemy's dispositions and movements than we are. It quotes, with an evident reservation of doubt, our statement that if the airship can only fulfil its present promise, the time is not far distant when the art of war as practised to-day will be stripped of its most important element of success (secrecy), and its prosecution, at least along modern lines, will be rendered well-nigh impossible. Our contemporary believes that we, in common with others who believe in the usefulness of the future aeroplane scout, have failed to realise how completely such a large object in the air will be at the mercy of the sharpshooters of the enemy. This is a point well worth consideration.

"In the first place, then, let us state our conviction that an aeroplane in motion will be an extremely difficult object to hit. To 'wing' it successfully it will be necessary to use a gun of considerable calibre; for the perforation of the canvas wings by the tiny, clean-cut holes of a modern rifle bullet, would amount to nothing at all. Now, for a modern field gun to do any accurate shooting, it is absolutely necessary to have the exact range. To get the range, even with the best range finders, is a difficult matter either ashore or afloat, and when the object is in motion the difficulties are increased; but both on sea and land the gunner has the advantage that he can mark the fall of his shots and make corrections until he has found the exact range.

"Moreover, he has the advantage, particularly on the sea, of knowing that the change of direction of the object takes place only in one, or approximately in one plane. Furthermore, the speed of the moving object is usually not more than fifteen miles an hour at sea, and less than a fifth of that speed on land. But the perfected aeroplane, moving through the air at forty to sixty miles an hour, at an elevation of, say, from two thousand to three thousand feet, will be a totally different proposition. At these high speeds it will change its position at the rate of from sixty to eighty feet a second. Unlike the army or navy target, instead of being confined to movement in one plane, it can move in as many planes as the operator may choose. It is certain that, if he finds himself under fire, he will follow an undulating or wave-line course, varying from a direct line both vertically and laterally.

"Nor could an object, sweeping through the air at high speed on a sinuous line of flight at the height named, be hit by point-blank fire with the heavy field guns, which alone would possess sufficient disabling power to bring it down. In spite of the great improvements that have been made in the training mechanism of field guns, it would be impossible to hold the piece on such an object a sufficient length of time to secure a point-blank hit. Perhaps something might be accomplished with time-fuse shells; but even with these, the firing, for the reasons stated above, would be largely of the 'pot-luck' kind.

"An important advantage in favour of the immunity of the aeroplane scout from hostile fire is that, in order to make a reconnaissance, it would not be by any means necessary to sail directly over the enemy's camp, fortifications, or line of march. Any one who has done topographical work is well aware of the great advantage of observation afforded by each additional fifty or one hundred feet of elevation. It would be possible to make a fairly good map of Manhattan Island and its environs, even from the six hundred or seven hundred feet elevation of the Singer or Metropolitan tower, and to include in the map quite a wide radius of country. Hence the aeroplane, if subjected to hostile fire, could draw off to the outskirts of the locality to be observed and mapped, and still have a sufficiently detailed view of the country for all practical purposes. Now at this greater distance, the machine would have the advantage that its planes would be directed fairly tangential to the curve of the trajectory, or curve of flight of the projectiles; and should the aeroplane be reached by the shells of the enemy, the chances are that a large majority of them, even if they fell within the area of the cross section of the machine, would pass harmlessly between the planes, rudders, etc., without making a hit."

ADDENDA TO SECOND EDITION

CHAPTER XVI

THE COMMERCIAL USES OF AIRSHIPS

THE application of airships to commercial uses in peace time has developed more slowly than the military uses, for the conditions are more exacting and the need not so pressing. If military science were carried to its highest point, a most important branch of it would be the stimulation of invention and improvement in every department, and the immediate testing of every new contrivance which showed the slightest possibility of being usefully adapted. Through various reasons the process actually followed by the military authorities is not so progressive, but nevertheless to a certain degree many new inventions, if at all suitable, have a chance of being tried for warlike purposes ere they can be applied commercially.

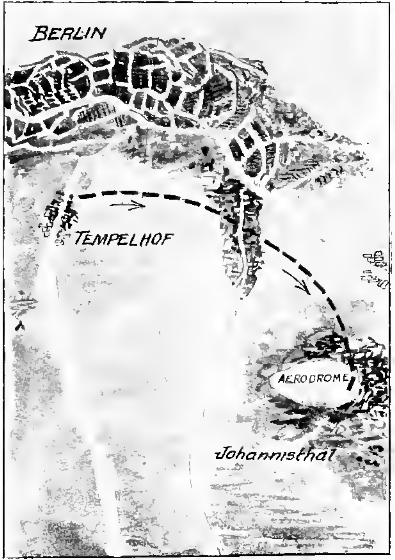
To be adapted for commercial use the airship would have to meet severe competition of older forms of locomotion, and the opposition, both theoretical and practical, set up by those interested in the well-established modes of travel. We see this fact demonstrated in the enmity of horse owners and railway companies to motor-cars. Even if adapted as an amusing novelty, the airship will have to contend with a vast amount of competition, and will have to show that it can be taken up profitably ere any serious attempt will be made to commercially exploit it.

The war authorities, on the other hand, have no profit-and-loss account of this nature to check them. They seek at all costs to obtain new weapons, knowing full well that a bold policy pays best in this respect. War is terribly dear, but once prepared for or entered into, victory must be striven for regardless of the expenditure in lives and money. The wars of the future will be won by long and scientific preparation, and by the skilful employment of every mechanical device which will give superiority over a foe. The airship in at least one form has already been employed by most of the military powers, and the time is now approaching when some commercial applications will be found for aerial vessels.

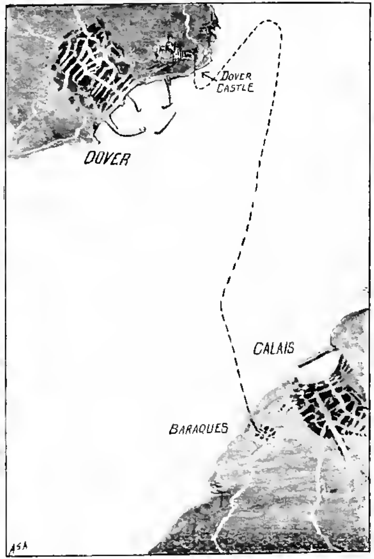
Taking the peace uses of airships in their widest sense, I may thus set forth the main purposes to which they can be put :—

Sport	Exploration
Spectacular displays	Emergency despatch carriers
Recreation	Passenger carriers de luxe
Scientific research	High-speed transport work

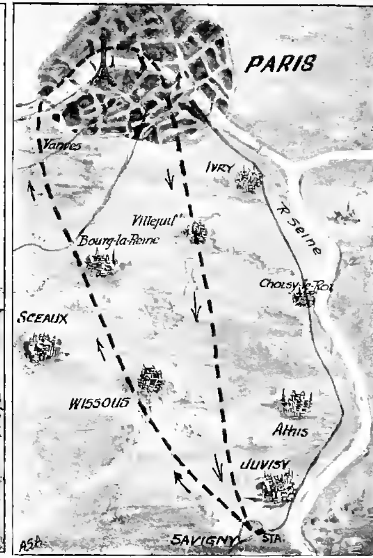
Coastal rescue agents.



LATHAM'S COURSE OVER THE SUBURBS OF BERLIN



BLERIOT'S CROSS-CHANNEL ROUTE



COMTE DE LAMBERT'S COURSE FROM JUVISY TO PARIS

THREE GREAT AVIATION FEATS OF 1909

SPORT

Already the dirigible and the aeroplane have been employed in sport, spectacular displays, and as the recreation agents of wealthy people. In all these respects the aeroplane has a very promising future before it, for we have only to call to mind that the bicycle and the motor-car were first employed as sporting instruments ere they assumed practical value. Sport is a most important agent of development in these days, and aeroplane racing will form a highly exciting and attractive pursuit. Already in France and Germany large sums of money have been spent in laying out grounds for aeroplane racing, and the results attained by the Rheims and Blackpool meetings illustrate the wonderful possibilities of aerial sport.

This sudden success has had a harmful effect, however, and unless the whole affair is controlled by responsible bodies aeroplane racing will degenerate into a showman's business, in which a little band of highly trained professionals will render it impossible and undesirable for the best type of amateur sportsman to take part. Ill-considered encouragement, and the ignorance of many writers on aviation matters in the daily press, have helped to bring about these pernicious developments, which unless checked will imperil the future of the sport. Aeroplane racing will be best developed as an amateur sport, and it should be maintained on the same high level as every first-class English sport.

EXPLORATION

In the realm of exploration Mr. Wellman has already made two unsuccessful attempts to reach the North Pole by airship. With his slow-speed, non-rigid vessel the task was hopeless from the outset, but he must be given credit for a great deal of courage and enterprise in attempting the work. Count Zeppelin hopes in the near future to carry out Polar exploration by means of his rigid airships, and working from a northern base, such as Spitzbergen, he will have a strong possibility of accomplishing most useful work. In various forms of scientific research and exploration over the most difficult regions of the earth, the airship in several forms will eventually render invaluable service.

DESPATCH CARRIERS

As emergency despatch carriers the aeroplane in a more developed form than the present one may be usefully employed. By following a bee-line course through a free medium at high speed it can easily excel any form of emergency carrier on land or water. It will be subject to special dangers, of course, and in severe weather may be impracticable. Indeed, in our present state of knowledge, we cannot expect that the aerial vessel will be employed so frequently or regularly as the most approved forms of land and sea vessels. We must bear in mind, however, that we are comparing a very new vessel with others based on centuries of experience.

A flying machine capable of travelling at eighty miles an hour would, when in motion, have little to fear on most days of the year; but sundry difficulties in starting, and more particularly in landing again, would be encountered if it were employed in windy weather. High speed is the great essential; but when people talk glibly of speeds of 200 miles an hour they show a deep ignorance of the many complex problems which would arise ere half that speed could be attained by an aerial vessel through its own power.

This aerial despatch work would be for articles of light weight and small bulk, for the aerial vessel will always be quite unsuited for the carriage of heavy and bulky articles. Letters and urgent despatches will be the things most usually carried, and in our high-pressure times there will be many occasions in business and politics when such a speedy special service will be much appreciated.

EMERGENCY AGENTS

In emergency, too, the aerial vessel will be used to carry some person to whom every moment is of vital importance. A minister of state, a general, a medical expert, or some professional or business man with great issues at stake will have use for a vehicle which can transport him to his destination in a direct line, and at an average speed of sixty or eighty miles an hour.

In judging speeds by other modes of locomotion we must take into mind the amount of time lost in getting under way, and the many checks due to interruptions en route. Thus, if a special train is required, various preparations have to be made, time is lost in getting to the station, and in waiting for the train to be got ready and the line cleared. Various stops or checks en route must also be allowed for, and the train may bring one to a place many miles from the actual point required. All these delays affect the average speed. So too with a motor-car chartered, for instance, in London. A moderate speed will have to be maintained until the many miles of streets and suburban roads have been passed; and slow traffic on the roads, as well as corners, obstructions, and the winding nature of the route will all cause loss of time.

The free bee-line route through the air at a set high speed will thus show enormous advantage over other emergency modes of locomotion. Let us assume that an eminent medical specialist in London is suddenly summoned to attend a man whose life is of great value to the nation, and who lies in a precarious condition 100 miles away by bee-line; 120 miles by rail, nearest station four miles; 140 miles by road. Let us further assume that the doctor has the choice of a special train to a point four miles from the dying man, or a high-speed motor-car from London, or a reliable aeroplane with an average speed of 60 miles an hour. The following table gives a theoretical comparison at the time when the flying machine will be perfected to a commercial article:—

COMPARATIVE TIMES OCCUPIED IN AN EMERGENCY JOURNEY

Special Train.	mins.	Special Motor-car.	mins.	Special Aeroplane.	mins.
Getting ready .	30	Getting ready .	10	Getting ready .	15
Passenger's time to starting point	15	Journey to doctor's door .	15	Passenger's time to starting point	15
Time in getting clear of London	10	Delay in getting clear of London	35	100 miles at 60 miles an hour .	100
120 miles at 50 miles an hour .	145	130 miles at 35 miles an hour .	222	Landing and getting to house .	20
From station to house . .	20	Delay in getting to house . .	8		
	220		290		150

Saving as compared with special train . 70 minutes.
„ „ „ motor-car . . 140 „

I have referred to the various delays in connection with a special train, and the schedule given shows a very smart performance over a main line, under favourable conditions. I purposely take a case in which no ordinary service express train is available, as I wish to show the emergency values of the three modes of locomotion. A powerful motor-car, specially chartered, would also lose much time in getting out on the open roads, and then it would have a course which would measure about 130 miles. Allowing the very high and dangerous average speed of 35 miles an hour over English roads, the whole journey would take over four hours, and would be an undertaking of no small risk. Its action, moreover, would be illegal, and might lead to serious consequences.

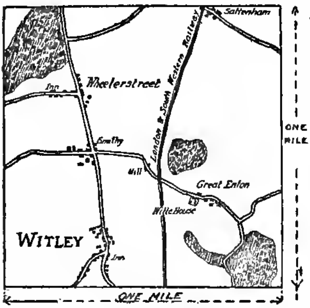
Granting that in the up-to-date conditions governing the hiring of emergency aeroplanes it would take half an hour to charter one, and for the medical man to be transported by swift motor-car to some central point in London from which a start could be made, less than two hours need be occupied on the journey if the machine could make sixty miles an hour. Moreover, by going in a bee-line it would save the many miles due to detours by road or rail. Thus it would be quite feasible under these conditions for the medical man to be landed at some point quite near his destination within two and a half hours from receiving the summons. At the time that aeroplanes would be used for such purposes the whole country would be well mapped out as regards suitable landing-places, and special charts would be available. If the journey had to be made at night the circumstance would favour the railway, and the motor-car to a lesser degree. At night the aeroplane would have to make for some specially appointed landing-place which would be lighted up. By the aid of its own powerful searchlight, the operation would not be too dangerous. Fog would delay all three modes of locomotion, but otherwise only a storm might prevent the aeroplane from being used.

