The Aeroplane in War

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Transcriber's Note

This book was transcribed from scans of the original found at the Internet Archive. I have rotated some images. The name Blériot in the original book has the accented e only in captions to illustrations. I have used the accented version in the rest of the text as well. There are several variant spellings in the text which I have left alone.

[image]

[image]

CLAUDE GRAHAME-WHITE.
Winner of the Gordon-Bennett Aviation Cup, 1910; author of "The Story of the Aeroplane"; and joint author, with Harry Harper, of "The Aeroplane: Past, Present, and Future," "Heroes of the Air," and "The Aeroplane in War."

THE AEROPLANE IN WAR

BY
CLAUDE GRAHAME-WHITE
AND
HARRY HARPER
AUTHORS OF "THE AEROPLANE: PAST, PRESENT, AND FUTURE"

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PREFACE

Although it is still a crude machine—in view of the perfected apparatus which is the aim of thoughtful designers—the aeroplane has demonstrated, in a conclusive way, its value as an instrument of war.

In peace manœuvres in France and Germany, and under actual war conditions in Tripoli, scouting machines have proved their ability to pierce most effectually what is known as "the fog of war." Air-scouts have, indeed, revealed the dispositions of an enemy so precisely as to make it necessary to alter—at a moment's notice—an entire plan of campaign.

Ceasing to be fair-weather craft, powerful, modern-type aeroplanes can combat high and gusty winds, and are already capable of being used, for reconnoitring flights, on at least 80 per cent of the days of the year. No longer unreliable, they have become practical weapons.

A squadron of war aeroplanes, carrying pilots and observers, can, as has been shown again and again, lay bare the disposition of a widespread battle-front. In one hour, they can perform the reconnoitring work which has hitherto been carried out in a day, and in a necessarily hit-or-miss fashion, by cavalry and other scouts.

The use of well-trained corps of military airmen will revolutionise the tactics of war. No longer will two Commanders-in-Chief grope in the dark. They will sit, so to speak, on either side of a chess-board, which will represent the battlefield. Each will watch the other's moves; nothing will be concealed. From a blundering, scrambling moving about of masses of men, modern warfare will become—through the advent of the aeroplane—an intellectual process.

The Commander-in-Chief who has no proper air-corps, in the next great war, will be in a hopeless position. He will have lost a battle practically before it begins. Whereas his opponent will know exactly what *he* is doing, he will be able to obtain nothing but vague and confusing tidings as to the movements of the enemy. Imagine two armed men approaching each other, one being blindfolded. The Commander-in-Chief without aeroplanes will be like a blindfolded man.

One nation stands head-and-shoulders above all others in the matter of her

aerial equipment and experience. That nation is France. So far ahead is she that it will be a long time before other countries will be able to come up with her; but Germany is now making desperate efforts to do so.

Until recently, it must be said, England lagged inactively not only behind France and Germany, in the organising of an air-corps, but even behind such countries as Austria, Italy, and Spain.

Now, however, there are promises of a change. For this, mainly, we must thank the energy and enthusiasm of Colonel Seely, Parliamentary Under Secretary of State for War. When these lines are being read, British aeroplane manufacturers will be preparing for an important military trial of aeroplanes, which is to be held in England during the summer.

The War Office has begun to buy aeroplanes, although on a small scale. We now have a Royal Flying Corps; a body of skilled airmen is being trained. But money is spent very sparingly. Our equipment, compared with that of France, is still a negligible quantity. In machines, and men, and, above all, in training, we are very far behind.

Only by persistent and intelligently directed work, by the spending of more money, by the practical encouragement of manufacturers, and by the appointing of executive officers who are experts in their field of work, can we hope even to approach the organisation of the air-corps of France.

But a beginning has certainly been made. By the end of the forthcoming flying season, we should have in England a small, but well-equipped air service. And the work of this corps will be its own advertisement. Once the potentialities of the war aeroplane are realised adequately, a stinting policy will be impossible.

It is our aim, in this book, to show what the war aeroplane has done, and can do. At present, its work has been confined to scouting. But it has other, and grimmer possibilities. It can, and without doubt will, be used as an engine of destruction—not by means of the bomb-dropping attacks of a few aeroplanes, but by the organised onslaught of large squadrons of weight-lifting machines, which will be able to rain down tons of missiles over any given spot.

And there is another possibility, also. Machines are carrying heavier loads every day. Soon the practicability of aeroplanes to transport troops—particularly in regard to hurrying up reinforcements in an emergency—will be demonstrated.

When two opposing armies both have large fleets of war aeroplanes, and these machines take the air in squadrons, prior to a battle, what will happen when they come in contact with each other?

The question is one which the greatest military experts are discussing. Obviously, there will be an aerial battle, each aeroplane corps seeking to cripple the other. Each Commander-in-Chief will in fact desire, above all else, to obtain supremacy of the air. If he can do so, it will have the effect of seriously handi-

capping his opponent.

Thus—probably waged with light guns firing explosive shells—the next great war will begin, not on earth, but several thousand feet in the air.

Claude Grahame-White.
Harry Harper.

London, 1912.

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ILLUSTRATIONS

BUILDING WAR AEROPLANES. In this picture—taken in the Bristol works—skilled artizans are seen busy with the building of the bodies of a consignment of military-type monoplanes. Although apparently frail, these frameworks are—owing to their method of construction—immensely strong.

WEIGHT-CARRYING WAR BIPLANE. By Fitting "extensions" to the upper main-plane of the machine, as seen above, it is possible to achieve sustained flight with two, or even three occupants—or, should necessity arise, with a pilot and an appreciable load of explosives! The actual machine photographed is a Bristol, flying over the Brooklands aerodrome.

WAR MONOPLANES "VOL PLANE." In the above picture, a two-seated, military type Bristol monoplane is seen descending, with engine stopped and propeller motionless, from a reconnoitring flight. Pilot and passenger are plainly discernable.

MAPS FOR MILITARY AIRMEN. Photo, M. Roe. The French authorities are busy with the preparation of a complete set of "air maps" for the use of the military pilots, when flying from point to point. A section of one of these maps—which are coloured—is illustrated above.

THE PILOT'S SEAT. Photo, M. Branger. In the illustration above is seen the driving seat of a military-type Blériot monoplane, with the airman's map, in its case, fixed immediately before him.

PILOT AND "OBSERVER." Photo, M. Roe. The above photograph shows a military-type Breguet biplane, as used in the French manœuvres, with pilot and observer in their places.

MILITARY AIRMAN'S REPORT. Photo, M. Branger. After descending from a reconnoitring flight on a Blériot monoplane, in the French manœuvres, the pilot seen above is imparting details of what he has observed to another officer.

TRANSPORT OF WAR AEROPLANES Photo, M. Roe. In the manner depicted above—and also by means of motor lorries—were military aeroplanes transported from point to point during the French manœuvres.

MOTOR TRANSPORT. Photo, M. Branger. This picture shows how a Breguet military biplane, with its main-planes folded by the sides of its body, can be towed from point to point behind a motor-lorry.

TRAVELLING WORKSHOP. Photo, M. Branger. In the French manœuvres, a completely-equipped aeroplane repair shop, in the form of a motor-wagon, followed the military airmen as they moved from point to point. One of these invaluable "ateliers" is pictured above.

FIRST SECTION REVIEW OF PROGRESS PRIOR TO THE FIRST MILITARY TESTS OF AEROPLANES

I. Dawn of flight—Encouragement in Europe and America—England's lost opportunities—The pioneers.

In order to pave the way for a description of what the war aeroplane, as we know it to-day, can accomplish, it is necessary to trace—although only briefly—the development of the heavier-than-air machine during recent years.

One fact immediately claims the attention of any student of this question. He sees that England might to-day, had she not shown initial apathy, be the first nation in the world in the fostering, and development, of aerial navigation.

Instead of holding such a proud position, however—and any nation may well be proud of having encouraged this new art—we suffer for having displayed a lack of interest in the conquest of the air, and for having given practically no help to far-seeing enthusiasts who first devoted themselves to the great problem.

There was no lack of pioneers in England; but, instead of giving them assistance, we discouraged them, with the result that such countries as France and Germany—wide awake to all forms of progress—have moved forward from one triumph to another.

More than a hundred years ago, for instance, England had an opportunity of displaying a definite interest in flying. Sir George Cayley, a remarkably clever engineer, turned his attention to the design of a flying machine, and actually produced, in the year 1809, plans of a machine which anticipated many constructional features of the monoplane as it is built to-day. Of course there was not, in those days, any such efficient motive power as is now supplied by the petrol engine; but Sir George Cayley lectured upon his ideas, and sought to interest

people in them. Had his deductions been greeted with enthusiasm, it is not probable that any successful flying machine would immediately have been produced; the difficulty of finding a reliable propelling medium would have prevented this. But what a ready and encouraging acceptance of Sir George Cayley's pioneer work would inevitably have done, would have been to turn the minds of other inventors towards the problem, and so pave the way for a series of discoveries, each more important than its predecessor.

The imaginations of those who might have exercised a great influence upon future progress were not fired, however; and the same remark applies to the efforts of those who followed in Sir George Cayley's footsteps, and endeavoured to give his ideas more practical shape.

Stringfellow and Henson, for example, pored over the great engineer's drawings, and produced working models of a flying machine. Their apparatus was crude, it is true; but this toil represented so many steps forward along the path of progress. It had been man's ambition, for centuries, to fly; success could not be expected without infinite labour. Nothing definite came of the work of these pioneers, however. They had little encouragement; they were regarded as "cranks." The importance of the work they were engaged upon was not, indeed, realised.

Now, as a striking contrast, let us turn to the reception which early enthusiasts received in other countries. Let us take France, for example. Ader, an electrical engineer, devised, in 1896, a very ingenious, bat-like aeroplane. With it, having fitted a small steam-engine, he actually achieved a short flight—or, rather, a brief "hop" from the ground.

Instead of being greeted apathetically, or having his sanity doubted, Ader was promptly called to appear before the military authorities. They, after hearing his theories expounded, cheerfully voted him £20,000 in order that he might continue his experiments upon an adequate scale. Thus, even at this early stage, France revealed her keen interest in aerial navigation. Ader, lacking the petrol motor, could not carry his investigations much further. But the encouragement he received gave heart to other inventors. And so France went forward to success.

America offers another example of a sane, far-seeing policy. Professor Langley, an eminent scientist, was making a series of wonderfully interesting model aeroplanes at about the time Ader was experimenting in France. To further his work, the American authorities very promptly came forward with a grant of £10,000.

He, like Ader, was unable to carry his individual experiments to a successful issue; but further investigation, on the part of other workers, was greatly stimulated. It is interesting to note what position these two countries, which

first encouraged flying, afterwards took when the aeroplane became a reality.

To America, in the work of the Wright brothers, has gone the honour of the first practical flights with a heavier-than-air machine, while France is to-day the premier nation in the world in the development of airmanship.

Thus it is legitimate to pass to a consideration of the first machines that flew, and consider their capabilities from the military point of view. The Wright biplane, naturally, is the first to attract attention, because it was as long ago as 1903 that these two quiet, determined Americans made their first successful flights. From a military aspect, this aeroplane had many drawbacks; and to cite them is instructive, seeing that, by this means, a reader will be better able to judge, later on, what vast strides towards perfection the aeroplane has already made.

The first Wright biplane would, indeed, just fly; that was all. Its pilot only dared to leave the ground when an absolutely dead calm prevailed; he feared the overturning influence of even the smallest gust of wind. His engine, being then a novelty as applied to the aeroplane, required the most patient "tuning up" before even a brief flight could be essayed; and, when it was aloft, the machine only passed through the air quite close to the ground.