In many other journeys over a bee-line distance of a hundred miles the perfected flying machine would show even a greater saving over the special train and the motor-car: although, of course, cases could be made out in which the saving would not be so great, as if, for instance, there were straight and high-speed motor roads radiating from London over which very high speed could be made. But I think the aeroplane will come to a practical stage ere that innovation is made, great though the progress be from the crude and fragile aeroplane of to-day to the powerful machine which can compete in an emergency with train or motor-car.

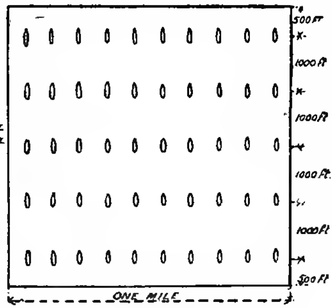
As the distances increase, and as regions become more hilly or difficult for terrestrial travel, the airship would score in a yet more marked fashion. If, for instance, a minister required to get from London to Paris late at night on a most important errand he could, by means of a high-speed flying machine, cover the distance in about four and a half hours. By train and steamer he would take nearly eight hours, and if the regular services were missed he could not hope by emergency means to perform the journey in equal time, as two special trains and a steamer would have to be chartered, and all this would entail considerable delay. The airship by its power of uninterrupted bee-line travel over sea and land has many unique advantages which will eventually make it superior to any form or combinations of terrestrial travel, and this, without requiring those fantastic speeds which so many people think necessary.

AERIAL TRAFFIC

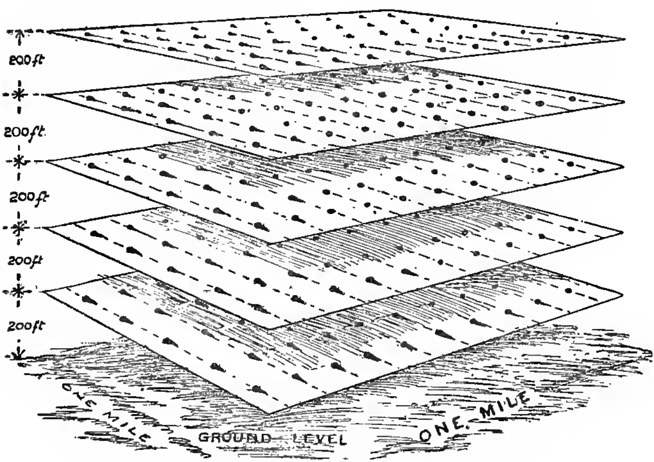
To understand fully the peculiar advantages of aerial navigation, we must realise that locomotion on sea and land lies along one plane, in other words it is of two dimensions, being governed by the length and breadth of the area over which it works. Now aerial navigation is of three dimensions, since it can avail of length, breadth, and depth. In a square mile of land and sea there is a definite limit to the number of vessels which can safely operate there at the same time.



LAND TRAFFIC
154 vehicles per square mile



SEA TRAFFIC
50 vessels per square mile



AERIAL TRAFFIC
Five layers, or a total of 250 vessels per square mile

On land there will be a number of narrow and specially prepared strips for roads and railways;

whilst on the water the whole area of the square mile can be covered with but one layer of ships, each having a certain amount of sea room.

In one square mile of air we can, however, have several layers of vessels operating at different levels. Dirigibles already can work up to 5000 feet for instance, and aeroplanes up to 1000 feet. Taking the practicable navigable area to be from 100 feet to 1100 feet, we have a depth of 1000 feet in which aerial vessels can work in separate planes one above the other. Allowing a distance of fifty feet between each layer of vessels we could have twenty such layers. If we suppose that fifty vessels can be safely navigated simultaneously over a square mile of sea (that is, on one plane), it can be argued that in the twenty planes of air over a similar area our three-dimension traffic can be made up of nearly 1000 vessels, or in other words nearly twenty times the traffic that can be accommodated over the same area of the earth's surface. If we reduce this allowance by one half, and say that ten times as many aerial vessels as sea ships can be accommodated, it will still be seen what immense possibilities of development lie in aerial navigation, and it may also be realised that a great element of safety is introduced.

Vessels of various types will be set to run normally at determined levels, and will make special signals when changing from these. There will always remain, in case of a collision being imminent, the possibility of each vessel carrying out a new rule of the road in the *vertical plane* as well as in the horizontal plane. Vessels at sea can only steer to the right or left in endeavouring to clear each other. Aerial ships, in addition, can dive under or leap over each other, and definite rules will be laid down to determine the course of action to be pursued by each vessel in an emergency. In the diagram, for purposes of clearness I have shown only five layers of aerial vessels, and each thus has 1056 feet between it and the next vessel in the same horizontal plane, and 200 feet between it and the vessels in the planes above and below it. Even then the superiority of the third dimension is very apparent, though it is too far to look forward to the time when aerial traffic will be so great that full advantage will need to be taken of this factor.

As regards land, it is difficult to institute an exact comparison of the amount of traffic that can be borne per square mile. In cities we see great congestion, and the average speed of the entire volume of traffic is very low, so that the full benefit that would be derived from a great number of vehicles is unobtainable. If an aerial vessel can average forty miles an hour as compared with land vehicles in a city area averaging ten or fifteen miles an hour the advantage is all on the side of the aerial vessels. In land locomotion over the roads there will never be a great average speed maintained until fast mechanical traffic has special routes of its own to avoid those checks and delays which must inevitably arise where slow horse-drawn traffic and high-speed motor traffic endeavour to use the same routes. But every route costs a very large sum to lay out and maintain, whilst in the air the route costs nothing. Thus land routes will always be very limited and liable to congestion.

I have taken a square mile of land in Surrey as a specimen of the general amount of rail and road accommodation to be found per square mile in England. In this space we have under three miles of main roads, and this is a far higher average than usual, as I have purposely selected an area with a village from which several routes radiate. There is also a little over one mile of railway. Allowing 200 feet between each vehicle running at high speed we could assume that about 150 vehicles could use the three miles of road at the same time, and on the railway lines we could allow four trains. Thus in all it might be said that 154 high-speed vehicles could simultaneously use the routes of that area under ideal conditions.

Needless to say, with cross-roads, sharp corners, and other dangers and obstructions, nothing like 150 high-speed road vehicles could be run at the same time in such a small area, and the average speed would be much lower, and the danger of accident and collision much greater, than in a square mile of aerial traffic. The prime cost and the expensive upkeep of these land routes must also be borne in mind in comparing the two systems of traffic.

A bare year ago all these considerations would have been regarded as too fantastic. But in the interval the Channel has been crossed by aeroplane at record speed; Farman has flown for 145 miles without a stop; aeroplanes and dirigibles have manœuvred in the sky together at different heights; Comte de Lambert has flown from Juvisy to Paris and circled over the Eiffel Tower; Santos Dumont has attained speeds up to 55 miles an hour; and so all the points elaborated have been demonstrated to be feasible. We can reasonably hope for increased power, reliability, length of journey, and improved manœuvring power, and with them we may come near to the condition of things I have sketched out, although I would point out that enormous improvement will have to be made ere any regular service can be undertaken by aeroplanes.

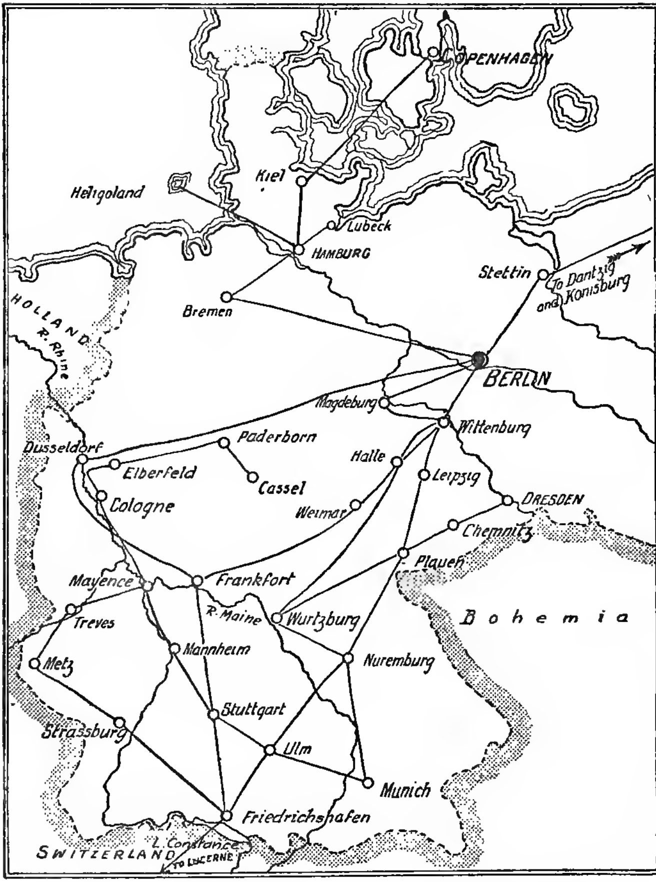
OVERSEA TRAFFIC

As regards long-distance oversea traffic, as, for instance, between Europe and the United States, new types of aerial vessels will have to be evolved ere such projects can be attempted. The aeroplane of the future will be of a large size, with fish-shaped central body so contrived that it can float on the water, and even be navigated there. Mr. Lanchester limits the range of action of small machines to about 1000 miles, but it is an open question if a large vessel could carry fuel enough for such a journey and bear a useful load as well. We must remember however that developments in fuel and engines are to be allowed for, and indeed one deep thinker holds that atmospheric electricity may eventually be the great source of power. The transatlantic airship, whether dirigible or aeroplane, can only come, however, after short-distance aerial transit has been very highly developed.

PASSENGER SERVICES

In the matter of passenger services *de luxe* the Zeppelin Company has already taken the initiative. Failing the employment of many Zeppelin dirigibles by the German naval and military authorities, it is the intention of the company to establish passenger service lines over

Germany. The project was first to link up



MAP OF THE PROPOSED ZEPPELIN AIRSHIP SERVICES

South Germany with Berlin, Hamburg, and Lucerne; and further developments are suggested of making Hamburg or Kiel a great aerial port in the north, and run services to Heligoland, the North Sea watering-places, Copenhagen, and even to England!

Too optimistic a view must not be taken of the proceeding, and we have yet to see a beginning of the scheme. Possibly the experiment will first be tried of running a few ships from Friedrichshafen to Lucerne in the summer months, when the immense tourist traffic to and from Switzerland can be tapped. The airship will afford a unique and unrivalled way of studying the beauties of Switzerland, and provided the ships have suitable harbours, and are improved in speed and reliability, they should in time win the favour of wealthy tourists.

The expense of operating a Zeppelin ship is enormous, however. The prime cost is very great: pure hydrogen is used for inflation, and this needs frequent replenishing, the gas bill being thus a serious item. The fuel bill is very high also, and with upkeep of harbours, payment of crew, etc., the running cost will be balanced only by very high charges being made. Once the scheme is proved workable there will be found many people willing to pay the costly fares, for as a means of locomotion it will prove infinitely more attractive than any other form now available for tourists.

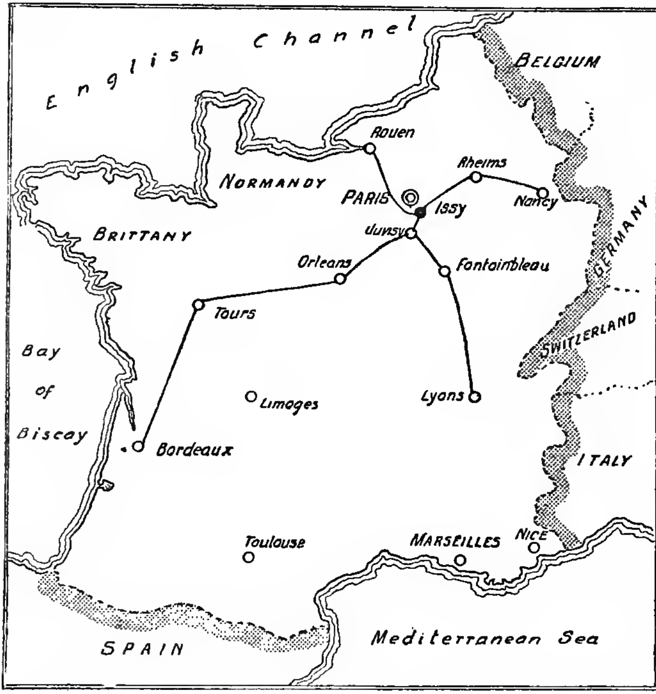
So too in various other parts of Germany this passenger service *de luxe* will find supporters, and it should have little difficulty in excelling the German railways in speed over long distances. But it cannot be hoped that the service will be reliable all the year round; and the many interruptions owing to unsuitable weather will materially reduce the profits. In effect the scheme will be a new luxury, highly experimental, and likely to be faced with many difficulties ere it can be placed on a sound commercial basis.

But for some years at least the dirigible will have the advantage over the flying machine as a passenger carrier, since the aeroplane in its present form is not suited for taking more than one passenger in comfort. The difficulty will not be overcome by making larger machines. A new type will in all probability be found necessary; and there are many ways by which the desired end may be attained.

An important meaning underlies the commercial development of the Zeppelin airship in Germany. If at all successful the fleet will be rapidly increased, and by active service and possible competition the vessels will be very quickly improved. Should the scheme of making the vessels suitable for use along the North Sea coast prove feasible, Germany will in time have a great auxiliary aerial fleet available in time of war which will give her an immense advantage over any other power. The whole scheme is fascinating in its boldness of conception, and even if it succeeds only in part, Germany will have a valuable ally for both its army and navy. Furthermore, should the aerial services pay for themselves in peace times the cost to the Government will be very little when they desire to make use of them in time of war.

France, ever mindful of the progress of Germany, has also worked out a scheme for aerial services. A centre will be established at Issy, near Paris, and here lines will radiate to various important points. The ships will be much smaller than the Zeppelin, and will not be so speedy. Harbours will be erected at various important points. It is computed by the promoters that a thirty-mile trip can be made at a profit by charging from £2 to £4 per passenger. A government subsidy will probably be obtained to help on the enterprise, for it will mean a most useful addition to the French fighting forces. In connection with the establishment of a permanent aerodrome at Bétheny, near Rheims, it is also proposed to work out an aeroplane route from Paris to Bétheny, with intermediate landing places at Meaux, Dormans, and Epernay. By this means flying machines could travel by their own power from Paris to Rheims.