Each flight had to be started by sliding the aeroplane forward along a rail; away from this rail, the machine was helpless. From the point of view of a military expert, indeed, this early machine could have been condemned upon several counts. It was unreliable. It could not fly in gusty winds; it was not portable; it could only take the air when launched from its rail.

But the true expert is far-seeing. He makes light of present imperfections if, in any idea, he can see future developments of undoubted importance. Such an expert, for instance, was the late Captain Ferber, of the French Army. He was the first military officer to whom the task fell of reporting, for his Government, upon the capabilities of a military aeroplane.

Representations were made by the Wright brothers to the French Government in the year 1905—two years after their first flights. They had improved their machine considerably; they were now ready to carry a passenger; and they wished to sell their secret. So Captain Ferber was instructed to go to America and investigate their claims.

The Wrights were anxious to sell their secret for a lump sum of money. They had begun their experiments in the humblest possible way, being small cycle-makers at Dayton, Ohio; and they were unable to protect, by patents, the machine which they had evolved by so vast an amount of patient work.

Thus they sought to enter into negotiations with some Government. They asked for a guarantee that their machine would be bought, for a certain price, were it to perform a series of stipulated flights. Their position was, as a matter

of fact, a somewhat awkward one. Even a brief examination of their aeroplane, by an expert, would have revealed its principle.

In this quandary, they were led to approach the French Government. They chose France for a very good reason. Already, as has been indicated, this country was keenly alive to the possibilities of flying. The two brothers imagined, therefore, that they would be able to make their best bargain with the French Government.

The practical interest which the French authorities took in the question of military flying was evidenced by their action when they received a communication from the Wright brothers. Although reports of the Wrights' experiments had been greeted, in Europe, with great scepticism, and there was reason, in view of the failure of other inventors, to doubt their claims, the French Government at once detailed Captain Ferber to make the long journey to Ohio, so as to go into the matter in a business-like way.

Captain Ferber, who was one of the first officers in France to become actively interested in airmanship, duly visited America, and interviewed the Wright brothers. They could not show him their machine. Had they done so, their secret would have been revealed. Regarding the flights which they had made, up to this time, Captain Ferber had to rely, for testimony, upon the statements of certain responsible men living in Dayton, who had witnessed them.

The position, so far as he was concerned, was rather an unsatisfactory one. It was like buying "a pig in a poke." But this officer, being a student of character, and an enthusiast regarding flight, saw what manner of men these two brothers were. He did not doubt their word, nor the statements of those who had seen them fly. So, when he returned to France, he recommended his Government to enter into negotiations with the Wrights, and buy their invention before any other nation took steps to secure it.

It was a tribute to his foresight that he should have done this; but, for the time being, the negotiations fell through. The Wrights, for one thing, wanted a very considerable sum of money; and there was difficulty, also, in arranging what the series of tests of their aeroplane should be. Thus it was that, after many communications had passed between the interested parties, the matter stood in abeyance.

In the meantime, however, other inventors were striving with the great problem. In France, in 1906, Santos-Dumont effected "hops" with a machine like an exaggerated box-kite; and this led the way to the remarkable achievements of two particularly clever brothers, Charles and Gabriel Voisin. They busied themselves with a biplane which, at the end of 1907, they asked Henry Farman, a well-known racing motorist, to test for them.

This led to the first famous flights of the Voisin machine at the military

parade-ground of Issy-les-Moulineaux, outside Paris. France went wild with enthusiasm when this big, clumsy machine, piloted by the quick, agile Farman, succeeded in flying for a mile, and in making a turn while in the air.

The Voisin aeroplane needed to run along the ground for quite a hundred yards before it could gain sufficient support from the air to enable it to rise. When it did so, it was only just able to skim along above the ground. Compared with present-day aeroplanes, it was an unwieldly, unsatisfactory machine; and, to make matters worse, its motor became overheated after only a minute or so's running.

As a machine for military purposes, it would have been useless. But it represented a definite stage in the progress of aeroplaning. From this machine of the Voisin brothers, which Farman first flew, developed the great school of biplane construction in France.

Also experimenting in France, at the same time as the Voisin brothers, was another great master of flight—M. Louis Blériot. His methods were original. He pinned his faith to the monoplane.

II. First practical flights—The Wright brothers; the Voisins; Farman—The cross-Channel flight.

Hastening our review, in order to reach matters of more definite interest from the military point of view, we find that, in 1908, the Wright brothers made aerial history by a series of magnificent flights which were, however, unfortunately marred by a tragedy.

Coming to France, Wilbur Wright flew for a couple of hours, without descending, at Le Mans. At about the same time, in America, Orville Wright was carrying out a series of demonstrations before the military authorities. He achieved remarkable success, particularly from a war point of view, by carrying a passenger in his machine for quite a long flight.

[image]

THE NIEUPORT MONOPLANE.
Photo, M. Branger.
This exceedingly interesting machine, which won the great French Military Trials, is generally admitted to be one of the most efficient flying machines in existence. A similar machine can be seen at work in Hendon, where it is piloted by Mr. Grahame-White.

Then, when taking up Lieutenant Selfridge, of the American army, he met with disaster. One of the propellers of his machine broke; it crashed to the ground from a height of about 100 feet. Lieutenant Selfridge was killed, being the first victim of the aeroplane, and Orville Wright broke his thigh. The accident, as may be imagined, cast a gloom over flying in America for a long time.

Longer flights by Henry Farman, on an improved Voisin biplane, were also to be noted in the year 1908; and thus the way is cleared for a description of the wonders achieved in 1909, when it may be said that the importance of the aeroplane, from a military point of view, was first demonstrated, and the attention of nations seriously directed towards the possibilities of this new "arm."

Early in the summer of 1909, after innumerable disappointments, and the breaking-up of many experimental machines, Blériot began to achieve success with a simply-constructed monoplane, driven by an equally simple three-cylinder petrol motor; and, at the same time, another French monoplane, the Antoinette, larger than Blériot's, and having an eight-cylinder motor developing sixty horse-power, was also flying surprisingly well.

It was in July, 1909, that these two machines, representing a distinct type, when compared with the biplane, were brought down to the French coast at Calais with the intention of invading England by air, and winning a prize of £1000 offered by the *Daily Mail*. Piloting his small monoplane was M. Blériot himself, while the Antoinette was flown by Mr Hubert Latham, an airman already famed for his daring.

The method of Blériot's arrival at Calais gave promise of the eventual utility of his machine from the military point of view. The two wings of his monoplane could easily be detached. They were then folded on either side of the body of the machine; and, thus dismantled, it could be placed for transport upon an ordinary railway truck.

In this fashion it reached Calais, greatly to the surprise of those who had, hitherto, only been familiar with the huge cases needed for the transport of biplanes. When taken from the railway van, the monoplane was tied with ropes behind a motor-car, and ran upon its own pneumatic-tyred wheels to the shelter prepared for it near the sand-hills of Les Baraques, a mile or so from Calais.

Blériot, as history records, won the £1000 prize by flying across the Channel from France to England, just after the dawn on 25th July, 1909. He landed near Dover Castle, after a flight of thirty-seven minutes. Latham, unfortunate with his engine, made two attempts at the crossing, but fell into the sea on both occasions.

Blériot's feat made a deep impression upon all thoughtful men, and particularly upon the military authorities in France. If such a flight could be achieved with a small, crude machine, what might not be possible with a perfected apparatus? This, naturally, was the question which was asked.

In the next important demonstration of the possibilities of flight, which was made at the Rheims flying meeting, held in August, 1909, the French Government took a very active interest. They sent special representatives to this meeting—the first of its kind—to study the various types of flying machines which took part in the contests organised. As a further instance of the practical ideas already being displayed by military men in France, it may be mentioned that one of the competitors at this memorable flying meeting was the French officer whose work has previously been mentioned—Captain Ferber. He flew a Voisin biplane. It was not, unfortunately, very long after the Rheims meeting that this enthusiastic military airman met with his death at Boulogne, his loss being sincerely mourned by the French Government. His biplane overturned in a ditch, and he was killed by the heavy motor, which was torn from its bed, and fell upon him.

III. Aeroplanes at Rheims, 1909—Wright, Voisin, Farman, Blériot, Antoinette—The Gnome engine—First military orders.

Seeing that the Rheims meeting of 1909 was the first occasion upon which a definite military inspection of aeroplanes was made, it should be interesting to describe the machines which were then available. Let us take, for example, the Wright biplane, of which we have previously spoken. This machine, as piloted at Rheims by Lefevre, Tissandier, and the Comte de Lambert, undoubtedly proved itself one of the best all-round machines then in existence.

The aeroplane represented the usual biplane form of building, having one sustaining plane fixed above another, the two being held apart by wooden struts, made taut by cross-wiring.

In front of these main-planes, upon outriggers, was a small double-plane elevator. At the rear of the main-planes, also carried upon outriggers, was a double-plane vertical rudder. The engine of the machine, set upon a wooden bed on the lower plane, actuated two wooden propellers, which—driven by chains—revolved in opposite directions behind the main-planes.

The pilot's seat was on the front edge of the lower main-plane, and his control of the aeroplane, when in flight, was effected by means of two levers. One, moved forward and backward, actuated the elevating planes, and the other was given a dual motion. Moved to and fro, it operated the rudder of the aeroplane. Shifted from side to side, it warped the rear extremities of the main-planes, and so controlled the lateral stability of the aeroplane.

This wing-warping mechanism was, as a matter of fact, one of the salient features of the Wright biplane. The system is considered to be the most effi-

cacious method of combating the effect of wind-gusts when an aeroplane is in flight.

In operation, this wing-warping device was simple. When the airman discovered that his machine was tilting over one side, owing to a sudden inequality in wind pressure, he quickly warped down the plane-ends on the side of the biplane that was depressed. The result was that there was increased wind-pressure under the plane-ends warped down, thus tending to force the machine back again upon an even keel.

The pilot who distinguished himself greatly at Rheims, when flying the Wright biplane, was Lefevre; but this daring airman was, unfortunately, killed shortly afterwards at Juvisy, when testing a new machine. At Rheims he circled in the air, and effected sharp turns, in an altogether remarkable way, demonstrating an absolutely complete control over his machine. So impressed were the representatives of the French Government by the performance of the Wright biplane, that they ordered several machines for military use. This represented their first definite order for aeroplanes for war purposes.

The chief drawback of the Wright biplane, in comparison with other machines flown at this time, was that it needed to make a start into the air from a launching rail, as has previously been mentioned.

The advantage of this system of starting—in which a weight, dropped from a derrick, gave the aeroplane its initial impetus along the rail—was that the machine could be fitted with a lower-powered engine.

But the disadvantages were obvious. Were an involuntary descent made at a point some distance away from the machine's rail, it had to be carted back to the starting-point, or a rail and derrick brought to the place where it lay. However, the French Government did not regard any aeroplanes at this time as representing serviceable war weapons. They took the wise view that they were purely instructional craft, upon which military airmen could gain experience, and so fit themselves for the use of the more perfect machines which were likely to be evolved as time went on.

After describing the Wright biplane, we may now consider the Voisin machine. This aeroplane represented an improvement upon the type first piloted by Farman at Issy-les-Moulineaux. It had two main supporting planes, like those of the Wright biplane, fitted one above another. In front of the main-planes was a single horizontal elevating plane. At the rear of the biplane was a large cellular stabilising tail, made up of horizontal and vertical planes, and resembling a box-kite. In the centre of this cellular tail was the rudder, a single vertical plane.

Instead of adopting a wing-warping device, for maintaining lateral stability, the Voisin brothers fitted vertical planes, or curtains as they were called, between their main-planes. These, when the machine was in flight, resisted any sideway

roll and, in conjunction with movements of the rudder, gave the aeroplane a certain amount of automatic stability.