We must wait for a further period of development ere aeroplanes or dirigibles can be usefully employed as high-speed transport agencies for

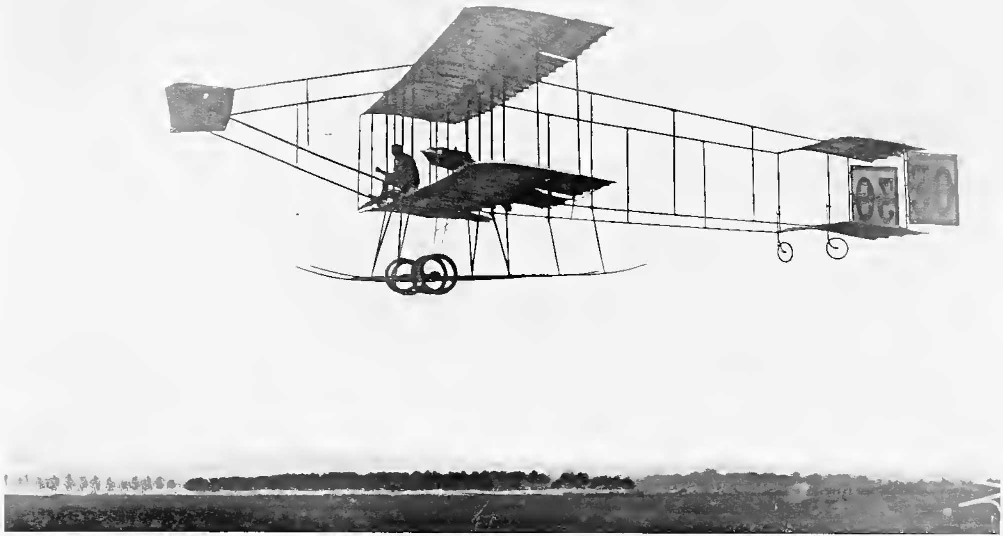


MAP OF THE PROPOSED AIRSHIP SERVICES IN FRANCE

An aeroplane route from Paris to Rheims, with various intermediate landing stages, has also been suggested.

light and small articles, as the conditions of work here will necessitate more reliable services than the carriage of tourists or pleasure-seekers. When aerial vessels are built capable of high speeds, and reliable in every respect, they can be usefully stationed at ports, seaside resorts, and other parts of the coast so as to render service in cases of wreck and disasters at sea. The wind may have abated enough to permit of powerful aerial vessels flying over a wreck or a vessel in distress at a time when the water remains so rough that no effective aid can be sent in any other way. Many other uses will suggest themselves for aerial vessels when they have reached a high stage of efficiency, but enough has been said to indicate that the commercial possibilities of airships justify the matter receiving serious attention. We must deprecate "wild-cat" schemes, and projects established by swindlers to extract money from the gullible public. Great strides have yet to be made in every type of vessel ere any serious application to commercial uses can be recommended. But the employment of airships in sport will do much to hasten progress.

On November 17th, 1909, the German Airship Navigation Co. was incorporated at Frankfurt with a capital of £150,000. The company intend to acquire two vessels, "Zeppelin IV" and "Zeppelin V"; and will establish harbours at Frankfurt, Baden-Baden, Mannheim, Munich, Leipzig, Cologne, Dusseldorf, Berlin, Dresden, and Essen.



THE FARMAN BI-PLANE IN FLIGHT
(The combined skids and wheels can be clearly seen)

CHAPTER XVII

AEROPLANE PROGRESS IN 1909

WHEN, on the last day of 1908, Wilbur Wright surpassed all his previous records by a flight lasting 2 hours 20 minutes 23 seconds, it was felt that he had set up a record which his French rivals would find it difficult to beat. The Paris Aeronautical Exhibition, which opened on December 24th, and continued into the new year, showed that strenuous efforts were being made, however, to evolve new machines which would excel the American flyer. The early months of 1909 passed away, nevertheless, without Wright's record being broken, and indeed as time went on it appeared as if the new machines would not give a good account of themselves. Close analysis of the situation revealed the fact that engine trouble was the principal factor in the delay, and the difficulty in evolving a light motor which would do the work required was not easily settled.

The Wrights had favoured two propellers driven by a strong and simple type of motor at relatively slow speed. Their "catapult" device got over the initial trouble of starting, and rendered a high-powered engine unnecessary. French designers worked to evolve a machine which would start without the need of an extraneous apparatus, and they adopted a single propeller driven at high speed by a light but powerful engine. The claims made by the rival schools were vigorously discussed, each side persisting in the correctness of its principles, when perhaps a compromise would have been better.

Whilst seemingly little progress was being made in France news came from Canada of the success of Mr. McCurdy, who carried out several remarkable flights over the frozen surface of a lake near Baddeck Bay, Nova Scotia. He used a machine designed by the Aerial Experiment Association. This body included Messrs. Curtiss, Baldwin, McCurdy, and Dr. Graham Bell, a truly remarkable combination of talent and inventiveness. Amongst the first products of the organisation were the *Red Wing*, *White Wing*, and *June Bug* biplanes.

In 1909 the *Silver Dart* was employed by the Aerial Experiment Association, a nine miles course being marked out over the frozen lake Bras d'Or. In February and March Mr. McCurdy made the first successful flights of the year.

Considerable distances were accomplished, and in all over 1000 miles are said to have been covered in about 100 journeys. Dr. Graham Bell also tested his curious cellular machine, but a mishap checked the work.

Eventually the Aerial Experiment Association was dissolved, as the members felt they had arrived at the stage when a purely experimental organisation was no longer advisable. Messrs. McCurdy and Baldwin decided to work in Canada, whilst Mr. Curtiss devoted himself to the American trade, founding the Herring-Curtiss Company at Hammondsport, N.Y.

During February Mr. Wright made many flights at Pau, and they attracted many distinguished visitors. King Edward of England, the King of Spain, and Mr. A. J. Balfour were amongst those who saw the flying man accomplish his wonderful evolutions, and these demonstrations helped considerably to awaken public interest in aviation.

Efforts were made to hold aviation races over the Bay of Monaco, but they failed completely, as at that time no flyer was daring enough to travel over the sea, even for a short distance. Not until the end of April was the new Farman biplane tried, and about the same time a newcomer, Hubert Latham, made his first flight on the Antoinette monoplane.

In May the British Government appointed a Scientific Advisory Committee to give expert opinion to the naval and military authorities on aeronautical matters. The committee was made up of distinguished scientific men, but save Mr. Lanchester none had any experience of aeronautics. Thus the new body did not give complete satisfaction, nor was it a guarantee that England would move quickly in practical work.

At the end of May, Latham flew for 37 minutes 3 seconds, and thus established a new monoplane record. He showed extraordinary skill in the control of the machine. Tissandier, one of the French Wright pupils, made a good flight of 1 hour 2 minutes.

Unfavourable weather, trouble with engines, and other causes led to many delays with the numerous new machines built in Europe and America, and the majority of the trials were unsuccessful. On July 17th, however, Curtiss flew for 52 minutes 30 seconds in America, and Blériot early in the same month made a flight of 50 minutes. Latham now suddenly came to the front by a monoplane flight of 67 minutes; and he therefore quickly decided to compete for the cross-Channel prize of £1000 offered by the *Daily Mail.*

Setting up his establishment on the cliffs at a point near Calais, he began his preparations for the first oversea trip made by a flying machine. The venture was daring in the extreme, for all the conditions of oversea flight were unknown.

After many weary waits owing to windy weather, he set out on July 19th, and made a magnificent plunge over the high cliffs, soaring, as was his wont, at a great height. But when barely six miles out from land his engine stopped, owing to a failure of the ignition apparatus, and he dropped into the sea. He was quickly picked up by a French torpedo-boat destroyer, which acted as his escort, and he proved to be little the worse for the adventure.

Louis Blériot, his great rival, could resist the temptation no longer, and he hurried to Calais, also to prepare for the cross-Channel flight. (At that time, in America, Orville Wright was carrying out his tests for the military authorities, which I deal with elsewhere.) The eagle-eyed Blériot found a period of tempting calm early on the morning of July 25th, 1909, and whilst Latham slept, and his watchers waited for better weather, Blériot got out his little machine, made a trial trip, and warned his escort to be ready. It was all done so quickly that Latham was awakened to see his rival flying towards England. Then it was too late to follow, for the wind had risen too.

Blériot was lucky, but never was luck better deserved. For years he had been the sole exponent of the monoplane, and had risked his life scores of times, and spent a small fortune in proving the correctness of his idea. He flew fast and well, but in mid-channel there came an anxious time when he was out of sight of both countries and lost his course.

He kept on straight ahead, and eventually sighted the English coast, but not Dover, for the wind had taken him eastward. Then with his indomitable courage he fluttered along by the cliffs until he found his goal. There was nearly a tragic end to the voyage, for he got into a regular aerial maelstrom, and was whirled round twice when he had got in over Dover. This caused him to make an abrupt landing.

But he had come to England as no other man before him had been able to travel, and he had made the crossing in better time than the fastest ship. Here in the dawn of an English Sunday a Frenchman had flown over one of our great naval ports unobserved and unexpected. It was only a sporting feat, another sign of friendship between the two nations, but it gave one pause for thought.

From France to England in forty minutes by a little craft which cost £400, which can travel high up in the air, and elude fleets and guns! One day the flyers will be as silent and as numerous as birds in the air—and not much larger—at the great heights they will soar to. Will it be well then with the laggard nations?

Latham tried the Channel flight some time after Blériot's success, and failed only when close to Dover. Then in August came the great race meeting at Rheims, which was yet another revelation of the power of the aeroplane. This I treat of separately. A meeting at Brescia followed, and here again Curtiss, who had been so successful at Rheims, showed extraordinary speed. Here Rougier made a new altitude record of 645 feet.

Mr. Cody in England made a flight of 66 minutes in September, in which he circled over a wide area of country. A consistent improvement extending over several months had led up to this fine performance, and he followed it up with several other good flights in preparation for the London to Manchester flight, for which the *Daily Mail* had offered £10,000. After two short flights on October 9th he postponed the trial.

September was notable also for the cross-country flight of Santos Dumont on his tiny monoplane. He went from St. Cyr to Buc in five minutes, travelling 4¾ miles cross-country in that time, and showing a speed of over 55 miles an hour, thus beating all the speed records. He repeated the feat several times, and made a new record in rapid starting by getting his machine into the air after running 70 yards along the ground. In an unofficial trial he rose after a run of but 20 yards. Orville Wright in Berlin made several records, his best being in carrying a passenger for 1 hour 35 minutes 47 seconds. In October he had the honour of taking the German Crown Prince for a successful trip. Some days previously he had soared alone to a height estimated at 890 feet. Meantime Wilbur Wright at New York had made some magnificent flights in connection with the Fulton celebrations, circling over the assembled fleets, and presenting a striking spectacle. On October 4th he flew from Governor's Island, off Manhattan Island, out past the Statue of Liberty, up the Hudson River, high above the warships, and back to the island. The distance was over 20 miles and was accomplished in 33½ minutes. It must be classed as one of the grandest events of the year.

Races at Berlin, Port Aviation (Paris), Frankfurt, Doncaster, and Blackpool, and a great aeronautic *salon* in Paris, brought the most eventful season in the history of aeronautics to a close.

In November Paulhan flew for 2 hours 49 minutes 20 seconds at Brooklands, near London, thus ranking next to Farman. Mr. J. T. C. Moore-Brabazon flew for nearly two miles a few days previously, being the first British-born subject to make a flight of over a mile on a British-made machine. He was soon followed by the Hon. C. S. Rolls, who used the first British-built Wright machine. Herr Grade made the first flights in Germany about this time on his all-German monoplane.

Mr. Henry Farman eclipsed all his previous feats by a magnificent flight of 4 hours 17 minutes 53 seconds at Mourmelon-le-Grand on November 3rd. He was the first man to fly for more than four hours.

Two fatal accidents, causing the deaths of Lefebvre and Captain Ferber, marred the year, and showed that the aeroplane was still far from the desired stage of reliability.

Viewed from the technical point the improvements effected were mainly in the engines and in the increased skill and daring of the aviators. In no machine save the Voisin was any attempt made to secure automatic stability, and many of the vessels flew merely by the "brute force" imparted by unnecessarily powerful engines. There is thus much room for improvement in many vital respects, more particularly that of stability.

CHAPTER XVIII

AEROPLANE RACING

The Rheims Aviation Meeting

THE first aviation race meeting ever held took place on the Plain of Bétheny, near Rheims, from August 22nd to the 29th, 1909, and proved a complete success, both as a public spectacle and as a test of flying machines. The affair aroused extraordinary interest, and it was proved beyond all question that aeroplane racing can be made a very attractive sport. As many as seven machines were to be seen in the air at one time, and despite windy weather the races were held every day without serious mishaps. The presence of two French airships the *Colonel Renard* and the *Zodiac* afforded a striking contrast, and for the first time in the history of aeronautics dirigible balloons and flying machines were seen in the air at the same time.

The course was laid out to form a rectangle measuring 10 kilometres in all. The aeroplane sheds were set back from the track so that a large manœuvring ground was reserved for them ere they came on the course proper. This was a very sensible arrangement, but from the spectacular point of view it would have been better had the course itself not been quite so large. At the same time it was evident that aeroplanes require ample "sea room," and many serious accidents would have occurred had there not been such ample space available at Rheims.

The competing machines included the French Wright machines, Voisin, Farman, Blériot, Antoinette, R.E.P., and Curtiss.

There were in all thirty-eight aeroplanes entered, and all save the Curtiss (the sole American representative) were well known in Europe.

On the opening day, when the weather was rather boisterous, the French-owned Wright machines accomplished the best performances and showed a wonderful controllability. But on the succeeding days they were beaten in speed and length of flight by most of the other machines.

Owing to the wide range of engine power (see table in "Aeroplanes of the Year") exact comparisons are not feasible between the different machines, as it is obvious that a machine with half the engine power of another can hardly excel it in speed. A review of the results will show that the biplane more than maintained its position, although the monoplane enthusiasts expected that their machines would sweep the boards. The longest flight was made by a biplane, and the highest speed was also attained by a double-decker.

Nevertheless, the monoplane pressed it pretty close, and showed a relatively greater amount of improvement. The Curtiss biplane, which has about the weight and bearing surface of the usual monoplane, proved faster than its single-deck rival, and the ease and rapidity with which it took the air showed new possibilities in the light small-sized biplane. But, all things considered, it was evident that there was room for all classes of aeroplanes, and this as proving that flying machines can be made in many different types should be of considerable comfort to inventors.

Appended are the results of the races :—

LONG-DISTANCE CONTEST.

Grand Prix de la Champagne.

			Distance in Miles.	Time. Hr.	Min.	Sec.
1	Henry Farman	Farman biplane	112½	3	4	56
2	Hubert Latham	Antoinette monoplane (No. 29)	96½	2	13	9
3	Louis Paulhan	Voisin biplane	82	2	40	
4	De Lambert	Wright biplane	72½	1	50	59
5	Hubert Latham	Antoinette monoplane (No. 23)	69	1	38	5

Farman made a world's record for time and distance.

FIRST GORDON BENNETT AVIATION RACE.

International and Interclub Race over 20 kilometres or 12½ miles.

			Min.	Sec.
1	Glen Curtiss (America)	Curtiss biplane	15	50⅗
2	Blériot (France)	Blériot monoplane	15	56⅕
3	Latham (France)	Antoinette ,,	17	32
4	Lefebvre (France)	Wright biplane	20	47⅗

This contest was made up of two laps of the course. For the first lap Curtis took 7 minutes 57⅖ seconds, whilst Blériot did it in 7 minutes 53⅕ seconds. Curtiss's second lap was done in exactly the same time as Blériot's first lap; and Blériot lost the race by his slow time in the second lap of 8 minutes 3⅕ seconds. The winner's average speed was 45½ miles an hour.

PASSENGER-CARRYING CONTEST

		Miles.	Min.	Sec.
1	Farman (one passenger)	6	9	52
2	Farman (two passengers)	6	10	39
3	Lefevbre (one passenger)	6	10	39

SPEED PRIZE

For swiftest flight over 30 kilometres (18¾ miles.)

		Min.	Sec.
1	Curtiss (Curtiss biplane) . . .	25	39
2	Latham (Antoinette monoplane) .	26	33
3	Tissandier (Wright biplane) . . .	28	59
4	Lefebvre (Wright) . . .	29	—
5	De Lambert (Wright) . . .	29	2

Next in order were Latham, 29 minutes 11 seconds; Paulhan (Voisin), 32 minutes 49 seconds; Bunau-Varilla (Voisin), 42 minutes 25 seconds; and Sommer (Farman), 1 hour 19 minutes 33 seconds.

HEIGHT CONTEST

		Ft.
1	Latham (Antoinette monoplane)	508
2	Farman (Farman biplane)	360
3	Paulhan (Voisin biplane)	180

FASTEST LAP PRIZE

Distance, 10 *kilometres*, *or* 6 *miles* 376 *yards*.

		Min.	Sec.
1	Blériot (Blériot monoplane)	7	$47\frac{4}{5}$
2	Curtiss (Curtiss biplane)	7	$49\frac{2}{5}$
3	Latham (Antoinette monoplane)	8	$32\frac{2}{5}$
4	Lefebvre (Wright biplane)	8	$58\frac{4}{5}$
5	Farman (Farman biplane)	9	$6\frac{2}{5}$

Next in order were Tissandier (Wright), 9 minutes $26\frac{1}{5}$ seconds; De Lambert (Wright), 9 minutes $33\frac{2}{5}$ seconds; Legagneux (Voisin), 9 minutes 56 seconds; Paulhan (Voisin), 10 minutes 50 seconds; Delagrange (Blériot), 11 minutes 3 seconds; Sommer (Farman), 11 minutes 24 seconds; Cockburn (Farman), 11 minutes 44 seconds; Bunau-Varilla (Voisin), 13 minutes 30 seconds.

The winner's speed was $47\frac{3}{4}$ miles an hour.

The Brescia Meeting

Although not so successful or important as the Rheims Meeting, some good sport was witnessed at the first Italian Aviation Meeting, held near Brescia, September 5th to 12th.

RESULTS

GRAND PRIZE OF BRESCIA

50 *kilometres*.

		Hr.	Min.	Sec.
1	G. Curtiss (Curtiss)	0	49	26
2	M. Rougier (Voisin)	1	22	0

MODIGLIANI PRIZE

International, for altitude.

1 M. Rougier (Voisin), 198½ metres (645 ft.).
2 G. Curtiss (Curtiss), 51 metres.

Rougier made a world's record for height.

PRIZE FOR CARRYING PASSENGER

International.

Lieutenant Calderara (Wright).

PRIZE FOR STARTING IN SHORTEST DISTANCE

1 G. Curtiss (Curtiss), 80 metres.
2 M. Leblanc (Blériot).

Lieutenant Calderara, on his Wright machine, won all the prizes confined to Italian aviators.

The Berlin Meeting

At the new aviation ground of Johannisthal, near Berlin, a meeting was held from September 26th to October 3rd, but was not brilliantly successful, owing to unfavourable weather and poor management. M. Latham made a sensational flight from the Tempelhofer Feld to Johannisthal, passing over the outlying districts of Berlin.

RESULTS

DISTANCE CONTEST

1 Rougier (Voisin), 131 kilometres.
2 Latham (Antoinette), 82½ kilometres.
3 Farman (Farman) 80 kilometres.

Rougier's time in the air was 2 hours 41 minutes 43 seconds.

SPEED CONTEST

20 kilometres

		Min.	Sec.
1	Latham (Antoinette) . . .	18	46
2	Farman (Farman) . . .	22	2
3	De Caters (Voisin)	22	47

ALTITUDE CONTEST

1 Rougier (Voisin), 158 metres.
2 Latham (Antoinette), 85 metres.

At almost the same time, in another part of Berlin, Orville Wright in an unofficial trial rose to an estimated height of 500 metres, or 1637 feet.

Blériot, at Cologne, made a new record for himself in duration of flight, remaining in the air for 1 hour 4 minutes 56 seconds.

The Blackpool Meeting

Only by extraordinary luck was any measure of success attained, for it looked almost foolhardy to arrange an aviation meeting so late in the year over an exposed region such as that at Blackpool. But out of this very daring experiment invaluable results have been obtained, and the Blackpool week, October 18th to 23rd, is of great importance in the annals of aviation. The meeting had not the glamour nor the success of Rheims: the number of useable aeroplanes was much smaller, and as no new types were tried there was not the same element of novelty. The Farman, Antoinette, and Voisin were the only successful machines of the meeting.

The wind gradually increased in power until on the concluding days it was almost a gale, reaching speeds up to 40 miles an hour at times. Two machines were tested in these high winds, the Farman and the Antoinette, and the intrepid Latham carried his daring to the limit when on October 22nd he set out against a wind which had a speed of from 25 to 35 miles. The saving factor was that the wind blew straight from the sea, and with the exception of some sand-dunes was little disturbed in its course as compared with the eddying and swirling winds which would be encountered further inland when hills, trees, houses and the contour of the country had disturbed the aerial currents.

Latham's achievement in making a circular flight at such a time stands out as one of the grandest feats of the aviator, but the affair has been so garbled and so badly understood by the majority of the reporters in the daily press that the public have been given very erroneous impressions. Latham is not the first man to have battled against a strong wind, though at the time of writing he holds the record for flight in the highest wind. There was no great marvel in flying against a gale which blew with reasonable steadiness of direction and speed, and in an exposed seaside place like Blackpool these conditions prevailed to a considerable degree. Flight is possible only to an aeroplane because it makes a gale of its own, and rides upon it. Theoretically Latham when running dead on to the wind could have stopped his engine and soared in the manner of the sea-bird, for the wind blowing against the plane would have given the requisite lifting power.

But of course he did not dare to do this, nor would it have been feasible in the present stage of aviation. Latham drove full force against the wind, and at times his forward speed dropped almost to zero, so that he actually hovered or soared. (The soaring bird, however, has no driving power at such a time.) At one period Latham declares that he was carried slightly backward. There were certain irregularities in the wind which disturbed his balance, and he tossed and swayed in a fashion which alarmed the public. His engine-power, however, never failed, and with the Antoinette's admirably sensitive system of control in the hands of a man who has a natural genius for the work, he triumphed over the forces opposing him.

He had critical moments in turning ere he was caught on the full current of the wind and borne along at speeds which were as high as 70 miles an hour. So for two rounds of the course he put the flying machine to the most crucial test it has yet been subjected to. He triumphed by his genius and skill, but it was apparent that the type of machine could not be trusted on such an occasion to ordinary hands, nor in an inland region could Latham himself have come through a similar ordeal safely.

Mr. Farman accomplished several notable flights in winds not quite so strong, and he too demonstrated the power of his machine, and the excellence of its quick and simple method of control. Rougier tested a Voisin, and this did not perform quite so well in a strong wind, the side panels of the tail being acted on by the wind in a manner which threw the machine out of its course. The Voisin has been pronounced inferior by some self-styled critics as a result of this performance, but we must remember that Rougier was far less experienced than Farman, and we should have to make a very careful enquiry into relative engine-power, wind-speed, etc., ere deciding fully on the comparative merits of the machines. Certainly no one experienced in aviation matters would condemn the Voisin on such insufficient data.

Several new English machines were present at Blackpool, but they were unable to make flights owing to the strong wind. There were some well-known French machines present also, but their owners were too inexperienced to carry out flights. More than any other meeting the Blackpool week showed the importance of great skill and long experience to aviators.

The results of the contests are appended :—

LANCASHIRE AERO CLUB'S GRAND PRIX

For the longest distance flown.

		Hr.	Min.	Sec.
1	Farman (Farman biplane), 47 miles 1544 yards	1	32	$16\frac{4}{5}$
2	Rougier (Voisin biplane) 17 miles 1544 yards .	0	34	$27\frac{4}{5}$
3	Paulhan (Farman biplane), 15 miles 1568 yards	0	32	$17\frac{4}{5}$

In the hour Farman travelled 30 miles 1577 yards.

"DAILY SKETCH" PRIZE

For speed (about 6 miles).

		Hr.	Min.	Sec.
1	Farman (Farman biplane), speed 36.38 miles per hour	0	9	$49\frac{3}{5}$
2	Paulhan (Farman biplane), speed 32.8 miles per hour	0	10	$54\frac{2}{5}$
3	Rougier (Voisin biplane), speed 32.33 miles per hour	0	11	$3\frac{3}{5}$
4	Latham (Antoinette monoplane, completed two circuits only), speed 23.67 miles per hour .	0	10	$15\frac{2}{5}$

Latham's flight was made in a violent wind.

"MANCHESTER GUARDIAN" PRIZE

For the slowest circuit (about 2 miles).

		Hr.	Min.	Sec.
1	Latham (Antoinette monoplane), speed 21.65 miles per hour.	0	5	$30\frac{2}{5}$
2	Paulhan (Farman biplane), speed 21.9 miles per hour	0	4	$6\frac{1}{5}$
3	Rougier (Voisin biplane), speed 27.72 miles per hour	0	4	$0\frac{3}{5}$
4	Farman (Farman biplane), speed 30.86 miles per hour	0	3	$19\frac{2}{5}$

PRIZE FOR GENERAL MERIT

For the three competitors who in the opinion of the stewards of the meeting shall have performed the most meritoriously.

1 Latham (Antoinette monoplane), for his flight of nearly 6 miles in a high wind, when its velocity ranged from 23 to 40 miles an hour.

2 Paulhan (Farman biplane), for his flight of nearly 16 miles, in a wind varying from 15 to 23 miles an hour.

3 Rougier (Voisin biplane), for his flight of nearly 18 miles at a high altitude.

"DAILY MAIL" PRIZE

For the greatest altitude, of £600, £240, and £160.

Fell void, no competitor rising to the minimum 200 ft. to be attained.

"ALL BRITISH" PRIZE

For British aviators piloting British-made machines throughout. Minimum distance, 100 yards.

Mr. A. V. Roe (triplane) had two hops in the air.
Mr. E. H. Saunderson (monoplane) did not leave the ground.
Mr. E. H. Crux (monoplane) did not leave its shed.
Mr. J. E. Neale (monoplane) did not leave its enclosure.
Mr. J. Humphreys (monoplane) did not leave its shed.
No prizes awarded.

"ASHLEY" COMPETITION

For British aviators, on any machine. Minimum distance of flight, 250 yards.

No award made.

The Doncaster Meeting

Inaugurated two days before the Blackpool meeting, the aeroplane contests at Doncaster were not at all so successful or interesting. With the exception of Sommer none of the men were of the first rank, and the various new machines which were entered accomplished nothing. The wind was more troublesome and more irregular than at Blackpool. Mr. Cody met with an accident early in the meeting, which put his machine out of the running. Delagrange on his Blériot achieved very little, whilst the English machines made no flights at all. Sommer did nothing remarkable save a picturesque flight by moonlight, and Le Blon after many daring attempts was the victim of a rather serious accident. The whole meeting showed that the modern aeroplane is not yet stable enough to be used in the highly irregular winds which are to be found over inland regions in broken weather. The total duration of the flights made at Doncaster in a week was under four hours; and the meeting resulted in a financial loss, which showed the unwisdom of holding these events at unsuitable times.

The meeting at Doncaster was prolonged until October 26th, and on the concluding day several brilliant flights were made in calm weather. The most notable was that achieved by Delagrange on a Blériot, when he travelled 1 mile 1543 yards in 1 minute 47 seconds, or at a speed of 53 miles an hour. This has been claimed as a world's speed record, but as the meeting was not sanctioned by the federated clubs it can hardly be allowed.