The biplane rested upon a chassis made of hollow metal tubing. It had pneumatic-tyred bicycle wheels, mounted in connection with heavy springs, to resist the shock of landing after a flight. Small wheels bore the weight of the tail when the aeroplane was running along the ground.

An engine of sixty horse-power, fitted upon the lower plane, drove a two-bladed metal propeller, placed behind the main-planes. The pilot, seated midway between the planes, operated a wheel like that of a motor-car. He pushed it away from him, or drew it back, to operate the elevating plane, and turned it sideways to actuate the rudder.

This machine had the advantage over the Wright biplane that it was not dependent upon a starting rail. But, in general comparison with the Wright machine, it was heavy and sluggish. It required a long run before it would lift into the air, and its engine-power, although twice that of the Wright biplane, was only just sufficient to make it fly. In a side wind, owing to the influence which the gusts exerted upon the vertical panels which were fitted between the main-planes, it made an appreciable amount of "lee-way," which rendered steering difficult.

Altogether, regarded from the point of view of experts to-day, it was a heavy, awkward machine. But it flew, and flew steadily. And anything that flew, in the year 1909, represented a triumph. Several famous airmen were piloting the Voisin biplane at the Rheims meeting, notably M. Louis Paulhan and M. Rougier.

From a military aspect, the Voisin biplane had many drawbacks. It was not at all portable; it could not rise quickly; it was slow-flying. But, with the very laudable intention of encouraging such ardent pioneers as the Voisin brothers, the French Government gave orders for certain military machines of this type.

Now we may turn to what was undoubtedly the most successful biplane at the great Rheims carnival—that designed and flown by Mr Henry Farman. This famous airman had, it will be remembered, first learned to fly upon a Voisin biplane. After piloting this machine in 1908, he turned his attention, early in 1909, to the design of a biplane which should be lighter and more efficient.

In this endeavour, he certainly succeeded. The biplane which he first flew in public at the Rheims meeting represented a distinct step forward in the development of this type of machine. In general construction, it was lighter than the Voisin machine, and it had other excellent features as well. Instead of the heavy, cellular tail, as fitted to the Voisin biplane, it had a lightly-constructed tail made up of two horizontal planes, with a vertical rudder fitted between them. In front of the main-planes, upon light wooden outriggers, was placed the horizontal elevating plane.

One of the features of this machine, was its method of obtaining lateral

stability. Farman recognised the disadvantages of the vertical planes, as used in the Voisin machine. So he fitted small flaps, or horizontal planes, at the rear extremities of his mainplanes. These were hinged to the main-planes, and were termed "ailerons."

Their operation produced the same result as in the application of the wing-warping device of the Wright brothers. When the biplane tilted sideways in flight, the "ailerons" were drawn down, by means of controlling wires, on the side that was depressed. The air pressure, acting upon the surfaces of the "ailerons," forced the aeroplane back upon an even keel. When not in operation, the "ailerons" flew out straight in the wind, on a level with the main-planes.

The control of the Farman biplane was effected by means of a hand and foot lever. The hand lever, when moved forward or backward, operated the elevating plane. When shifted from side to side, it actuated the "ailerons." The pilot's feet rested upon a pivoted bar, which he swung from side to side to move the rudder of the machine.

[image]

BRITISH-BUILT SCOUTING MONOPLANE.
This aircraft, an exceedingly fast, single-seated machine, represents the type of machine now favoured by French authorities for urgent, rapid, general reconnaissance. Its constructors are Messrs. Short Brothers.

Another constructional feature of this first Farman biplane was notable. This was the landing chassis. Appreciating the disadvantages of the Wright launching rail, and recognising that the Voisin chassis was heavy, Farman aimed at something lighter, and at the same time more efficient.

Again he succeeded. He devised a chassis which was a combination of wooden skids and bicycle wheels. Below his biplane, upon wooden uprights, were fitted two long wooden skids. On either side of each skid, were two little pneumatic-tyred bicycle wheels, connected by a short axle. The wheels were held in position on the skid by stout rubber bands, which passed over the axle.

Normally, the skids were raised off the ground by the wheels, upon which the biplane actually ran. But, in the case of a rather abrupt descent, the chassis was so designed that the wheels were forced up against their rubber bands, thus allowing the skids of the machine to come into contact with the ground. Then, when the force of the shock had been absorbed, the wheels came into play again. With this biplane, Farman achieved fine flights at Rheims.

Apart from its constructional excellence, the biplane was fitted with a motor which was destined to have a remarkable influence upon the development of flying—and upon military aviation in particular. This was the seven-cylinder, revolving "Gnome." To-day, the application of this wonderful engine is practically universal. In August, 1909, it was regarded quite as a freak, and was seen for the first time upon Henry Farman's biplane.

Up to the time when this motor was introduced, makers had, in designing aeroplane engines, followed very largely upon motor-car design, constructing motors with fixed cylinders, either upright, or in "V" shape, and with their parts lightened wherever possible. Some were water-cooled; others air-cooled. But with both systems, and particularly with the latter, the tendency—owing to the high speeds at which the engines had to turn—was to overheat, and either lose power, or stop altogether.

The specially-lightened water-cooling systems which were devised gave a great deal of trouble; and, in the case of air-cooled engines, it was usually found almost impossible to prevent overheating, after the engines had been running for ten minutes or a quarter of an hour.

In the case of the "Gnome," the designer struck out in a new line. Instead of making his cylinders fixed, and his crank-shaft revolving, as was the method with other engines, he set his seven cylinders revolving around the crank-shaft. Petrol and oil he fed to the cylinders by way of the stationary hollow crank-shaft.

The internal complications of this engine, in the opinion of experts who first saw it, were such that it could not be expected to achieve reliability.

But it did, nevertheless; and it ran so well, in fact, that, at the Rheims meeting, Henry Farman remained in the air, while using it, for more than three hours, and won the prize for the longest flight.

The advantages of this remarkable engine proved to be many. In the first instance, its method of construction enabled it to be built remarkably light; and the fact that the seven cylinders revolved, generally at a speed of 1000 revolutions a minute, effectually disposed of cooling difficulties. In fact, the engine automatically cooled itself; and its fly-wheel effect, as it flew round, gave a smooth, even thrust to the propeller.

From the very day of its first introduction, the "Gnome" motor gained overwhelming success. It represented a piece of mechanism made specially for the work in hand, and not a motor-car engine adapted to aerial purposes. This fact was the secret of its success.

As rapidly as they could acquire them, other aeroplane makers fitted "Gnomes" to their machines. It proved all-conquering. Fixed-cylinder engines did not languish completely, however. Some of them were steadily improved, and performed reliable work. But the "Gnome" was then, and is now, regarded

as *the* aeroplane engine.

The Farman biplane, being so good a machine in itself, and being equipped, in addition, with so excellent a motor, naturally aroused keen military interest; and it was not long before the inventor received Government orders for his machine. At this time, before the monoplane had assumed the commanding position which it now holds, the Farman biplane certainly represented the premier aeroplane of the day.

Two more machines, which were flown at the first carnival of flight at Rheims, merit careful description. These were the Blériot and Antoinette monoplanes. Blériot's machine, of the type upon which he crossed the Channel, was especially interesting.

Its simplicity was, as has been stated, its great recommendation. Upon either side of a tubular body, built up of light woodwork, and partly covered in with fabric, were the two supporting planes, outstretched like the wings of a bird, and supported by wires, above and below.

In the front of the body was the engine, which developed about twenty-five horse-power, and had three air-cooled cylinders. At the rear extremity of the body, which projected some little distance behind the lifting planes, was a small stabilising and weight-carrying plane, the end portions of which, on either side, were capable of being moved up and down. Behind this plane, fitted to the end of the body, was a small vertical rudder.

The pilot sat in the body of the machine, a little behind the engine, and on a level with the rear extremities of his wings. His method of control was extremely simple. Rising up between his knees was a metal *cloche*, or lever. This he shifted forward or backward to make his machine rise or fall, the movement of the lever actuating the extremities of the rear stabilising plane.

For maintaining the lateral stability of the monoplane, he moved the same lever from side to side. This action drew down, or warped, the rear portion of the supporting planes—effecting the same action, in fact, as produced in the case of the Wright biplane. When wishing to make a turn, the pilot pushed from side to side a bar upon which his feet rested. This moved the rudder at the rear of the body.

Already, as can be seen, the control of an aeroplane in flight had become more or less standardised. One lever was usually employed for elevating and lowering the machine, and also for controlling lateral movements. Steering was effected, as a rule, by movements of the pilot's feet.

Another machine, representing these first types, which it will be necessary to describe, is the Antoinette monoplane. This machine had, and has still, many original features. It was, to begin with, a very ambitiously-designed machine. It had very large and strongly-built wings. These were set at a dihedral angle, so

as to increase the machine's stability. The engine, developing sixty horse-power, was fixed in the bow. The body of the machine, which was appreciably longer than that of the Blériot monoplane, ended in fixed horizontal and vertical planes, or "fins," rather resembling the feathering of an arrow. Hinged horizontal planes, at the extremity of the tail, provided means for elevating or lowering the machine. Vertical rudders were also fitted.

The controlling mechanism was original. On either side of the pilot, as he sat well back in the body of the monoplane, was a wheel. These wheels he turned when he wished to rise or descend, or correct the lateral stability of the monoplane.

By means of this wheel control, which locked the planes in any desired position, a very fine adjustment was possible. But the manipulation of the wheels, with which separate movements had to be made with each hand, was declared by many airmen to be difficult to learn. On the first of the Antoinette machines, it should be mentioned, "ailerons," or balancing flaps, were used to control lateral stability. Afterwards, however, wing-warping was adopted, and adhered to.

Such were the first aeroplanes, as seen at Rheims in the year 1909. Other more experimental machines there were, too, which did not figure prominently at the time, but which were destined to play a prominent part in future work. In this regard should be mentioned the R.E.P. monoplane, designed and built by M. Esnault Pelterie, and the Breguet biplane, designed, built, and flown by M. Louis Breguet.

IV. The human factor—Growing skill of airmen—Feats of 1910, as compared with those of 1909—Cross-country flying.

What the aeroplanes which we have been describing could not do was to combat a wind. No flight was essayed, indeed, unless weather conditions were quite favourable. A notable exception must, however, be made in the favour of the Antoinette monoplane. This aircraft, owing to its weight and stability, and the skilful and daring handling of Mr Latham was, on several occasions in 1909, and notably at the Blackpool flying meeting, able to remain aloft in very high and gusty winds.

Apart from the question of wind-flying, which was, of course, all-important, there were grave structural drawbacks in connection with many of these early machines. Some were too light; others too heavy. Save with those upon which the "Gnome" engine was fitted, there was almost constant engine trouble.

Above all, however, the human factor entered into the question. Men were *learning* to fly. Apart from any consideration of the good or bad points of their machines, they were invading a new element. As one shrewd observer, at this time, remarked: "The men who fly now are like those who first ventured upon the sea in frail cockle-shells. They tremble at their own daring."

More might have been accomplished in 1909, in fact, had men possessed greater confidence.

Take, for example, the attempts which were made, at the Rheims meeting, to win the altitude prize. To the amazement of spectators, one pilot rose until he flew slightly more than 500 feet high. This feat was, in 1909, considered a marvellous one. In 1911, only two years later, a man rose to an altitude of nearly two-and-a-half miles! The heights attained in 1909 could, indeed, have been appreciably increased had men possessed the necessary confidence in themselves, and in their machines, to force them higher.

But, in these pioneer days, a height of 150 feet or 200 feet from the ground was considered quite an appreciable altitude. Nowadays, when carrying out a long cross-country flight, an airman will fly several thousand feet high. Thus it can be seen what definite progress has been made in this aspect of flying alone.

High-flying has considerable importance. The airman who does not soar high, when going across country, meets the worst of whatever wind is blowing. It eddies from hill-tops, and around woods. The higher he flies, therefore, the steadier the wind blows, because it is unaffected by any inequalities of the ground. This is why the great cross-country flyers invariably ascend to a considerable altitude.

In the year 1909, it may truly be said, men were really learning to fly. Their machines were crude, and they were invading a new element. Therefore they made comparatively short flights, and confined nearly all their operations to aerodromes, where there was always a smooth place of descent below them, should the failure of their engines compel a hasty landing.

But, in 1910, a new and more daring spirit developed. With growing confidence, airmen soared higher and higher. Breezes no longer made them hasten to descend; and, with this new spirit of adventure, came the desire for cross-country flying, instead of monotonous circling round the aerodrome.

With the commencement of long flights across country from point to point, came the first practical opportunity for applying the aeroplane to military reconnoitring work. The first cross-country flights marked, indeed, a very definite stage in the development of the aeroplane; and it was in 1910 that the possibilities of the flying machine, in this regard, were demonstrated, on a convincing scale, by such aerial contests as the flight from London to Manchester, and the Circuit de L'Est in France—the first taking place early in the flying season of 1910,

and the latter towards its end.

Two machines had, by this time, emerged as representing the best of their type. One was the Farman biplane, with the invincible "Gnome" motor; the other was the Blériot monoplane, now also equipped with the "Gnome." So far as distinction can be made, the Farman machine stood for ease of manipulation and general "air-worthiness"; while the Blériot represented the development of a small, portable, high-speed machine.

It was on the Farman biplane that M. Louis Paulhan flew, with one halt, the 183-miles aerial journey from London to Manchester; and Mr Grahame-White (one of the joint authors of this book), who also piloted a Farman, had the distinction of competing against him in what is now regarded as an historic contest.

In the Circuit de L'Est in France, Leblanc, the winner, flew some 400 miles on his Blériot monoplane, passing over all sorts of country, and finding his way accurately from point to point by means of his map and a special compass. He made frequent landings, without damaging his machine, and demonstrated its reliability in a most convincing way.

One question naturally arises, in any consideration of such flights as these, seeing that they were so greatly superior to anything that had been done in 1909. Had the aeroplanes which these pilots used been improved to any remarkable extent? In reply, it is certainly accurate to say that they had not. The "Gnome" engines with which they were fitted had, it is true, been strengthened in small ways, and perfected in the manufacture of certain delicate parts, the result being an even greater reliability in running than had first been attained.

As regards the aeroplanes, they were, in essentials, the same which had been flown in 1909. Their controlling mechanism was, for instance, unaltered. Their method of construction was practically the same, although experience had taught manufacturers the need of strengthening certain parts. Landing devices had been slightly improved, from the point of view of everyday wear.

Although aeroplanes and engines had both been improved a little, neither had been altered sufficiently to account for such a vast stride forward as was made in 1910. It was not to the machines, indeed, so much as to the men, that this striking progress was due.

Practice had begun to make perfect. Pilots now felt more comfortable when they were in the air. They had growing confidence in their aeroplanes. They had learned how to maintain stability when assailed by wind-gusts. Thus, they were ready to attempt far more ambitious flights.

SECOND SECTION FIRST EXPERIMENTS WITH AEROPLANES IN THE FRENCH AUTUMN MANOEUVRES, 1910.

I. The historic Picardy tests—First official report upon movements of troops, as gleaned by aeroplane.

After these introductory notes, intentionally brief, we are led to a consideration of the first practical tests to which aeroplanes were put, so far as their military use is concerned.

During the summer of 1910, the French authorities were instructing officers in the handling of machines. They had purchased several Voisin, Wright, and Farman biplanes, and possessed also a few monoplanes, including Blériots and Antoinettes.

For the autumn army manœuvres of 1910, which were due to take place in Picardy, it was decided to make as complete a test as possible of the value of the aeroplane as a scout in time of war. Ten or fifteen machines were requisitioned for the experiments, some being stationed with each of the manoeuvring forces.

To augment the military pilots, several civilian airmen readily gave their services, notably Mr Hubert Latham with his Antoinette, and M. Louis Paulhan, flying a Farman.

Although this was the first time aeroplanes had been used in mimic warfare, and although the airmen themselves, and the military authorities, were naturally unacquainted with the best methods of utilising the new "arm," astonishing results were nevertheless obtained.

Two French officers. Lieutenant Sido and Adjutant Menard, were highly successful in their work. This was due to the fact they had gone through a careful course of training and were, in consequence, familiar with the task of compiling

precise and informing reports of all that they saw when upon a reconnoitring flight.

Lieutenant Sido acted as observer upon the Farman biplane which they were using, and Adjutant Menard undertook the work of pilot. The former carried maps with him, and made frequent notes as the machine flew from point to point.

The value of the work these two officers were able to perform, is best indicated by setting forth the actual result of two of their reconnoitring flights. On the first occasion, acting under definite instructions, they left a place named Poix at 6 a.m., and flew over a sixty-kilometre course, being an hour and five minutes in the air, before returning to their starting-point.

This is the form in which they presented their report to Headquarters:—

6.5 A.M.— At Thieuloy, three squadrons of *chasseurs-a-cheval*, hidden behind the southern edge of the village on the road from Thieuloy to St Maur.

6.30 A.M.— At Feuquieres, a brigade of infantry on the march eastward on the road from Feuquieres to Brombos. Head of main body just leaving Feuquieres. Six batteries of artillery parked south of Feuquieres.

6.32 A.M.— At point 1800 metres north of Feuquieres, two companies on outpost, one facing north and the other northeast, astride the Feuquieres-Sarcus road. One company has dug rifle-pits to the west, and the other company section trenches to the east of the road. A Blériot monoplane has just landed behind the company west of the road. We followed its flight for three minutes.

6.40 A.M.— Agneres—A company in column of route marching from Agneres towards Mereaucourt along the Saint Martin-de-Ponsis ravine.

The completeness and detail of this statement certainly surprised the officers who received it. No one, save a well-trained military observer, could have presented such a report. Its value was self-evident. It revealed, indeed, in a manner that was undeniable, the extremely useful work which could be done, in time of war, by a well-handled scouting aeroplane.

II. Second conclusive test—Detecting an army in retreat—France's determination to possess an air-fleet.

On another early-morning flight, during these same Picardy manœuvres, Lieutenant Sido and Adjutant Menard made a second important aerial reconnaissance, surveying a specified tract of country occupied by the "enemy."

This was how they presented their report:—

5.56 A.M.— At Halloy, a cyclist company.

5.59 A.M.— Thieuloy—Sixteen squadrons of cavalry and six batteries at the southwest entrance to the village.

6.5 A.M.— South-west of Rothois—At the north point of Malmifet wood, a company and two batteries of artillery on the march towards Marseille-le-Petit.

6.7 A.M.— Haute-Epine—Northern entrance to the village, one company of infantry to the right and one to the left of the road. One company at point 188. One company in the village of Haute-Epine.

6.9 A.M.— At the cross-road to Lihus, a squadron of dragoons concealed behind the edge of the wood.

6.14 A.M.— On the road Cievecoeur-Marseille south of Lihus, a squadron on the march towards Marseille-le-Petit, and a troop in the village of Lihus.

6.16 A.M.— On the Lihus-Potangy road, a squadron and two machine-guns marching towards Marseille-le-Petit.

6.19 A.M.— South-west entrance to Cieve-coeur, three regiments of cavalry, including cuirassiers, and six batteries of artillery, in assembly formation.

"The value of these two reports," declared one of the chief French military experts, "cannot be overestimated. Each one exposed the dispositions of the enemy, and the information was obtained in a remarkably short space of time."

As regards the second report of the two air-scouts, it provided one remarkable instance of the practical value of the aeroplane in time of war. Upon the night before the airmen carried out their reconnaissance, the troops they were observing had been heavily attacked, and the Commander-in-Chief for whom they were acting was particularly anxious to know whether his enemy intended to hold its ground, or was about to fall back.

The aerial report, when received, threw a clear light upon this point. Mainly cavalry and rear-guards had been detected during the flight. It was obvious, therefore, that the enemy was in retreat. Such results as these convinced the military experts who were studying the manœuvres that the future of the aeroplane, at any rate from the reconnoitring point of view, was practically assured.

For the splendid work which he had accomplished, Lieutenant Sido received promotion, and his pilot, Adjutant Menard, was presented with the Cross

of the Legion of Honour. Lieutenant Sido, explaining afterwards how he succeeded in setting out such terse and informing reports, made several interesting observations regarding the work of a military observer.

At first, he said, the man who attempted aerial scouting could not distinguish things below him with sufficient clearness. He himself had found that quite a number of flights were necessary before he could make anything like satisfactory or accurate observations. But practice, he added, was everything. Granted plenty of this, and sharp eyesight, he considered that an aerial observer should make few mistakes in reporting what he saw when in an aeroplane.

A military correspondent of *The Times*, who went through these manœuvres in Picardy, and thus had ample opportunity of studying the work of the air-scouts, declared afterwards: "In my belief the aeroplane, given a trained pilot, and a skilled observer, must revolutionise the whole service of reconnaissance." No statement could be more definite.

This, as has been said, was the first practical revelation of what an air-scout might accomplish in time of war. France was not slow to profit by the lesson. Without delay, she began to create an efficient aeroplane fleet. If feats such as those recorded in the Picardy manœuvres could be carried out with a few aeroplanes, what could not be achieved with highly-organised squadrons of machines? This, in effect, was the question which France asked herself.

[image]

READY FOR A SCOUTING FLIGHT.
Here a latest-type reconnoitring monoplane, with its observer in the front seat and the pilot behind him, is seen just about to start upon an aerial voyage. The machine is a British-built Bristol, such as will be used in the forthcoming military trials.

THIRD SECTION THE GROWING AIR-FLEETS OF FOREIGN NATIONS

I. Activity in France—Two hundred machines at the end of 1911; a thousand promised by the year 1914.

Practically all leading nations, with the exception of Great Britain, are now equipping themselves, on an adequate scale, with the war aeroplane.

At the time of the autumn manœuvres in 1910, France possessed about a dozen aeroplanes. But she soon increased this number, being full of enthusiasm, and determined upon a strong aerial policy.

Thus, an official report, which was presented at the end of 1910, showed that the French authorities had increased their fleet of machines, in two or three months, from a dozen to thirty-two. The list of the French war aeroplanes at this time was, it is interesting to note, made up as follows:—

Wright biplanes	5
Blériot monoplanes	4
H. Farman biplanes	11
M. Farman biplanes	4
Breguet biplanes	2
Sommer biplanes	4
Antoinette monoplanes	2

To pilot these thirty-two aeroplanes, there were, at this time, thirty-four fully-qualified military airmen.

The activity which prevailed, at the end of 1910, among the aeroplane manufacturers in France, is revealed in the report of one well-known maker, Mr Henry Farman.

He stated, on 6th December, 1910, that he had received orders for military machines as follows:—

The commanding position of France, in this one list, as compared with the single order of Great Britain, forms an illustration of the attitude of the two countries, at this time, towards military airmanship.

At M. Blériot's flying school at Pau, early in February, 1911, the French Government had more than twenty officers learning to become airmen. No more striking indication could be found of the determination of this country to be in the forefront in aviation.

Early in the summer of 1911, the French War Minister authorised the pur-

French Government	35 aeroplanes
Russian ”	20 ”
Spanish ”	3 ”
Italian ”	2 ”
Belgian ”	1 ”
Japanese ”	1 ”
British ”	1 ”

chase of close upon a hundred and fifty aeroplanes. Of these machines nearly a hundred were, at this time, actually in the possession of the military authorities. Among the orders placed with French manufacturers was one for eighty monoplanes. This was secured by M. Louis Blériot. Two types of machine were resented in this large commission, one being a two-seated machine, and the other a single-seated craft, capable of high speed.