The awards were as follows :—

Whitworth Cup (for the longest distance of the day)—Sommer (Farman biplane), 38 miles 1580 yards, winner; Delagrange, 5 miles 1695 yards; Molon, 2 miles 1435 yards.

Doncaster Cup (for the greatest aggregate distance of the meeting, complete laps only to count)—Sommer, 136 miles 280 yards, winner; Le Blon, 39 miles 1745 yards; Delagrange, 29 miles 795 yards; Molon, 17 miles 1525 yards.

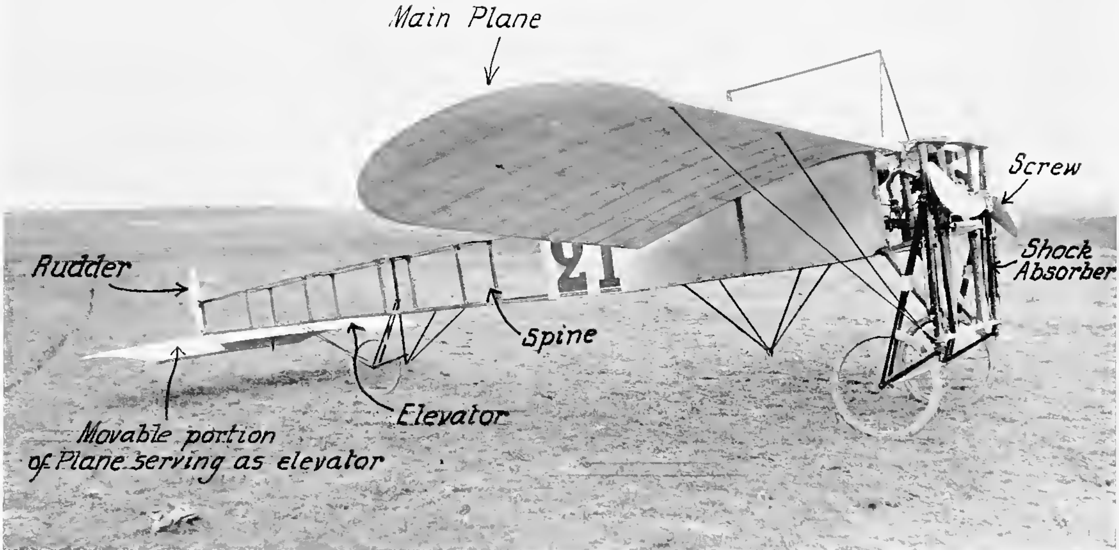
Tradesmen's Cup (for the fastest circuit)—Delagrange, 1 minute $47\frac{1}{5}$ seconds.

Chairman's Cup (for the best time over five circuits, distance 7 miles 495 yards, for biplanes)—Sommer flew over in 12 minutes $27\frac{3}{5}$ seconds.

Comte de Lambert's Flight over Paris

Only a small measure of success attended the aviation meeting at Port Aviation, near Paris, during October. There was not a sufficiency of first-class aviators to keep up interest. Comte de Lambert on his Wright machine was by far the best, and he saved the meeting by his recklessly daring flight from the aerodrome to Paris, over the Eiffel Tower, and back.

This, one of the grandest feats in aviation, was accomplished on the afternoon of October 18th. The distance out and home in a bee-line was 24 miles, but De Lambert took a winding course which made up the distance to about 30 miles, and this he covered in 49 min. 30 secs.,



THE BLERIOT MONOPLANE, CROSS-CHANNEL TYPE

or at an average speed of 36 miles an hour. Over the Eiffel Tower it was computed that he was at a height of about 1300 feet above the ground, and thus he easily beat all previous records in altitude. This event marked the first aeroplane flight over a great city, and conclusively reasserted the merit of the Wright machine. But in some respects it was a foolhardy feat, which might easily have brought disaster or death to other people had the aviator fallen in any part of Paris. Feats of this kind are to be deprecated in the present stage of aviation.

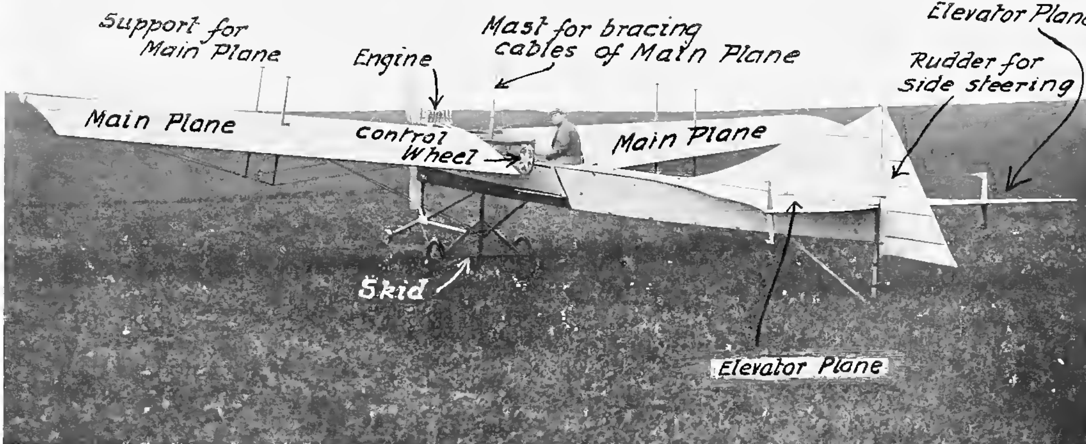
CHAPTER XIX

AEROPLANES OF THE YEAR

BLÉRIOT

THE evolution of the Blériot monoplane would form material for a little monograph of its own. After many changes M. Blériot has now arrived at two types which have proved themselves very successful. His smaller model was employed on the famous cross-Channel flight, and is thus the more interesting of the two. This machine has a bearing surface of 14 square metres. From the main plane (which can be warped for stabilising purposes) a long tail runs out which bears two minor planes, the extremities of which are capable of being moved up or down. They serve for elevating and balancing. Beyond these are fins and a vertical rudder. A three-cylinder air-cooled Anzani engine was used on his historic trip, and this little motor has many novel features. The chassis is mounted on three wheels, and a powerful shock-absorber is fitted.

The larger model has a bearing surface of 22



LATHAM AND THE ANTOINETTE MONOPLANE

(Control is effected by large hand wheels at each side which govern the elevator and the warping of the main plane; two pedals actuate the rudder, and smaller wheels govern the engine speed)

square metres, and in this the main plane is capable of being warped. The engine drives the screw through chain-gearing. A wide variety of motors have been tested, but on the whole this machine has not been so strikingly successful as the smaller model, though it of course has better carrying power. At Rheims M. Blériot was unable to do himself or his machines justice owing to the injuries he was suffering from. Since then he has accomplished several good flights.

ANTOINETTE

No machine has leaped so quickly into prominence as the Antoinette monoplane designed by M. Levavasseur. It had achieved very little success until M. Hubert Latham took up its exploitation, and he very soon showed its merits. The Antoinette has a central skiff-like body, from which springs on each side the main plane. The screw is placed right in front, and behind this is the Antoinette engine, which is conveniently placed in front of the aviator. The tail-piece carries a horizontal elevator, vertical and horizontal fins, and vertical rudders for side steering. Warping of the main plane assists in stabilising. Control is by means of cables actuated by wheels. The engine is notable in that the usual carburetter is dispensed with, and that a special form of cooling is employed. A very small quantity of water is used, and this is quickly turned into steam, which passes through a radiator, the tubes of which are placed along the side of the prow. Here it condenses to water, and is pumped back to the cooling jackets again. A powerful skid or runner protects the chassis from landing shocks.

SANTOS DUMONT

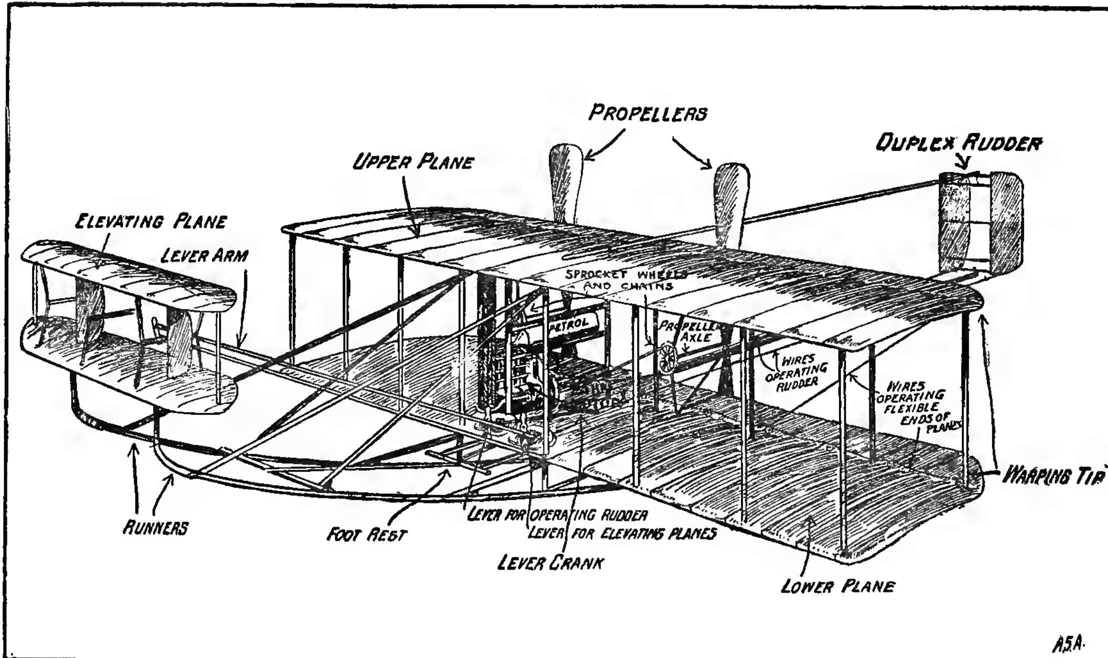
M. Santos Dumont has always favoured small flying machines, and for the season of 1909 he evolved a miniature machine with many novel points. This flyer did not prove successful until in the autumn, when, fitting a horizontal Darracq engine, he was able to carry out a series of astounding cross-country flights, in which he attained speeds of over 55 miles an hour. The monoplane has only a bearing surface of 9½ square metres, or almost half that of the smallest Blériot, and not one-fifth that of the usual Wright aeroplane. The engine is mounted above the single main plane, and drives a propeller direct. A notable feature is that the radiator tubes are lined along the inner surface of the main plane. A long tail-piece runs from the body and carries the rudder and elevating plane. Underneath the main plane the aviator is seated. In full running order the total weight is but 259 pounds. M. Dumont has shown that this little

machine can start from the ground after running a distance of 20 metres.

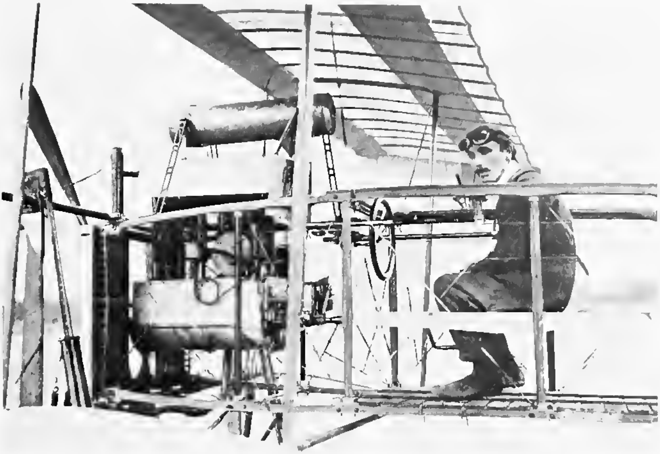
WRIGHT

The Wright biplane has undergone very few changes in the past year. The runners or sledges are still retained, although practically every other machine is now mounted on wheels, and can start from any level ground without the use of a rail or a "catapult." For the trials at Fort Myer in 1909 Orville Wright used a machine which was somewhat smaller in bearing surface than the older machines. Various details had been carefully improved, and the machine showed itself faster than the old types.

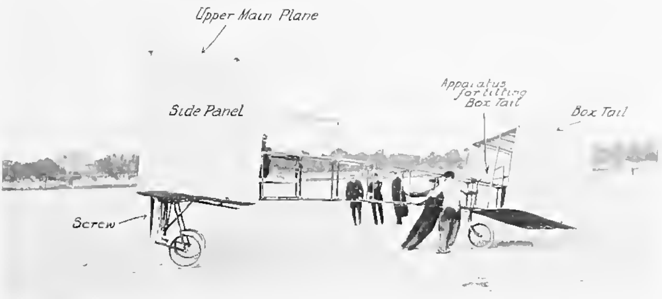
The Wrights have patented improvements relating to the wing-warping device, and also an automatic stabiliser of ingenious construction, but neither of these has yet been adapted to their machines. The main idea of the latter invention is to provide a supplementary mechanical control which will, when required, relieve the aviator of the necessity of manipulating the elevator, rudder, and warping levers by hand. The functions performed by the mechanical apparatus are exactly those which the operator normally performs for himself. The power for working the controlling gear is compressed air. The apparatus is brought into action in one



DIAGRAMMATIC VIEW OF THE WRIGHT AEROPLANE



MOTOR INSTALLATION ON THE NEW TYPE VOISIN
(In the old type the engines and propeller were behind the aviator)



SIDE VIEW OF THE NEW VOISIN
(This differs from other bi-planes in having no elevator plane in front, and in having a tractor screw instead of a propeller. The box tail serves also as a rudder and an elevator)

case by a pivoted plane acting under the influence of the wind pressure, and in the other case by a pendulum which is acted upon by gravity. In both cases the controller is merely used to operate a valve, which in turn brings into action other mechanism that acts on the steering gear or the elevator, as the case may be.

In October, 1909, one of the French-made Wright machines was fitted with wheels.