To Mr Henry Farman, whose biplane had performed so meritoriously in the 1910 Picardy manœuvres, an order was placed for forty war machines; and the French Government's large order was made up of a number of other machines.

With her energetic method of sending officers in squads to learn flying at the various schools, it was not long before France found herself in possession of a corps of at least a hundred fully-qualified airmen. These, as a matter of fact, she possessed quite early in the summer of 1911.

The business-like way in which she set herself the task of becoming the premier nation in the development of flying was especially notable at this time. Military commissions were appointed to visit the various aerodromes throughout France, and inspect all aeroplanes built. In the case where a machine had been purchased, one of these military commissions came to the flying ground on a specified date, and passed the aircraft through a series of tests, These experiments had to be carried out by the constructor of the aeroplane before the Government would take delivery of his machine.

One instance of this excellent policy is sufficient. In April, 1911, a military commission of several officers made a journey to the Brayelle aerodrome. Here, awaiting their inspection, were a couple of Breguet biplanes which the French authorities had decided to buy.

After the officers had examined the machines, the professional pilots of the flying school carried out a series of manœuvres. The officers noted, for example,

how long it took a machine to ascend to an altitude of 1000 feet. A specified load had to be lifted by each aeroplane. It was also necessary that it should attain a stipulated speed. When these conditions were fulfilled, and not before, the officers formally took over the aeroplanes on behalf of their Government.

With what determination this task of increasing the aerial armament of France was pressed forward may be gauged by the work of one of these military commissions, which visited the Pau aerodrome during the summer of 1911. No fewer than eight two-seated war monoplanes were waiting for their inspection; and all eight machines were tested and passed in the course of a day's flying.

The spirit which animated France, in regard to this question of military aviation, is evidenced by the words of M. Clementel, when placing an official report before the French Chamber. He declared: "The aeroplane has proved that it is a marvellous instrument of war—a new arm in our military organisation. We now possess an incontestable superiority in aviation, and this we hope to continue for a long period. We must maintain this advance. The sacrifices imposed on us in this matter are as useful as they are necessary."

This, indeed, supplies the keynote to the enthusiasm of the French for war aeroplanes. By the end of the year 1911 the War Minister possessed a fleet of more than 200 war aeroplanes and a corps of officers fully trained to pilot them, and act as observers.

After French tests of military aeroplanes in October, 1911—which will be described in the next section—there was a generous distribution of orders for machines.

Early in 1912, the French military authorities had 234 war aeroplanes at their disposal; and the financial grant for the year placed £920,000 for the purposes of military flying. In addition, there was a scheme on foot to augment the number of war machines. By the aid of public subscription this, quite soon, approached a sum of £100,000.

The latest plan of the French Government is to form a large regiment of military airmen, and in this connection more than 300 new aeroplanes have been ordered for delivery before the end of 1912. Sheds, to accommodate machines, are springing up all over the country. Quite early in 1912, nearly 300 officers had obtained pilot's certificates from the French Aero Club.

So far as can be ascertained, the military aeroplanes in France will number appreciably more than 400 at the end of this year; and it must be remembered that, in time of war, this country could call upon nearly a thousand privately-owned machines.

The policy in France may be summarised in the statement that the Government aim to create an air-fleet of at least 1000 machines by the end of the year 1914. In 1917, it is anticipated, the French air-fleet will approach, in numbers,

several thousand machines. Eventualities, of course, govern such a programme. It may, for example—should any remarkable development of aviation take place—be appreciably augmented.

What the limit of utility of an air-fleet may be, only the practical work of war will show. For reconnoitring, it is clear that very large squadrons of machines, divided amongst the various sections of an army, will be employed.

Then there is the question of using aeroplanes for dispatch-carrying, and for directing artillery fire, to say nothing of their probable employment for destructive work, and perhaps in the transport of troops.

Another crucial point must also be borne in mind, to which detailed reference will be made later. If, as is practically certain, a conflict takes place between the aerial forces of two armies, it is likely to be the larger of two fleets of machines—other things being equal—which will emerge victorious.

Therefore, it is impossible at present to lay down any rule as to limiting the number of war aeroplanes. No country can stay its hand. The wise policy, surely, is to be well armed in view of eventualities. If a great war comes—then, and only then, can the strength of an air-fleet be tested adequately.

II. The great French tests of military aeroplanes—Striking results obtained—Era of fast, "air-worthy," weight-carrying machines.

Any account of the splendid progress in military flying, which has been made in France, would not be complete without a reference to the trials of war aeroplanes which were carried out at Rheims in October, 1911.

In prizes, and prospective orders for machines, more than £50,000 had been set aside; and an astonishingly large number of French makers—bearing striking testimony to the progress of aviation in that country—brought their machines together. Despite bad weather, a series of tests which were highly instructive and important were carried out.

One of the French aims, in the organisation of these contests, was to encourage the construction of a speedy, "air-worthy" machine, capable of carrying a pilot and passenger, and flying long distances when fully loaded.

The tests were most interesting, as showing the high state of efficiency to which aeroplanes had attained. Quite a number of machines, for example, were able to effect a regular series of non-stop flights of 300 kilometres (187.5 miles), when carrying a pilot and observer.

A surprising number, also, were able to ascend to a height of 1640 feet in fifteen minutes—a remarkable indication of the reserve of power they possessed.

One difficult feat was set the competing machines. This was that they should rise, when fully loaded, from a ploughed field. Hitherto, of course, only smooth ground had been considered suitable for the ascent of a machine. An appreciable number passed even this test successfully. Their ability to do so was due to the fitting of exceptionally-strong landing devices of the wheel and skid type, and to ample engine-power.

In all, seven aeroplanes emerged triumphantly from all the trials imposed. The winning machine, which owed its final triumph to its high speed, was the Nieuport monoplane. Even when heavily laden with pilot, passenger, and fuel, it flew across country at the rate of more than seventy miles an hour.

One of the most impressive features of the trials was the reliability shown by the competing machines. They made voyage after voyage with the regularity of express trains. The striking aspect of the tests, indeed, was the practical demonstration of the fact that not one French builder, but dozens, could make a thoroughly-efficient war aeroplane.

It was shown conclusively, also, that it is no longer necessary to wait for calm weather before embarking upon aeroplane flights. In astonishingly high winds—blowing, in some cases, at a velocity of approximately forty miles an hour—the large military machines went out and, ascending 1000 or 1500 feet, battled triumphantly against vicious gusts.

A striking point in connection with the competition was the big horse-power of the engines employed. There was a vivid contrast, indeed, between the motors now used and the little three-cylindered, twenty-five horse-power engine with which Blériot crossed the Channel in 1909.

Many of the machines taking part in the contest were fitted with fourteen-cylinder hundred horsepower "Gnome" motors; and some employed even higher power than this, being equipped with engines developing a hundred and forty horse-power. Such big power was, of course, necessary in view of the loads which were carried, and the arduous nature of some of the tests.

To indicate the weights raised, it may be mentioned that the Breguet biplane, which was driven by a hundred and forty horse-power "Gnome," weighed, with pilot, two passengers, and fuel aboard, 2420 lb.

Representatives from all the great countries in the world, including Great Britain, visited Rheims to witness these military tests, and the French manufacturers who produced successful machines were quickly supplied with sufficient orders to keep their factories busy for a long time to come.

The value of the flying work accomplished in these trials, and the obvious practicability of military machines, stimulated interest not only in France, but in Russia, Germany, and other countries. It was, undoubtedly, the means of determining our War Office to make a move. In view of what was achieved at

Rheims, in fact, there no longer remained any possible excuse for refraining from a constructive policy in military aviation.

III. Germany's aerial policy—Secret energies in creating a fleet of war aeroplanes—Rivalry with France.

Leaving France for the moment, we may now turn to a consideration of Germany's advance in the matter of military flying. Here, first of all, we shall need to consider an interesting question. It concerns the relative merits of the dirigible balloon and the aeroplane. Although, in this book, we are concerned exclusively with the heavier-than-air machine, it is certainly necessary to mention the dirigible at this point, in explanation of the fact that Germany almost abandoned her airship policy, after the French manœuvres in the autumn of 1910, in favour of the aeroplane.

She was not led to take this step, after spending many thousands of pounds upon dirigibles, without mature consideration. Among her advisers in matters of aviation, Germany possessed many particularly-staunch and even obstinate supporters of the airship. These refused at first to admit the enormous strides which the aeroplane was making. But soon it was impossible to turn a blind eye towards them; and so came a reversal of German policy.

The facts of the case could not, indeed, be controverted. While the aeroplane leaped to the front during 1910, the airship made practically no forward strides at all. In comparison with the aeroplane, it was ruinously costly. It required large crews of men to handle it. It needed huge garages dotted about the country at all strategic points. It was slow-flying, as compared with the aeroplane. It offered a far easier target to artillery fire from below. The advantages which were claimed for it, over the aeroplane, were that it could remain in the air longer, and that observations could be carried out from it in a more leisurely fashion than from the heavier-than-air machine.

But the German War Office is notoriously shrewd in all matters appertaining to modern warfare. When it was seen that a mistaken policy was being pursued in spending large sums upon unwieldy dirigibles, a new plan was quickly evolved—and that was to overtake France in the creation of a fleet of war aeroplanes.

It was in November, 1910, that the German military authorities began to purchase machines. They then placed orders for five or six aeroplanes, mostly biplanes. This was quickly followed, a month later, by an order for nearly twenty Etrich monoplanes—strongly-built, extremely-efficient machines, constructed in Austria.

Military experts in Germany had, by this time, arrived at an approximate estimate of what should be the salient features of an aeroplane for war purposes. They stated that machines should be of as simple a construction as possible, and very strong. They declared high speed to be an essential, and they demanded, also, that machines should be able to carry appreciable weights.

It was characteristic of Germany that she should make steady progress, once a decision had been arrived at to develop the aeroplane. Thus, in February, 1911, it became known that seven military airmen had, in one week, obtained their certificates of proficiency at the Johannisthal and Bork aerodromes. Three of these pilots were using Wright biplanes. It was just about this time, too, that Germany placed an order in France for several Farman biplanes.

By the spring of 1911, the German War Office had assembled a fleet of close upon fifty aeroplanes. Nearly half of them were Etrich monoplanes, of the type previously mentioned. Metal now entered very largely into the framework of these machines. They were heavily-engined, and fast in flight, and could easily raise a reconnoitring officer, in addition to the pilot, and an engineer to attend to the motor as well.

In March, 1911, so as to hasten forward the work of training officers to fly, the German Minister of War sent fifty or sixty unmarried lieutenants to the Doebritz military aviation camp. Here, while they were learning to fly, these officers received a special allowance. The military authorities also came to the conclusion, at this time, that it would be wise to arrange for an aviation section at all the garrisons in Germany which had suitable parade-grounds attached to them.

It was decided in May, 1911, to spend large sums of money upon the purchase of new types of military aeroplanes; and the officers who had already learned to fly were encouraged to design machines, embodying ideas formed during their period of tuition. At the same time, in order to encourage a general study of flying in Germany, the War Office made up its mind to contribute special prizes to the various cross-country contests then in process of arrangement.

Going ahead with such determination, it was not surprising to find that, in August, 1911, Germany had established a fleet of nearly eighty aeroplanes; and the total of her officer-airmen, a month later, approached the same figure.

The Kaiser himself had, by this time, become greatly interested in the development of heavier-than-air machines for war purposes, and he thoroughly approved of the forward policy which had been initiated. At the end of the summer of 1911 Germany had quite a hundred aeroplanes either on hand, or in order; and her list of army airmen had grown appreciably.

Recently, however, development in Germany, so far as aeroplanes are con-

cerned, has been kept more or less secret. Information regarding tests which have been carried out has been carefully withheld. The results of several carefully-organised reconnoitring flights have not, for instance, been allowed to leak out.

But this much is known. During 191 2, Germany will spend a sum of £640,000 upon the development of her aeroplane service. The Kaiser himself now offers a prize of £2500 for the best aeroplane motor of German construction.

It seems fairly clear, indeed, that Germany has now set herself the task of keeping pace with France in the development of military airmanship. A great point is made by the German War Office of encouraging the production of entirely German-built aeroplanes, and much experimental work is now being conducted.

This much is certain: there is the greatest activity in Germany in regard to military aeroplaning. No stone is being left unturned, indeed, to produce a thoroughly-efficient military machine; and the training of army airmen is steadily pursued.

Many estimates have recently been made as to the strength of the German air-fleet. One credits Germany with 300 war aeroplanes; another with nearly 200. The most reliable figure would appear to be a little in excess of 100 machines.

Dirigible balloon work, also, still continues. It has been reported, in fact, that German military experts have overcome some of the difficulties of the rigid type, and that heights of over 6000 feet are now attained with them. It was, indeed, only in January that France was warned, by a well-known advocate of dirigible balloons, to beware of the secret development of lighter-than-air craft in Germany. The destructive possibilities of a fleet of hostile dirigibles, sailing across the German frontier into France, and raining down missiles, were pictured; but, in this regard, it is certainly pertinent to inquire what the French fleet of aeroplanes would be doing while such an attack was in progress.

IV. Progress in Russia, America, and other countries-England's position in the autumn of 1911.

The country which next merits attention, as a keen, observant student of the value of the aeroplane for war purposes, is Russia. The Russian military authorities recognised the importance of this new weapon early in 1911, and the steps taken to deal with the question were eminently practical. The Duma Committee of National Defence approved an expenditure of nearly £1,000,000 upon military aviation.

Since then, Russia has been acquiring aeroplanes, and training airmen, at a great rate. A sum of £25,000 a year, for three years, was voted exclusively for the building of experimental machines of a military type, in order that aircraft

on original lines might be evolved. It was also decided to spend £2500 a year in employing skilled instructors. Military air-stations were, at the same time, established at Keiff, Odessa, Sebastopol, and Tiflis.

Having thus made the first move towards creating an efficient air-corps, the Russian Government sent a commission of military officers on a tour of the French flying grounds, in order that they might see the best work being produced by the aeroplane manufacturers.

While in France, this commission purchased a number of machines of various types. They visited England, also, and after inspecting the biplanes built by the British and Colonial Aeroplane Company at Bristol, ordered several military-type machines of this make.

By May, 1911, Russia had acquired forty machines, and was using them to teach a large number of officers to fly. A determination has been expressed to have a fleet of several hundred aeroplanes by the forthcoming flying season.

The activities of other nations also present an interesting study. Take America, for example. In this country, despite the wonderful example set by the Wright brothers, military flying languished until towards the end of 1910. Then came a somewhat tardy vote for the purchase of a few machines, and general development.

In the beginning of 1911, Mr Dickinson, the United States War Secretary, returned from a visit to France, where he had seen what the French war aeroplanes were accomplishing, and had enjoyed a flight upon a military machine at Chalons. He promptly recommended a more generous money grant, and the result has been that machines have been bought, while officers are now learning to fly.

In a recent speech, Brigadier-General James Allen, of the American Signal Corps—in connection with which the Air Corps is operated—said: "It is the ultimate intention, I believe, to teach aviation to several thousand Army men."

For the year ending June, 1912, a sum of 125,000 dollars was voted for the aeronautical work of the American Army.

Austrian military experts have been very energetic in their study of flying. In November, 1910, war aeroplanes were ordered, and it was then specified that each machine must fly for two hours without descending, at the rate of forty-four miles an hour. It was also stipulated that the aeroplanes should be dismantled in an hour, and rebuilt in two hours. During 1911, Austria operated two military air-stations, and now possesses an excellent fleet of war aeroplanes.

Italian interest in military aviation has been keen from the outset. In the summer of 1911, at the Centocelle military aerodrome, a number of officers were training, and a variety of machines were in use. Since then, also, definite progress has been made, and Italy quickly reaped the reward of her aeronautical labours

in the war with Turkey. A reference to the work of aeroplanes in Tripoli will, however, be found in a later section.

In March, 1911, Japan placed orders in France for nearly twenty war aeroplanes. This was in addition to a previous purchase, in Berlin, of a number of Wright biplanes. Japanese officers have been learning to fly in large numbers lately, both in France and Germany.

Spain must not be forgotten. She has bought a number of machines in France, and is now training a corps of officer-airmen.

[image]

TWO-SEATED, BRITISH-BUILT WAR MACHINE.
The Blackburn military-type monoplane, with accomodation for pilot and observer, has already made many successful flights; and it is expected to perform meritoriously in the War Office trials. In some respects it resembles the graceful Antoinette.

And what about England? It is sufficient to say, for purposes of direct comparison in this section, that for the autumn manœuvres of 1911—which were abandoned owing to the drought—the War Office had only half a dozen qualified army aeroplanists, in comparison with the well-trained squadrons of France and Germany. As regards machines, we possessed at this time about a dozen—most of them obsolete—being hopelessly out-matched by France, Germany, and Russia.

FOURTH SECTION IMPORTANCE OF ORGANISATION IN THE USE OF WAR AEROPLANES

I. French plans for the concerted use of squadrons of machines in time of war.

After describing the air-fleets with which far-seeing nations are now arming themselves, another point arises—and a point which is of supreme importance. This concerns the organisation of the military air service.

In organisation, it is clear, will lie the secret of success when aeroplanes are used in time of actual war.

France has certainly more right to speak on this subject than any other country, because she *knows*. Her experience has, indeed, been unique. She has bought machines, trained men, and has already dissected the results obtained from many experiments. And her greatest authorities affirm, definitely, that it is not sufficient to have a large number of machines, or a big corps of men. What any nation must possess, they say, in order to make its air-fleet really efficient, is faultless organisation.

Aeroplanes, either for scouting or destructive work, cannot be operated in haphazard style. Combination is essential. Every requisite of the air service must be in its place, and ready to hand; and everyone must know his work, and do it with precision, from the aeroplane pilot to the humble mechanic.

It is upon this question of organisation that the French authorities have been concentrating themselves. They see its vital importance, and are determined to formulate definite, practical schemes for the employment of large squadrons of machines. In this work, M. Milleraud, the French Minister of War, has been most active.

It is held that a fleet of aeroplanes should be divided up into separate aviation squadrons, each complete in itself, and that these depots should be attached to the various Army Corps.

Thus each squadron would act with its own Army Corps, performing its scouting and other work, and moving from place to place with the Corps.

In command of an aviation squadron, without doubt, should be an officer of great experience. Already, as a matter of fact, such men are being produced. They are officers who have gone through the whole routine of flying, and know every practical detail of the work, besides possessing a general knowledge of tactical operations.

Such a Commander of Aeroplanes should be constantly in touch with the officer in charge of the whole Army Corps. When military operations reach a stage that demands a rapid aerial reconnaissance, this officer in charge of aeroplanes will be called into conference, and told exactly what is required. He, in his turn, will indicate how his airmen can go to work; and he will then transmit orders to the pilots and observers, and also summarise their reports, for the benefit of Headquarters, after a reconnaissance has been carried out.

The value of such an officer, possessing complete practical experience, would be very great. The question might arise, for example, as to whether the

wind was too high to allow a scouting expedition to be made. The Commanding Officer would, in such circumstances, promptly consult the Commander of Aeroplanes, who would come to an expert decision without any misunderstanding or delay.

Operating with the Commander of Aeroplanes should be other officers, all experienced men, and each specialising in one branch of aerial work. There should be an officer immediately in charge of the airmen. To this officer would fall the task of seeing that each scout thoroughly understood the work that he had in hand, that he was adequately equipped, and that his reports were presented in proper form.

Then should come an officer in command of the engineers. His would be important work. The engineers in charge of aeroplanes represent highly-skilled men, whose work is vital to the success of aerial operations. Several of them are usually detailed to each machine.

When aeroplanes are on active service, replacements and repairs will need constantly to be made; and the officer in charge of engineers will be called upon to superintend this work, and to see that all machines in the corps are in first-class condition. An aeroplane, at any rate as at present constructed, is a machine that needs unremitting attention in a variety of small ways. The use of a fleet of machines in time of war will mean that a very highly-organised staff of mechanics, under the supervision of a thoroughly-competent officer, will be required.

Then there may be a third officer, whose duty will be to take charge of all the baggage, supplies, and transport of the air service. His task will, it is clear, be no light one. There should be a number of motor repair-cars in connection with each aeroplane squadron, ready to move out, at a moment's notice, and succour an airman who may have come down through mechanical defects. These breakdown gangs will form a very important adjunct to the work of the aeroplane in war-time.

The question of transport is very important. As an army marches from point to point, so the aeroplanes attached to it will have to move also. Airmen will, in many cases no doubt, fly their machines from point to point; but there will probably be occasions when machines will need to be dismantled, and transported by road or rail.

In such circumstances the transport officer will be a busy man. In his hands, also, will lie the work of bringing up the supplies of petrol and oil which the aeroplanes will need.

The French organisation already strives to be as perfect as is possible, seeing that active service conditions are yet to be encountered. Motor waggons are provided for the transport of aeroplanes. Other, and slower waggons, bring up portable hangars. Then come heavier lorries carrying spare parts, and similar

equipment. Bringing up the rear are motor waggons in the form of portable workshops.

The mere detailing of any such scheme as that outlined above, affords an indication of the necessity for perfect organisation in the use of war aeroplanes.

With machines improperly employed, with airmen carelessly instructed, and with repair-depots badly equipped, no nation can hope to make a success of its air service.

The determination of France, in this regard, is beyond all praise. Aeroplanes are being allocated to frontier forts. Practical discussions are taking place, frequently, at the Ministry of War. It is intended to establish an annual overhaul of war aeroplanes, so that obsolete machines may be removed from the active list, and relegated to the flying schools.

In all this, France is finding things out for herself. She has no precedent to guide her. This makes the work she has already accomplished all the more valuable. How far advanced the French air service is, and how admirably arranged is its scheme of operation, only the practical work of war will reveal.

II. Value of air-stations—Selection of landing-grounds—Preparing air-maps.

A very important feature of the organisation of an air-corps, especially in times of peace, is the permanent air-station. Here one finds machines, men, and the whole equipment of military aviation work. Of such stations, France now possesses quite a number.

An essential of such an air-station is a good manoeuvring ground for aeroplanes. Then comes the need to erect a number of sheds for the machines.

Also necessary is a completely-equipped repair-shop, in which damages, generally brought about by experimenting with machines, may be repaired. At one or two of the chief French air-stations, the equipment is so complete that there are commodious shops for the building of aeroplanes, in addition to any repair work undertaken.

Another and very important feature of a well-organised air-station is the school for military pupils, under the charge of an officer of experience.

Another detail of aerial organisation, regarding which both France and Germany are concerning themselves, is the selection of a number of landing-places for aeroplanes, preferably in the vicinity of large towns. Military authorities in France are enlisting municipal aid in this matter.

The idea is to fix upon an aerodrome, or suitable landing-place, outside all cities or towns of importance. Once chosen, the ground will be set aside for the

arrival and departure of aircraft; and, in connection with it, there will be a small, permanent repair-shop.

Apart from their use for military flying, and particularly in connection with long reconnoitring flights, such landing-places, scattered all over the country, should, it is contended, do a great deal towards popularising touring by air, seeing that an aerial voyager would have some definite alighting point in view, when flying from point to point.