VOISIN

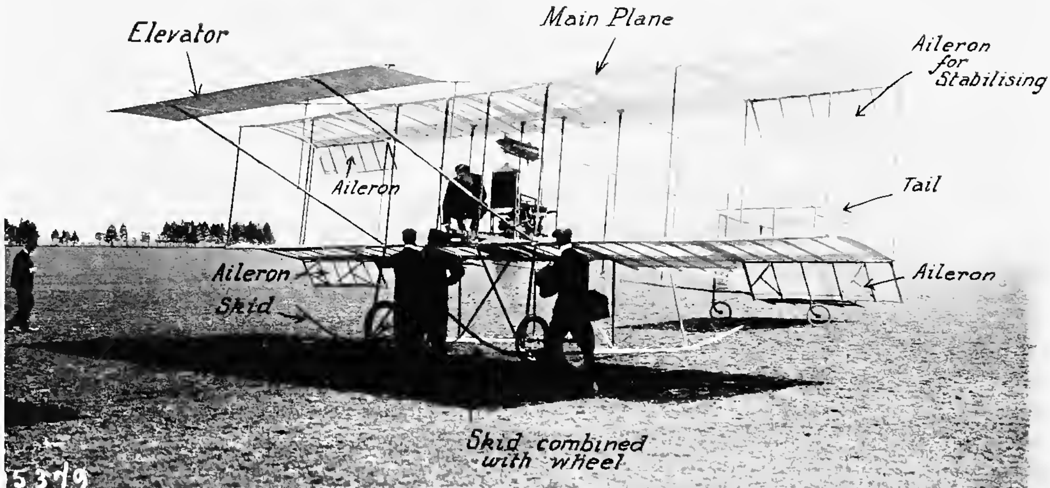
The Voisin machine, like the Wright, has altered very little since the previous year in its main outlines. There has been steady improvement, however, in the detail work, and with the long experience gained in the manufacture of these machines the general quality of the apparatus has been enhanced. The Voisin has for its essential features the box tail, the side panels between the main planes, the single elevator plane in front, and the wheels upon which the machine is mounted. Although the box tail and the wheels have increased the weight, the former has stood the test of time as a useful automatic balancing device, and the latter fitment has now become almost universal. A single propeller is still employed, and whilst there are many critics of this, it has been shown that the Voisin machines have been on the whole very successful during 1909.

A new type of machine was produced by Voisins in September, 1909. This has the engine mounted in front of the pilot, whilst the screw is of the tractor type mounted in front of the machine. The box tail can be tilted up and down, and moved from side to side. It thus serves as elevator and rudder. This machine marks a radical departure from the usual biplane design.

FARMAN

In the Farman machine we have an interesting variation from the Voisin type. Mr. Farman was the first successful exponent of the Voisin machine, and he took a very bold step when he broke away and set up for himself. Whilst retaining the biplane formation and a modification of the box tail, he added an important feature in the shape of *ailerons* or extensions to the main planes. These *ailerons* or flaps are movable to any angle, and are intended to assist in the balancing of the machine, for they accomplish in effect something analogous to that attained by the warping of the planes on the Wright machine.

Mr. Farman has also mounted his machine in a curious way, the wheels being so designed that they slide upwards in their frames when coming in contact with the earth, and thus allow runners



THE FARMAN BI-PLANE

(Distinctive features: quadruple ailerons, duplex rudders, and combined skids and wheels)

or sledges to take up the major portion of the landing shock. The arrangement of the engine and indeed many other details stamp the Farman as a very remarkable machine, and its phenomenal success at Rheims showed how well considered were its lines.

CURTISS

Reference has already been made to the work of the Aerial Experiment Association of America and the connection Mr. Glen H. Curtiss had with it. The *June Bug* and the *Silver Dart* were some of the most notable of their products. Now Mr. Curtiss works in partnership with Mr. A. M. Herring, a former assistant of Chanute.

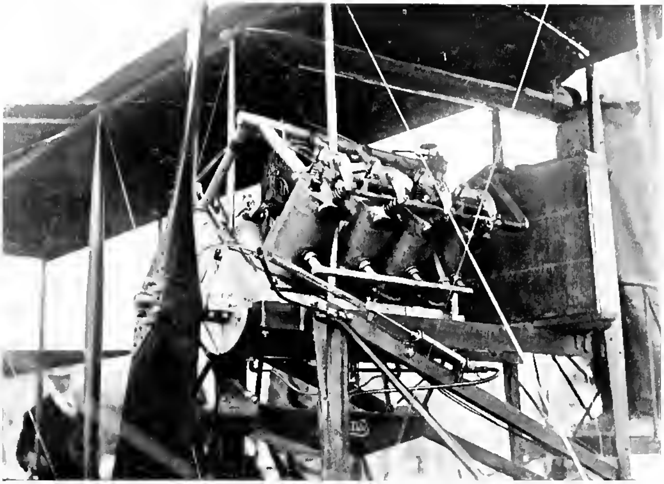
The partnership of these two men was bound to have highly important results; yet few people in America had any hope that when Mr. Curtiss came to Europe in 1909, an unknown man with a single aeroplane, he would be able to accomplish so much against his powerful rivals. He was, however, the great success of the Rheims meeting. With his one machine he won the Gordon Bennett race, with three French machines pitted against him. He also won the speed race, and was second in the lap contest. His total winnings were 38,000 francs. Going then to Brescia in Italy, he scored in splendid fashion, also winning several of the principal events.

His machine is worth careful study, for it sets the fashion in a new type of biplane, the one-man machine, in which lightness, efficiency, and speed are developed to a remarkable degree.

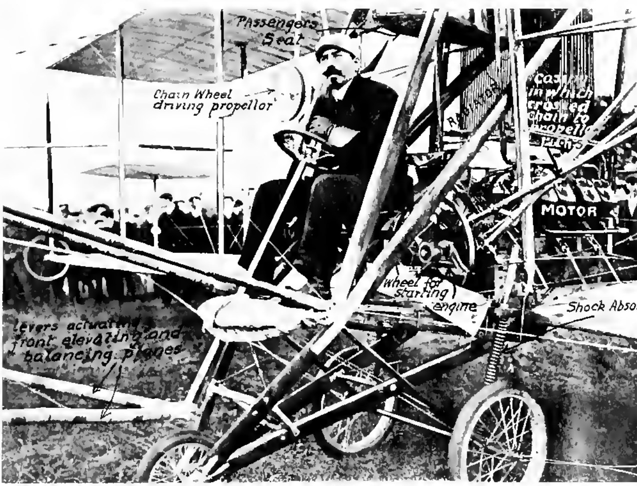
The Curtiss is of the biplane type, but has only a span of $28\frac{3}{4}$ feet, and its planes are only $4\frac{1}{2}$ feet deep. Unlike the Wright it is carried on a chassis mounted on wheels. Some 12 feet in front of the main planes the double elevator is placed, and well at the rear are a horizontal tail and a vertical rudder. Between the extremities of the main planes are two other small horizontal planes for balancing purposes. An important feature is that these planes project beyond the main planes. The control is by a steering wheel for the front elevator and the rudder, "shoulder pieces" actuating the stabilisers, and pedals controlling the throttle and ignition. The combination is highly ingenious. By swaying his body Mr. Curtiss can operate the "shoulder pieces" and so preserve his stability. This method of control is not so quick and responsive as by warping the planes.

The engine is of Mr. Curtiss's own design, and is notable for its lightness and simplicity. It drives a single propeller placed at the rear. The whole aeroplane when mounted only weighs 550 pounds.

When raced in Europe the main features of the machine were its speed and the rapidity with



PROPELLER AND EIGHT-CYLINDER ENGINE OF THE CURTISS AEROPLANE
(As used when winning the Gordon Bennett race)



MR. CODY AND HIS AEROPLANE
(Note pilot's position in front of engine, with passenger's seat tandemwise)

which it got clear into the air from a standing start. In both respects it beat the majority of the other machines, and was only excelled later on by Santos Dumont's featherweight monoplane. The Curtiss attained speeds up to 47 miles an hour, and was able to start within a distance of 60 yards. Mr. Curtiss proved himself a splendid pilot and engineer, and it was always noted that his machine was kept in first-class trim without being constantly tinkered with.

THE CODY

In 1907 the British Balloon Department turned their attention to the manufacture of an aeroplane from the designs of Mr. S. F. Cody, at that time an American resident in this country. After many delays and vicissitudes, due in no small degree to the unsuitable ground which the Government allotted to it for testing purposes, the machine was tried in 1908, but without any great success. Many accidents occurred, and the aeroplane went through numerous modifications. Eventually in 1909 Mr. Cody was presented with the machine by the War Office, they seemingly having lost confidence in it.

Working with great perseverance, Mr. Cody in the summer of 1909 made good progress, and proved to be at that time the only man who could fly in the British Isles. His best achievement at

MACHINES OF THE YEAR

Approximate Dimensions of the Principal Aeroplanes used during 1909

MONOPLANES

Type.	Country of origin.	Bearing surface in square metres.	Weight in flying order in lbs.	Balancing arrangement.	Chassis mounting.	Motor.	Horse power.	Mode of cooling.	Propellers.	No. of blades.	Diameter in metres.
R. E. P.	France	20	990	Warping planes	Wheels	7 cyl. R. E. P.	35	air cooling	1	4	2
Blériot	,,	22	1210	Ailerons	,,	3 cyl. Anzani	40	,,	1	2	2.7
,,	,,	14	765	Warping planes	,,	,,	25	,,	1	2	2
Antoinette	,,	50	1170	,,	Runners & wheels	8 cyl. Antoinette	50	water cooling	1	2	2.2
Santos Dumont	,,	9½	259	,,	Wheels	2 cyl. Darracq	30	,,	1	2	2

BI-PLANES

Type.	Country of origin.	Bearing surface in square metres.	Weight in flying order in lbs.	Balancing arrangement.	Chassis mounting.	Motor.	Horse power.	Mode of cooling.	Propellers.	No. of blades.	Diameter in metres.
Farman	France	40	1232	Ailerons	Runners & wheels	7 cyl. Gnome	50	air cooling	1	2	2.6
Voisin	,,	50	1230	Automatic	Wheels	8 cyl. E. N. V.	50	water cooling	1	2	2
Curtiss	U.S.A.	24	720	Ailerons	,,	3 cyl. Curtiss	30	,,	1	2	1.8
Wright	,,	50	1132	Warping planes	Runners	4 cyl. Wright	28	,,	2	2	2.5
Cody	England	60	2200	Subsidiary planes	Wheels	8 cyl. E. N. V.	80	,,	2	2	2

AEROPLANE RECORDS

A very unsatisfactory state of affairs prevails in connection with aeroplane records, as many of them are not officially certified, and not a few are based only on the observation of unskilled people. I append a list of the most reliable achievements, and have marked the principal officially observed records.

LONG-DISTANCE RECORD

*Henry Farman (biplane Farman, Gnôme motor), 234 kilometres (145 miles), 3 November, 1909.

DISTANCE AND TIME RECORDS

Kil.	Hr.	Min.	Sec.	
8	—	5	—	Santos Dumont (September, 1909).
*10	—	7	47⅘	Louis Blériot, Blériot monoplane (28 August, 1909).
*20	—	15	27⅘	Glenn H. Curtiss, Curtiss biplane (29 August, 1909).
*30	—	23	29	" " "
*40	—	34	55	Hubert Latham, Antoinette monoplane (27 August, 1909).
50	—	43	55	" " "
60	—	52	44⅘	" " "
70	1	1	51	" " "
80	1	11	0⅕	" " "
90	1	19	56⅖	" " "
100	1	28	17	" " "
110	1	36	46	" " "
120	1	45	32	" " "
130	1	54	29	" " "

* Official records.

Kil.	Hr.	Min.	Sec.	
140	2	3	54	Hubert Latham, Antoinette monoplane (27 August, 1909).
150	2	13	4 3/5	" " "
*160	2	43	35 2/5	Henry Farman, Farman biplane (27 August, 1909).
170	2	54	4 1/5	" " "
*180	3	4	56 2/5	" " "
*200	3	42	34	Henry Farman, Farman biplane (3 November, 1909).
*234	4	17	53	" " "

HIGHEST SPEED

55 miles per hour, Santos Dumont (September, 1909).
*47·7 " Blériot (August, 1909).

In half a gale at Blackpool, Latham was estimated to be travelling at 75 miles an hour with the wind. Delagrange attained 53 miles an hour at Doncaster.

ALTITUDE

155 metres (496 feet), Latham (Antoinette monoplane).
172 metres (550 feet), O. Wright (Wright biplane).
*198½ metres (645 feet), Rougier (Voisin biplane).
*270 metres (885 feet), Rougier (Voisin), Antwerp, Nov., 1909.
*300 metres (984 feet), De Lambert, Paris, Oct. 18, 1909.
303 metres (997 feet), Paulhan (Farman), Sandown Park, Nov., 1909.

During a flight at Berlin on October 2nd, Orville Wright rose to a height which he estimates at over 1500 feet. We may take his estimate as fairly accurate. Comte de Lambert in his flight over the Eiffel Tower rose to over 1300 feet.

INDIVIDUAL RECORDS

	Hr.	Min.	Sec.	Miles	
Farman (Farman biplane) . .	4	17	53	145	Nov., 1909
Paulhan (Farman biplane) . .	2	49	20	96	" "
Rougier (Voisin biplane) . .	2	41	43	82	Sept., 1909
Latham (Antoinette monoplane)	2	13	4	96½	Aug., 1909
Wilbur Wright (Wright biplane)	2	20	23	77	Dec., 1908

* Official records.

NATIONAL RECORDS

	Hr.	Min.	Sec.	
England				
M. Paulhan	2	49	20	(Farman biplane).
J. T. C. Moore-Brabazon	0	2	36	(Short all-British biplane).
France				
H. Farman . . .	4	17	52	(Farman biplane).
Germany				
Rougier	2	41	43	(Voisin biplane).
H. Grade . . .	0	2	43	(Grade all-German monoplane).
United States				
O. Wright . . .	1	21	0	(Wright biplane).
O. Wright . . .	1	12	36	(World's record with passenger).

The flights of Mr. Moore-Brabazon and Herr Grade represent the first officially observed aerial journeys accomplished by machines made entirely in England and Germany respectively, and flown by subjects of these countries. Mr. Cody was not a British subject when he made his flight of 66 minutes in England, and this was not officially observed. In November Herr Grade made a flight of 55 minutes.