Besides such general aspects of organisation as have already been touched upon, France has foreseen the need for providing her air-corps with suitable maps to use when flying across country, and particularly when on reconnoitring work. The officers who flew in the autumn manœuvres of 1910 were able to report the need for such maps—a clear indication of the value of practical flying in revealing exactly what is required.

The Geographical Department of the French Army went to work with characteristic promptitude. The result is that special air-maps are being prepared so as to cover, in sections, the whole of France. In connection with these maps, the plan is to eliminate all unnecessary detail. When flying fast and high, an airman sees only the bold outline of what lies below him; and so, when glancing quickly at a map, he seeks to find on it some prominent landmark which will tell him where he is.

On French military maps the roads—which an airman always sees well—are coloured white. Woods are green; and railway lines, which always form an excellent aerial guide, are prominently marked. So are such landmarks as spires and towers. Good alighting grounds and air-stations are shown; and the presence of telegraph wires, a menace when making a descent, are also indicated.

With the help of such maps as these, French military airmen are now making long cross-country flights almost daily, without fear of losing their way. It is now possible, also, to fit a reliable compass to aeroplanes. The result is that, with a special map and a good compass, an airman can fly with accuracy from point to point, even over strange country.

FIFTH SECTION ENGLAND'S POSITION IN REGARDS TO MILITARY FLYING

I. Lessons which were ignored—Work of the Parliamentary Aerial Defence Committee.

So far as the position, at the present time, is concerned, England is far behind other great nations in the matter of aerial armament, and our deficiency is open to the greatest criticism. But it is, in all things, necessary to be fair. Therefore, it must be remembered that the War Office has pledged itself to a definite move.

A scheme, to which further reference will be made, has been brought forward to obtain the services of a hundred army airmen. More aeroplanes have recently been bought; and a sum of £11,000 is to be spent upon a military competition in England, which will probably be held in July next.

Thus, although our present position is perilously weak, we have the promise of a firmer, more reasonable policy. By the end of the forthcoming flying season, if the War Office maintains its new attitude, we should have laid the corner-stone, at least, of an efficient air-corps.

Therefore, in the criticisms of Government policy which it is, of course, impossible to avoid, the fact must be remembered that at last something is to be done—nothing very ambitious, it is true, nothing that will put us on a level say with France, but, at any rate, something. A very unpretentious policy is better than no policy at all.

In this section, we propose to deal with those circumstances, and representations, which have led to the dispelling of official apathy in England.

Compared with the work being done in France and Germany, we have still practically no organisation; and yet such organisation as has been described will spell all the difference between success and failure, when aeroplanes are actually used in war.

All that has been definitely established in England, so far, is the Air Battalion, which is not in a position to give all its time and attention to the development of the war aeroplane. Within its scheme of duties, in addition to aeroplaning, comes the manipulation or dirigible balloons, and also of ordinary balloons, and kites.

It was in April, 1911, that the Air Battalion came into existence. One or two aeroplanes had, by this time, been purchased. A flying school was opened on Salisbury Plain; and there was much talk, in the House of Commons, as to the start which this country had begun to make in regard to military aviation. This, as has been said, was in April.

Four months later, however, there were only half a dozen officers of the Air Battalion who were competent to handle aeroplanes in reconnoitring work; the remainder had been either without machines, or had been engaged upon airship or balloon duties.

Thus, despite repeated demonstrations of the value of the aeroplane for war purposes, and in face of the activity in France and Germany, we found ourselves, in September, 1911, with half a dozen military airmen who were ready to take part in the autumn manœuvres. As it happened, the manœuvres were cancelled; but, had they not been, six air-scouts would have been altogether insufficient to make any adequate test of the value of aerial reconnoitring.

In sharp contrast to our lethargy, France was, at this time, ready to put thirty aeroplanes, with highly-skilled pilots and observers, at the disposal of the troops in her autumn manœuvres. More could have been obtained, if necessary; but this number was considered sufficient.

It must not be thought that our military airmen lack either initiative or experience: they do not. In the limited opportunities they have had of showing what they can do, their performances have been highly meritorious. They are enthusiastic, and full of aptitude for their work. But they have lacked facilities, and also encouragement. Instead of there being purpose, and a genuine spirit of progress behind them, they have found neither energy nor interest, to say nothing of a persistent stinting of money.

A question inevitably arises. It is this: why has England lagged behind such alert nations as France and Germany in the matter of aerial armament? The answer lies in the fact that, until recently, the importance of the aeroplane in warfare was denied.

Enlightened views have been expressed, it is true; many men, even in official positions, have pronounced progressive opinions. But results are all-important; and it is a fact that no really satisfactory step has yet been taken to place this country on an equality with other nations in regard to an air-fleet.

Lessons have been ignored. The whole subject has been neglected, and it has only been as the result of determined agitation that anything at all has been done.

In view of the apathy prevailing, it was in May, 1911, that the Parliamentary Aerial Defence Committee, a body comprising members of Parliament of all political views, organised, at the Hendon aerodrome—which had been placed at their disposal by the courtesy of Mr Claude Grahame-White—a special display of airmanship, to which they invited military experts.

So far as it was possible to do so, in a one-day programme, a most convincing demonstration was given, both of the reliability and controllability of the modern aeroplane. Many famous people were present; a long programme of flying was carried out. Dispatches were borne across country; reconnoitring flights were made; aeroplanes were quickly dismantled, and speedily reassembled. In every possible way, in fact, the practicability of the new "arm" was demonstrated.

II. Policy of "moving cautiously"—Peril of lagging behind in aerial armament.

After this display, the Parliamentary Aerial Defence Committee, feeling that the lesson taught should be pushed home, sought an interview with Lord Haldane, at the War Office. He readily saw the members of the Committee; but his reply to their representations—which were that we should keep abreast of other nations—indicated the spirit which then existed regarding the war aeroplane.

The chief point made by the Secretary for War was that it was "desirable to move cautiously." The War Office should not, in his opinion, "commit itself to an idea which, in the present rapid development of aviation, might become obsolete in a few months."

This statement was made to explain the fact that England's supply of war aeroplanes was inadequate. But the argument was not tenable. Naturally there has been, and will be, improvement in aeroplane construction from year to year. Such will always be the case. It is the same, for instance, in regard to battleships. Yet warships, despite their enormous cost, are built from year to year, in the full knowledge that they will be superseded by more modern types, and may even become obsolete while they are being constructed.

As regards aeroplanes, the machines which France bought, early in 1911, are most certainly made to appear somewhat out-of-date by more perfect craft now obtainable. But these earlier machines will still be serviceable; and France will, above all, have acquired an immense amount of experience while using them.

In this connection, it may be mentioned that, so far as can be ascertained at present, the aeroplane is likely to proceed along fairly steady lines of development—at any rate for the next year or so. There may be some revolutionary idea brought forward, of course; but, generally speaking, the immediate future seems to indicate a slow but sure improvement.

There is no excuse for a country to hold back upon the argument that aeroplanes may become obsolete soon after they are built. In the first place, the cost of such machines, when compared with any other form of armament, is ridiculously low.

To "scrap" a fleet of fifty or sixty aeroplanes would be an insignificant item in our general expenditure upon warlike instruments. But, as a matter of fact, there would be no need to abandon any type purchased. Out-of-date machines could still be employed, and made thoroughly useful, too, by being converted into "school" craft.

Lord Haldane gave the impression, in his conversation with the members of the Parliamentary Aerial Defence Committee, that the War Office was holding

back from the expenditure of money upon war aeroplanes until some fixed type of military machine was introduced. But it is not likely that any such machine will be designed—at any rate for some time to come. It is probable that progress will be represented by a succession of improving types, development taking place, chiefly, in regard to speed and stability.

During this period of progress, there is no possible excuse for Great Britain to lag behind other countries. To-morrow, if a war broke out, France and Germany would have the full use of their adequate squadrons of machines. And what would our position be? We should have no proper fleet of machines, because we had been waiting for some ideal type to be evolved.

As a matter of fact, neither France nor Germany consider that the aeroplanes they are at present using are anything but purely experimental machines. But they certainly represent the best obtainable at the moment; and, recognising the vital importance of keeping abreast of this new science, these two countries buy such machines, and will be quite ready to purchase more, as the process of improvement continues.

In 1909, Lord Haldane said in the House of Commons:—

> "In war there is little use for anything unless it can be applied with some certainty that it would do what we want it to do, and unless you have some exactness in results. Now that stage (referring to aeroplanes) has not been reached."

That, as has been said, was in 1909. At this time, certainly, aeroplanes were unreliable, although the promise of their practicability was such that there was no excuse for ignoring them, from the military point of view.

But now let us turn to matters as they stand today. The modern aeroplane, with its engine as reliable as that in a motor-car, can be used with the greatest certainty for military work, and can fly long distances—heavily laden—without descending, besides attaining a speed through the air exceeding that of an express train.

III. The financial aspect—Money England is spending—The airship policy—Insufficient provision for aeroplanes.

In the year ending 31st March, 1912, a sum of £113,000 will have been expended by our authorities upon military aeronautics. Of this sum, an appreciable amount is devoted to establishment charges, and such items; and a sum of £28,000 was earmarked for building a new dirigible balloon shed at Farnborough, and in mak-

ing improvements to the one at Wormwood Scrubs.

This leaves £85,000; and this sum of money, quite inadequate as it is, is free to be spent upon airships and aeroplanes. Quite an active airship policy is pursued, and a large percentage of this money remaining is dribbled away upon these costly machines—in building new ones, and in repairing old ones.

[image]

THE ENGINE-IN-FRONT BIPLANE.
With the above machine—a type increasingly used for Service work—the Naval officers now experimenting at Eastchurch, Isle of Sheppy, have been carrying out recent tests. It was designed, and built, by Messrs. Short Brothers, who are now constructing special aeroplanes for Naval use.

Criticising this policy trenchantly, soon after the announcement of the manner in which the War Office proposed to spend its money, Mr Arthur du Cros, M.P., the Hon. Secretary of the Parliamentary Aerial Defence Committee, remarked: "We, almost alone among nations, are developing the lighter-than-air type of machine to the exclusion of aeroplanes. France and Germany, formerly two of the staunchest advocates of the dirigible balloon, have almost ceased its development, in favour of the aeroplane.

"In a year, in regard to these two machines, the tables have been turned," added Mr du Cros. "Now the aeroplane, which costs so much less than the dirigible, is infinitely its superior. One aeroplane, costing say £1000, would, in the case of actual aerial warfare, have completely at its mercy a dirigible balloon costing perhaps £50,000."

Defending their policy, soon after Mr du Cros' attacks, and responding to the definite statement that "aeroplanes have become immeasurably superior to airships for military purposes," War Office experts advanced the argument: "There would be work in war-time, such as very detailed reconnaissance, that an airship could perform better than an aeroplane. Both types should, therefore, be developed."

It may be agreed, in this connection, that the airship would, in a number of cases, allow of a more detailed reconnaissance being made than from an aeroplane; its slower speed, and the fact that it could hover over one spot, would give it this advantage. But, to set against this, there is one very obvious disadvantage. The size of the airship, and the fact that it is moving slowly, makes it an admirable target for artillery. In actual warfare, it would, without doubt, very

soon be hit.

In this connection, too, the fact must be remembered that, whereas a wrecked aeroplane would represent a comparatively small financial loss, the destruction of a dirigible would be as great a calamity as the loss of a whole aeroplane fleet.

The expenses entailed in organising a dirigible balloon fleet are enormous, and altogether out of proportion to the useful work which these vessels could accomplish in time of war.

If an airship service is to be of practical value, monster sheds must be erected all over the country, so that a vessel may be able to run to one or other of them for shelter, when caught in a high wind. Apart from the expenditure which these sheds entail, the need arises to spend other large amounts upon the crews of trained men necessary to handle the aircraft when they leave the ground, or return from a flight.