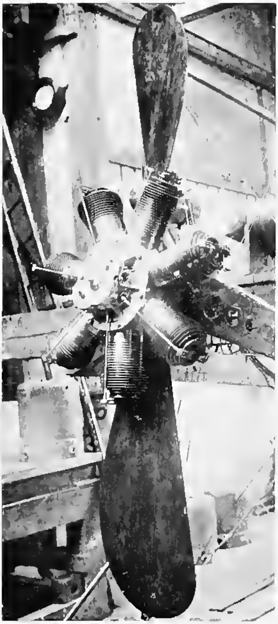
CHAPTER XX

FUTURE DEVELOPMENTS IN FLYING MACHINES

THOUSANDS of brains are now at work on the problem of aerial navigation, and it is reasonable to suppose that very important changes will soon come about. It is also becoming apparent that the successful machines of to-day have very little novel in their main principles, and manifestly do not mark the last stage of development. They are, in effect, the ancient gliding machines more carefully built, and fitted with powerful engines; and security is found in high speed, and in the skill of the operator. Accidents are numerous, and it cannot be said that any existing commercial type can be safely developed on its present lines to afford those large, powerful, and reliable machines which must be provided ere aerial navigation will be made really practicable.

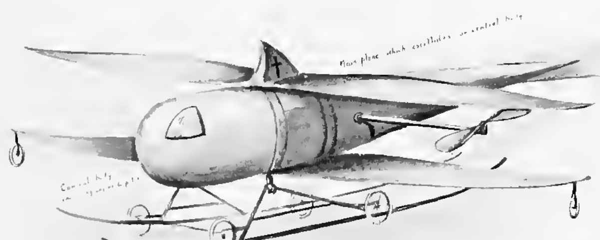
Various schemes for producing automatic stability are being tested, and some of them doubtless can be applied successfully to the present types of machines. These can then be somewhat enlarged so as to take more powerful engines and carry a greater number of passengers. But it is more likely that completely new types will be evolved. To my mind the ideal flying machine should have these basic principles:

Perfect automatic stability, longitudinally and laterally.
Power of proportioning bearing surface to the speed.
Reliability.
Ease and safety of operation.
Practicability of expansion to larger sizes.
Wide range of action.
Increased speed.
Duplex engines.
Variable pitch propellers.
Ability of rapid starting from any surface.
Ability to make safe descents on any surface.
Floating power on water.
Navigability on water.
Easy transport on land by the use of folding planes which do not necessitate the detachment of any part.
Possibility of connecting up the engine to drive the road wheels, the instrument then being narrow enough to be transported over an ordinary road.



THE MOST SUCCESSFUL AEROPLANE ENGINE OF 1909

The Gnome rotary engine was used by Mr. Farman to make his principal records. This motor has seven cylinders, which revolve in a solid mass with the propeller, here shown mounted behind them. The engine thus cools itself by its rapid motion through the air. It also dispenses with a fly-wheel



DIAGRAMMATIC SKETCH OF THE CRUCIFER AEROPLANE [COPYRIGHT]

[This patented machine has several novel features, such as the completely enclosed body borne on trunnions (not shown for the sake of clearness). The planes oscillate on ball bearing collars mounted on the body. It has two propellers, only one of which is shown]

Some form of vertical lift device (of either the lighter or heavier-than-air type) which in emergency will maintain the vessel in the air when the forward propelling device is out of action.

Comparative cheapness and simplicity of manufacture.

Such a vessel would render aerial navigation a practical problem. It would have high speed, security in the air, and the possibility of immense development. Furthermore, when disabled it would come safely to the surface of land or water, and there be capable of easy transport if aerial travel could not be resumed.

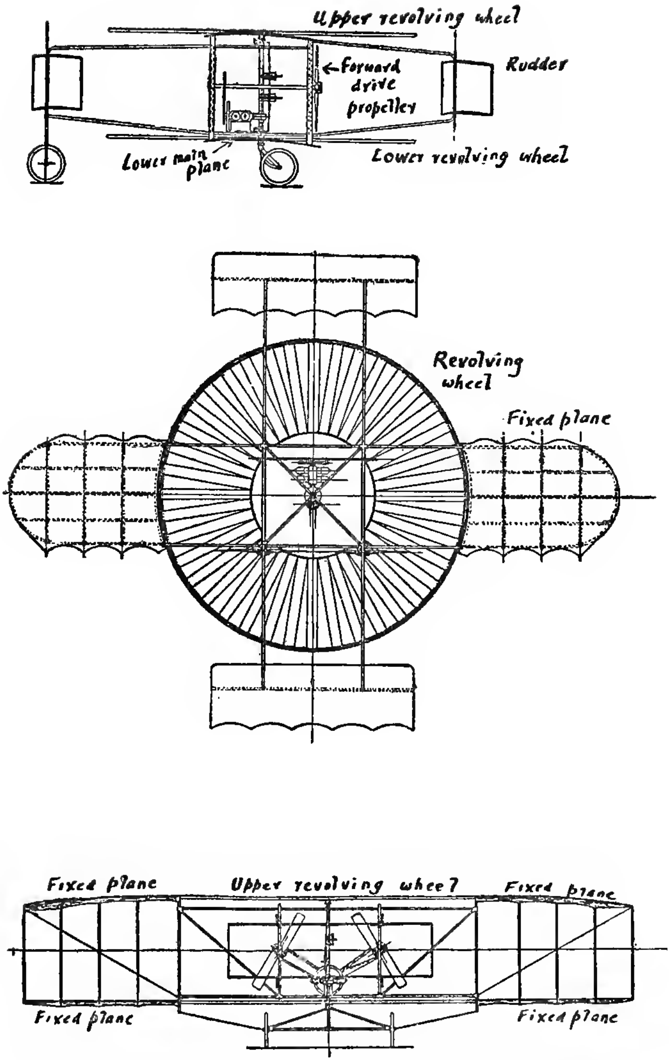
Some of these ideals may be unattainable in our time, and the whole combination may not be feasible; but we are now on the way to achieve a few of the points, and they will have an important effect on future progress. It seems most probable that new forms of machines will be invented to comply with these essentials.

As bearing on the matter I may refer to two remarkable patents of which I have knowledge. One is the Crucifer aeroplane patented by a Sussex gentleman, Mr. L. B. Goldman. He takes for the central body a completely covered-in structure rounded in front, and tapering to a point at the tail. This body contains within it duplex engines, accommodation for the pilot, passengers, and fuel store. It is carried on trunnions mounted on the chassis, whereby it can be tilted to any desired angle, fore or aft, and locked in this position. An ingenious system of sliding weights gives control over the balance.

This body reduces the head resistance enormously as compared with most modern types, and affords complete protection from the weather. It also can be made buoyant so as to float on water.

The planes are mounted on a ball-bearing collar fixed on the shoulder of the central body, so that the wings can oscillate from side to side within certain limits without disturbing the central body. Springs or other devices will check the oscillations, and serve to keep the planes in their normal position, whilst central vertical planes will also help towards the same end. Altogether the design is a remarkable one, for which many claims are advanced, and it seems to suggest a most important development.

Radically different is another type of machine of which I am not at liberty to give details. In this we have two great but light lifting wheels mounted horizontally, and fitted with vanes of variable pitch. Beyond them project two fixed bearing surfaces in the same planes. The engine also drives two propellers for forward travel, and these screws have variable pitch. The action of



SIDE, PLAN, AND FRONT VIEWS OF THE LORENZEN COMBINED AEROPLANE AND HELICOPTERE the revolving wheels is to give lifting effect at first, and then to maintain balance by their gyroscopic action. In an involuntary descent they would have a parachute effect, and would have so much stored-up momentum that they would keep running long after the engines stopped. The whole apparatus is now being worked out in every detail with scrupulous care by its inventor and patentee, Mr. Lorenzen, and remarkable developments are expected from it. The revolving wheels form part of the main planes, and thus give a bearing surface even when not in motion.

THE KOSTOVICH COMBINED DIRIGIBLE AND FLYING MACHINE

One of the most remarkable of the dirigible vessels now under construction is the Kostovich, which is being built in Russia, from the designs of a very clever inventor. He uses a specially prepared laminated wood for the body, thus securing a light and strong rigid envelope. The great feature is that the gas can at will be compressed in other chambers, and enough air admitted to make the vessel heavier than air at any moment; thus in full flight as a dirigible the vessel can be converted into a flying machine; and the body is fitted with plane surfaces so as to be suitably employed in this way. When it is desired to float in the atmosphere, the air is pumped out and the gas allowed again into the buoyancy chamber.

The main propeller runs right through the body, and thus, it is claimed, drives the vessel in the most effective manner. Numerous other special features are embodied in this extraordinary vessel, which represents a lifetime of study and experiment. If the inventor's claims are borne out it will prove to be a very extraordinary craft, and as may be seen, it gives suggestions of speed and utility which are denied to the ordinary forms of dirigible balloons.

CHAPTER XXI

THE WRIGHT MILITARY TRIALS

THE United States military authorities were the first to officially recognise the possibilities of the aeroplane in warfare, and in 1908 they laid down a programme of tests which were being complied with by Orville Wright when the tragic accident occurred which cost poor Selfridge his life and maimed Wright. There was a necessary postponement for a year; but with his grand courage Orville Wright prepared again in 1909 to comply with the conditions. As revised they stood:—

1. An endurance flight of not less than one hour, with a passenger on board.

2. A cross-country speed test with a passenger on board, for a distance of 10 miles, in which a speed of not less than 38 miles an hour must be shown, and fuel sufficient for a three hours' flight be carried.

When the Wrights had entered for the trials in 1908 they had given no public proofs of their ability to carry them out, and wiseacres asserted that the tests were quite beyond their powers. The tragic interruption of the trials was adduced as convincing proof of the assertion. But without delay Wilbur Wright in France set all doubts at rest as regards the endurance in the air and his ability to take a passenger. It remained to be proved whether a cross-country flight could be made in America under the conditions laid down.

The brothers returned to America in May, 1909, and soon got to work preparing for the trial. Unfavourable weather, trouble with the engine, and other causes delayed the first trial until June 29th, when a short flight was made by Orville Wright. On the following day the machine was slightly damaged in another preliminary trip. Then on July 2nd flights of 7 and 12 minutes were made, to be followed by another irritating mishap which put the aeroplane in dock until July 12th.

Still other vexatious delays occurred, but the Wrights worked with their usual patience; and some measure of success was attained in a practice trip on July 24th, when a flight of 20 minutes was made. Another slight mishap occurred when landing. On July 26th, Orville Wright successfully started from the rail without the aid of the falling weight. President Taft watched the flight, and many daring evolutions were accomplished, despite the fact that a wind of nearly 15 miles an hour was blowing. This was the first public demonstration in America of the machine being started without the aid of the catapult device, and it was successful, although the machine skimmed over the grass for some distance after leaving the rail.

The great trial came on July 27th, and Lieutenant Lahm was selected as the passenger. The wind had died down, and at half-past six in the evening the conditions were most favourable. This time the falling weight was employed to start the machine with its extra load, and the aeroplane rose quickly into the air. Round after round of the course was made in splendid style; and eventually, amidst great enthusiasm, Orville Wright was proved to have made a flight of 1 hour 12 minutes 36 seconds, thus beating the world's record (with passenger) held by Wilbur Wright (1 hour 9 minutes 45 seconds). It was a most remarkable performance in every way, and showed the wonderful carrying power of the Wright machine. The aeroplane used on this occasion was somewhat smaller than that of the previous year. The skids were increased in length, the wire stays were improved, and the area of the planes reduced by about 90 square feet.

The tide had now turned; and next day Orville Wright attempted to make the cross-country flight from Fort Myer to Alexandria, Va., and back, a total distance of 10 miles.

Various causes delayed this, and not until late in the afternoon of July 30th was the great feat accomplished.

Concerning this flight I have had from Mr. Orville Wright in person many interesting details, won out of him only by careful questioning, for he is quite modest over the affair, though I regard it as the greatest feat yet accomplished in aeroplane flight, and, if anything, more difficult than Blériot's crossing of the English Channel, for the wind conditions were more trying, and there was the added responsibility of carrying a passenger.

Mr. Wright confessed to me that flight in America is more difficult than in Europe, for apparently the wind is usually stronger and of a more complex character. This is especially the case over rolling and well-wooded country. Now from Fort Myer to Alexandria is a rough and undulating region with deep valleys, and so well wooded that had the engine stopped a safe landing-place could hardly have been found. Indeed, Mr. Wright admitted to me that had an involuntary descent been made they would probably have been impaled on the trees.

Faced with these dangers, Orville Wright set out with Lieutenant Foulois as passenger. He soon encountered a strong breeze on his side which swept the machine out of its bee-line course. Up-currents of air and other aerial disturbances threatened the stability of the vessel, but running in superb fashion it triumphed over all. The most exciting experience came on the return journey when crossing Shuter's Hill. Here the machine was seized in a mysterious down-draught which would have quickly pulled it to the earth had not Wright made good use of his lifting planes.

Without further adventure the run was concluded. His time for the whole ten miles was 14 minutes 42 seconds, which shows an average speed of 42¼ miles an hour. He maintained a very good altitude, and at times was nearly 500 feet high. One valley of nearly 200 feet in depth had to be crossed. As the journey was made in excess of the stipulated speed a bonus of 5000 dollars was won, and but for the wind affecting his course even a better speed would have been shown. His highest speed during the trials was 47 miles an hour.

It is stated that further trials of aeroplanes will be instituted in 1910 by the United States military authorities, with a view to testing engine powers more thoroughly, and provision may have to be made for carrying a light gun on each machine.

THE ITALIAN MILITARY DIRIGIBLE NO. I OVER ROME
(Note the conical formation and sharp pointed stern)

CHAPTER XXII

DIRIGIBLE BALLOONS IN 1909

THE progress of the dirigible balloon during 1909 was not so rapid or extraordinary as that of the aeroplane, but nevertheless many noteworthy improvements were effected, and there was a more general desire expressed by the principal nations to employ these vessels. The most remarkable indication perhaps came from England. Early in the year a little non-rigid balloon styled the *Baby* was launched from the military works, but this was of a size and a type which had long been demonstrated to be useless. The expectations founded by critics on this 100-feet non-rigid vessel carrying an engine of 24 h.p. were well borne out, for on trial the ship proved very slow, and was quite unfitted for military purposes.

Soon after this the British Government decided to adopt a new policy, and increased their vote for aeronautical expenditure to £78,000 as compared with £13,000 in the previous year.

The naval authorities were entrusted with the building of a rigid ship, whilst to the military department was delegated the work of building non-rigid and semi-rigid ships. A national airship fund was organised by the *Morning Post* with the object of purchasing a French Lebaudy semi-rigid dirigible which would be presented to the War Office; whilst Mr. Arthur du Cros and other members of the Parliamentary Aerial Committee arranged for a Clement non-rigid airship of new design to sail from Paris to London, and also qualify for purchase as a unit of the British aerial fleet.

In France several new vessels were launched during the year, including the *Liberté*, a sister ship to the *République*, the *Ville de Nancy*, and the *Colonel Renard*. The *Clement I* was wrecked, and another mishap befell the *République* when going to the autumn manœuvres. This was most unfortunate, though it was really traceable to bad handling by ignorant country people during a squall. When it is part of the military training that every man should receive instruction in handling airships in case of need, few vessels will be injured through the cause which led the *République* to be put out of action.

Working with magnificent energy and aided by a splendid organisation, the aerostatic corps carried out the repairs in the field, and at the temporary harbour at Lapalisse, which was the appointed head-quarters of the ship during the manœuvres. Thus under war conditions the vessel was ready ere operations commenced. It was a very fine example of French skill and enterprise, and it could only have been possible by the splendid facilities which the French airship division possesses.

The French manœuvres of 1909 were on a small scale, and new tactics were introduced in which the troops were worked in extended order over a large area, and practised taking full advantage of cover. A fog helped this. The airship was thus employed under conditions which are abnormal for continental warfare, and which indeed would hardly prevail when rival nations could put enormous armies in the field.

Opinions of military experts were thus divided as to the utility of the airship. Some declared that it came so near the enemy on many occasions that it would have been easily destroyed, whilst others averred that it remained so far off that it rendered very little assistance. General Goiran, who used the vessel on his side, declared, however, that it had been very useful to him, especially in the concluding days, when it was most important that he should gain some clue to the rather mysterious projects of his adversary.

On at least one occasion it gave him vital information of a turning movement directed against him which might have been disastrous. He was able to save the situation by the timely warning.

Not once during the manœuvres did the engine fail, and the ship showed very good speed, thus presenting a very elusive target. Thus under extraordinary circumstances the French airship made a really promising debut in manœuvres.

In Germany the early part of the year was rendered notable by several grand voyages carried out by the Zeppelin ships. Trips were made to Munich, Frankfurt, Bitterfeld, and back, and finally Count Zeppelin achieved his life's ambition by sailing his ship over Berlin, meeting with a magnificent reception. All these journeys were marred by mishaps of more or less gravity, mainly brought about by inclement weather. But the Zeppelin was in every case able to carry out its programme under its own power, and journeys up to 800 miles have been accomplished, thus placing this vessel very far ahead of all its rivals.

For some reason not clearly explained the *Zeppelin* was not employed in the German manœuvres of 1909, the only aerial vessel taking part being the *Gross II.* Here again military

THE FRENCH MILITARY AIRSHIP "REPUBLIQUE"

This semi-rigid dirigible of the Lebaudy type was totally wrecked by a fractured propeller near Moulins, Sept. 25th, 1909, and the entire crew killed

opinion is divided, as one might naturally expect. The weather was very unfavourable, and the vessel not having the speed of a rigid dirigible was handicapped. Wireless telegraphy was employed on this ship, and proved most useful, though when I suggested the fitment in the first edition of my book a learned American engineering paper ridiculed the idea as impossible! One Zeppelin is also provided with a "wireless" installation.

No official report has been issued on the work of the ship during the manœuvres, and the public reports have mainly been made by foreign attachés and correspondents who would naturally not seek to discover any particular merit in the vessels of a rival nation. It is beyond doubt that the vessel, however, rendered an appreciable amount of special service which could not be attained by other means, and from its first practical experience in the field much useful data will be gleaned. It would be absurd to expect that airships employed for the first time in military manœuvres could fulfil the expectations based upon them by optimists. One must remember that every other military and naval arm has been developed by slow and tedious stages, whilst the airship is as yet in its infancy.

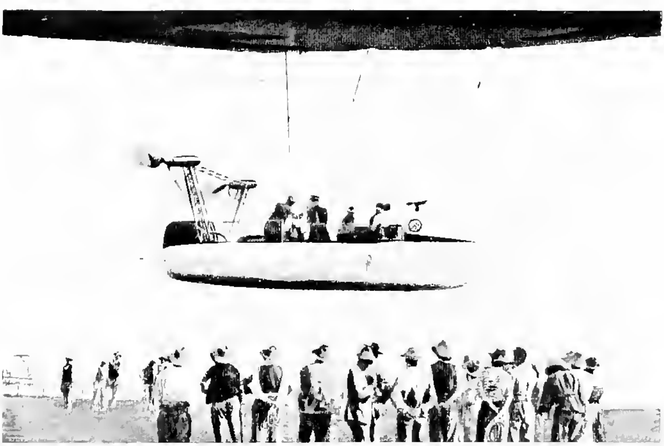
The progress of Germany in all that appertains to airships was well illustrated by the great aeronautical exhibition held at Frankfurt-on-Main from July to September. Astounding progress was manifested in every branch of dirigible balloon construction; and Krupps and Ehrhardts showed special types of high-angle, quick-firing guns to be used by terrestrial forces against aerial vessels. The most interesting type was a gun mounted on a motor-car, for it is now realised that to fight an airship from below it must be pursued by a high-speed agent. Special shells are used which leave a smoke trail in the sky, thus showing the gunner how near to the mark each shot goes.

Another great exhibition opened at Paris on September 25th, but here the aeroplanes were more important than the dirigibles. On the very morning of the inauguration the airship *République* was returning triumphantly from the manœuvres when suddenly a steel propeller blade fractured, and cut with terrific force through the gas envelope. It tore such a gaping wound that the gas escaped at once and the vessel fell from a height of several hundred feet with appalling velocity. The crew of four were killed and the vessel was totally wrecked.

Thus France lost her finest ship, and the second of the Lebaudy type. Public and expert opinion veered round in favour of the multi-

THE SECOND ITALIAN MILITARY DIRIGIBLE, THE FASTEST AND MOST SUCCESSFUL AIRSHIP AFTER THE ZEPPELIN

(Note the speed giving lines of the gas envelope and car; and the stabilising planes at the rear)



THE CAR OF THE ITALIAN DIRIGIBLE NO. II

cellular system as employed by the Zeppelin, where one or more of the seventeen gas bags could be deflated without destroying the buoyancy of the vessel. Even the much-despised Zeppelin rigid envelope was better thought of in France. Steel propellers were condemned, and many important modifications were settled upon in the newer French ships. It was a terrible lesson, and it showed how unwise the French had been in coddling their ships too much in the past.

Quiet but very progressive work was done in Italy during the autumn of 1909, when the second ship was tried. It differs in shape from the first vessel and looks a very important type. Several long journeys have been accomplished, and speeds up to thirty miles an hour have been attained. The shape of the envelope and the arrangement of the car are worthy of close study.

On October 20th, 1909, the new Italian airship made one of the most noteworthy dirigible voyages yet accomplished, and the first on record over the sea. Setting out from its station at Bracciano, near Rome, it ran to Civita Vecchia, and headed out to sea for six miles, then returning to land and making a circuit back to its starting place. The journey of 190 miles was accomplished in seven hours, or at an average speed of twenty-seven miles an hour, a record for long-distance speed work.

A yet more remarkable journey was made on October 31st, when it ran from Bracciano to Naples, cruised over warships in the Bay, and returned to Rome. The journey was over 290 miles, and the vessel was fourteen hours in the air. The return journey was delayed by strong wind. This is the finest record of any dirigible save the Zeppelin.

The new vessel has a gas capacity of only 2500 cubic metres, as compared with 3450 cubic metres in the former ship. Its gas bag is divided into seven compartments, so as to avoid the disaster which wrecked the *République*. The vessel has a range of action of ten hours.

All things considered, the dirigible balloon is yet far from being superseded, and I believe that the aerostatic principle is much too valuable to be dispensed with altogether.

BALLOON PROGRESS

American aeronauts showed most activity in 1909. The Gordon Bennett race from Zurich on October 3rd was won by an American, Mr. E. W. Mix, in the *America II*, who landed north of Warsaw after a journey of about 690 miles. In the same month Messrs. A. H. Forbes and Max Fleischmann travelled from St. Louis to near Richmond, Va., a distance of 731¼ miles, in 19 hours 15 minutes, or at an average speed of 38 miles an hour, which is a record for high-speed long-distance travel; at times they travelled at over 60 miles an hour.

AIRSHIP FLEETS OF THE WORLD

Vessel.	Type.	Length, feet.	Engine h.p.	Speed, miles per hour.	Longest run, miles.	Approximate range, miles.
ENGLAND						
"Baby"	Non-rigid	100	24	10	15	—
Admiralty	Rigid	Building	—	—	—	—
FRANCE						
Lebaudy	Semi-rigid	180	40	20	—	200
*République	"	200	120	25	125	300
Liberté	"	200	120	26	—	300
Colonel Renard	Non-rigid	200	—	—	—	—
Ville de Paris	"	220	75	20	—	300
Ville de Nancy	"	200	100	20	—	—
Clement-Bayard II	"	300	220	28	—	—
Egalité	Semi-rigid	200	120	26	—	—
GERMANY						
Zeppelin I	Rigid	440	200	30	378	700
" II	"	446	220	32	800	900
" III	"	446	220	32	500	900
Gross I	Semi-rigid	180	75	20	176	500
" II	"	180	150	25	—	—
" III	"	180	—	—	—	—

Parseval I.	Non-rigid	190	100	20	—	—
„ II	„	200	110	25	—	—
Siemens - Shuckert	„	400	500	—	—	—
Schutte	Rigid	—	500	—	—	—
RUSSIA						
Russie (Lebaudy type)	Semi-rigid	200	70	25	—	300
Kostovich	Rigid	200	100	Building	—	—
AUSTRIA						
Lebaudy type	Semi-rigid	—	Building	—	—	—
Parseval type	Non-rigid	—	Building	—	—	—
ITALY						
Dirigible I.	Semi-rigid	180	50	20	—	—
„ II	„	150	100	28	290	300
UNITED STATES						
Dirigible I	Non-rigid	100	20	15	—	—
JAPAN						
—	Non-rigid	110	50	—	—	—

* Wrecked September 25th, 1909, near Moulins.

THE GERMAN AIRSHIP TRIALS

A striking demonstration of Germany's aerial power was given by the official trials of the three vessels *Zeppelin II*, *Gross II*, and *Parseval I*, carried out by the German military authorities during the early part of November. No other country could put so many military airships into active service at the time, and no other nation possesses representatives of all three types of construction—the Zeppelin being rigid, the Gross semi-rigid, and the Parseval non-rigid. A fourth vessel, *Parseval III*, joined the fleet soon after the trials had commenced.

From Cologne as centre a series of speed, endurance, and altitude trials were made, details of which have been guarded with great secrecy. Several night voyages were carried out, the most interesting being when a night attack was directed against the fortress of Ehrenbreitstein near Coblenz. The full lessons of the trials are known only to the authorities, but it is believed that the vessels succeeded in carrying out many arduous trips, and that complete data have been obtained as to their relative powers, range of action, and general reliability. The Zeppelin had engine trouble at first, which handicapped it somewhat.

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unexpected aspect." Still, it is believed that the day has come for giving English versions of all his imaginative works, as well as of his monumental study JOAN OF ARC, which is undoubtedly the most discussed book in the world of letters to-day.

¶ MR. JOHN LANE has pleasure in announcing that the following volumes are either already published or are passing through the press.

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¶ The translation of these books has been entrusted to such competent French scholars as MR. ALFRED ALLINSON, MR. FREDERIC CHAPMAN, MR. ROBERT B. DOUGLAS,

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¶ As Anatole Thibault, *dit* Anatole France, is to most English readers merely a name, it will be well to state that he was born in 1844 in the picturesque and inspiring surroundings of an old bookshop on the Quai Voltaire, Paris, kept by his father, Monsieur Thibault, an authority on eighteenth-century history, from whom the boy caught the passion for the principles of the Revolution, while from his mother he was learning to love the ascetic ideals chronicled in the Lives of the Saints. He was schooled with the lovers of old books, missals and manuscripts; he matriculated on the Quais with the old Jewish dealers of curios and *objets d'art*; he graduated in the great university of life and experience. It will be recognised that all his work is permeated by his youthful impressions; he is, in fact, a virtuoso at large.

¶ He has written about thirty volumes of fiction. His first novel was JOCASTA & THE FAMISHED CAT (1879). THE CRIME OF SYLVESTRE BONNARD appeared in 1881, and had the distinction of being crowned by the French Academy, into which he was received in 1896.

¶ His work is illuminated with style, scholarship, and psychology; but its outstanding features are the lambent wit, the gay mockery, the genial irony with which he touches every subject he treats. But the wit is never malicious, the mockery never derisive, the irony never barbed. To quote from his own GARDEN OF EPICURUS: "Irony and Pity are both of good counsel; the first with her smiles makes life agreeable, the other sanctifies it to us with her tears. The Irony I invoke is no cruel deity. She mocks neither love nor beauty. She is gentle and kindly disposed. Her mirth disarms anger and it is she teaches us to laugh at rogues and fools whom but for her we might be so weak as to hate."

¶ Often he shows how divine humanity triumphs over mere asceticism, and with entire reverence; indeed, he might be described as an ascetic overflowing with humanity, just as he has been termed a "pagan, but a pagan constantly haunted by the pre-occupation of Christ." He is in turn—like his own Choulette in THE RED LILY—saintly and Rabelaisian, yet without incongruity.

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