There is another formidable item—the cost of the hydrogen gas necessary to inflate the huge envelopes; and, added to this, there is constant expenditure in effecting repairs, caused by the trifling accidents which are always occurring in handling these aerial monsters. Thus, a ruinous bill of cost is quickly arrived at.

And, as against all these disadvantages, the airship, as has been shown, has few, if any, definite advantages over the aeroplane. It can remain in the air longer, it is true; and it can, at the moment at any rate, carry heavier loads. But the great size of its envelope has, so far, made it the plaything of any high wind; and its bulk, in addition, renders it apparently impossible to force it through the air at anything like the speed attained by the aeroplane. Under favourable conditions, airship speeds of from thirty to thirty-five miles an hour seem to represent the best results yet attained.

Practical comparisons, between dirigible balloons and aeroplanes, were possible in the famous French manœuvres, in the autumn of 1910, which have been previously referred to. On this occasion, the aeroplanes were out, and at work in gusty winds, when the dirigibles were compelled to remain in their sheds.

And, when the airships did emerge, it was a subject of comment that, in comparison with the aeroplanes, they offered quite an easy mark for gun-fire.

This fact must be remembered, also. In actual warfare, the dirigible balloon would, inevitably, fall a prey to an attack by aeroplane. Aided by their greater speed, and by the fact that they could probably approach quite near to a dirigible without being seen, aeroplanes would be able to rise above its gas-containing envelope, and wreck the craft by dropping a destructive bomb.

Such points as these have, of course, weighed with the experts of Germany and France. Neither country has abandoned research work in regard to dirigibles. It is quite likely, in fact, that further improvements may be made with these

machines, which will better fit them for use in warfare. But, at the present time, when any contrast of utility is made, the aeroplane is immeasurably the more practical weapon; and, whereas a limited expenditure upon experimental work with lighter-than-air machines is not to be questioned, it is to the aeroplane corps that any War Department must look for reliable, everyday service in war-time.

IV. Dangers of a policy of "drift"—Experience which money cannot buy—Trained men, not so much as machines, the criterion of strength.

In connection with military airmanship, there is no policy more dangerous than that which may be summed up in the word, "drift."

It must be admitted that, until quite recently, the official policy in England, as regards the war aeroplane, could thus be summarised:

There is no danger in shirking the responsibility of a definite aerial programme—despite the strides made abroad—because a fleet of war aeroplanes can be bought or constructed at any time, should urgent need arise.

It was not a policy such as this that the Admiralty pursued in connection with submarines. Here was a new and untried addition to naval armament Without hesitating, or waiting while some other country proved its value in actual tests, the Admiralty used common sense, and spent money willingly upon a fleet of submarines. A full test of their use, in actual naval warfare, has yet to be made; but the experimental nature of the machines has not deterred the Admiralty from making definite advancement with them.

Had the War Office pursued such a policy as this in regard to aeroplanes, we should now have a fleet of aircraft as large as that of any other nation.

It is an undignified attitude to watch other nations at work upon the aeroplane problem, without spending money, and then to step in at the last moment, and profit by their experience.

From the point of view of strict economy, and setting all other considerations aside, such a policy might find acceptance, were it not for circumstances over which those who advocate it have no control.

At any moment, for instance, while one country is waiting for another to evolve an ideal aeroplane, a war may break out. In such an event, a cheese-paring policy would place its advocates in an awkward position. Even granting that they were using experimental machines, the nation which actually possessed a well-equipped aerial fleet, at the outbreak of hostilities, would have an immense advantage over the country which did not.

Wars, when they do break out, generally come quickly. There would be

little opportunity for a laggard nation to rush together an aerial fleet at the last moment; or, even if it could do so, lack of organisation would render such an air-force practically inoperative.

Even setting aside the danger of war suddenly arising, and assuming that a waiting policy has no immediate risks, the negative programme has another fatal drawback. Even if, at the last moment, large sums of money were expended upon an air-fleet, and there was time to provide both machines and men, the nation which had neglected aviation would still be lacking in the one essential for success.

That essential is experience. No money, however lavishly spent, can buy the experience which France and Germany are obtaining, day by day, in their pioneer work in handling war aeroplanes.

Any form of aerial work is new to man; and at first, when he attempts it, he is a fumbler. He has no confidence in himself, and so he makes mistakes. But, if he is given an opportunity of being in the air a good deal, and has a chance of handling aircraft, not once or twice, but practically all day long, for months on end, he becomes, gradually, quite accustomed to his work.

Instead of being anxious, and inclined to get into trouble through an excess of caution, he acquires a cool, firm judgment, and soon astonishes even himself by his feeling of security when in the air.

This is the opinion of all skilled airmen; an ounce of practice is worth a ton of theory. How was it that the quiet, unassuming French naval officer, Lieutenant Conneau, was able to win all the great flying prizes during the season of 1911? There is only one answer: he was more experienced than his rivals.

With absolute thoroughness, this man began at the very beginning. He studied the laws of the air first of all; then he made himself acquainted with the construction of machines, and of motors. Afterwards he began to fly. He progressed from stage to stage, with no impatience, or haste.

He undertook cross-country flights to note exactly what climatic conditions prevailed. He studied maps very closely, and tested compasses. He grew accustomed to being in the air; and he learned how to combat adverse winds. He acquired the skill necessary to steer a straight course across country, and to make landings upon all sorts of ground.

And then, so equipped, he entered for the principal long-distance races. Because he was absolutely competent in every way, he astonished everyone by the perfection of his flying. He made no mistakes. He flew correctly from one control to another. He did not fear gusty winds. He did not damage his machine. And so he won.

There are, in the air service of France, many such men as this. Neither France nor Germany, for the matter of that, are content with buying and building

machines. These they regard as being experimental, and likely to be superseded by faster, stronger aircraft. What they do consider of vital importance is the steady, irresistible growth in the number of their airmen, and the fact that, every day, these men are becoming more expert in the handling of their machines, and in the carrying out of their duties as pilots and observers.

The lead which France and Germany have obtained in military airmanship should not, indeed, be reckoned so much in machines, as in men; and England's backwardness should be gauged in a similar way.

In considering the danger of a laggard position in regard to men, rather than machines, a point of great importance arises. It concerns the length of time required to make a military airman thoroughly proficient.

The experience of France and Germany has now proved, fairly definitely, that a completely competent military flyer can only be produced after an arduous period of tuition, and practical tests. It has been laid down, in fact, that to produce a military airman who thoroughly understands his work, a year or eighteen months' hard training is required. The importance of this point is self-evident. Apathy may place a nation years behind.

A great deal, when the international relations of Europe are concerned, can happen in a year; and it is a perilous thing for any country to be far behind in regard to what is, admittedly, a vitally-important weapon.

Thus it is clear that England cannot hope to make up for a laggard policy even by the expensive method of acquiring aeroplanes, post-haste, at the last moment. We might buy machines, it is true, but we could not buy airmen of the type that France and Germany are rapidly training, in well-organised squadrons.

It has been assumed that machines might be bought in a hurry; but there is some doubt even on this score. Little encouragement has been given to home manufacturers. They would scarcely have facilities for producing machines in large numbers, even if it were a matter of urgency. On the other hand, the makers in France and Germany, always well supported by Government orders, have most complete workshops.

It might easily happen, in a case of urgent need, that we should be compelled to go abroad in an endeavour to obtain machines. In such a case, we might obtain them; or, on the other hand, we might not. Whatever the result, it would be highly unsatisfactory for a country to be dependent upon foreign makers for its war aeroplanes.

In the matter of aeroplane engines, the fact that we have no motor in England to equal the "Gnome" is because no financial support has been forthcoming, in this country, for aviation. To construct a successful engine, means the laying down of a large sum of money in preliminary tests. A number of experimental motors have to be made, and then "scrapped" again. As much as £10,000 may be

spent, before success is attained.

In France, with a Government eager to encourage progress, by the practical method of buying machines, men with capital have been found to finance the constructor who has ideas. This is why France has the best motors and the best aeroplanes, and why we have to buy French-built engines and machines.

Instances such as this throw into clear relief the fact that Government apathy, concerning such a new industry as that of building aeroplanes and engines, has an evil effect which is widespread, and lasting.

V. England's official awakening—The training of 100 airmen—The forthcoming trials of military machines.

Having dealt with England's backwardness, it is now only fair that the authorities should be given credit for their recent promise of a changed programme.

In the first place, attention may be directed to the official scheme for training a corps of 100 military airmen. This, announced towards the end of last year by Colonel Seely, Parliamentary Under-Secretary of State for War, has already been put into operation in a limited degree.

The officers chosen for aerial work are picked from various regiments. They are allowed to attend any flying school they select, and the authorities pay their tuition fees. When they have passed the tests for their certificates as airmen, they are taken in hand at the military flying school on Salisbury Plain, and are given instruction as military pilots or observers.

When they have attained proficiency in this direction, they return to their regiments, and are afterwards called upon, from time to time, to undergo "refresher" courses of military flying.

The criticism which is levelled against this scheme is that officers should be permanently attached to the air-corps, and should never be allowed to relinquish their flying duties. Experts who hold this view affirm that "refresher" courses are not sufficient to keep a man thoroughly *au fait* with such special work as military aviation.

As a matter of fact, the relief which has been expressed at the taking up by the War Office of any definite programme, has had the effect of robbing such criticisms as these of their sting. If the plan described were to be adopted as a permanent policy there would, indeed, be grave cause for complaint. French and German military pilots are placed once and for all in the air-corps, and are not withdrawn.

But the scheme of our authorities must only be regarded as a beginning. Directly any really definite work is done, the value of a well-equipped air-corps

will be so strikingly demonstrated that there should be little difficulty in extending the Government programme.

The ideal, undoubtedly, is a large and extremely skilful corps of pilots and observers, who do nothing save perfect themselves in their aerial duties. An airman cannot have too much actual flying practice; in every aerial voyage he makes, he learns some useful lesson. The French policy is: once a military airman, always a military airman.

Naturally, with the avowed policy of training these 100 military pilots, the War Office has found it necessary to acquire more machines. From time to time, therefore, since the announcement of this scheme, machines have been bought from famous French firms—notably a Breguet biplane, a Nieuport monoplane, and a Deperdussin monoplane.

But such purchases have only been made to meet the most pressing needs of the flying school. What will precede any large orders for war aeroplanes is a carefully-conducted and stringent test of military machines, which will be thrown open to the world.

The conditions for these trials, which will be held in England under the auspices of the War Office, probably some time in July this year, were issued in December last. Critical comment has granted their practicability, and it is agreed that the successful machines will represent all that is best in military aviation.

One criticism, however, is that the sum of money which will be expended in prizes, £11,000, is not sufficiently generous. In connection with the 1911 French military trials, a sum of more than £50,000 was earmarked by the Government to be expended in prizes, and in orders for successful machines.

But, in the forthcoming English contests, there is no definite financial offer save the £11,000 mentioned. It is stipulated, as a matter of fact, that the War Office shall have the option of purchasing successful machines for a sum of £1000; but there is no guarantee expressed that such purchases shall be made. Of course, it is expected that winning machines will be ordered in certain quantities, and no doubt such will be the policy adopted. But makers cannot count, definitely, upon this being done.

However, moderate though the financial inducements are, there is little doubt but that a satisfactory number of machines will be entered for the tests. English manufacturers, whose inducements to spend money have, in the past, been so few, are determined to make a good show. Both in connection with the main prize, and also in a subsidiary contest for British-built machines, in which the principal award is £1500, the home manufacturers are keen to demonstrate what their machines can do.

Already, it has been proved that English workmanship has nothing to fear from foreign competition. All that the industry in this country lacks is the steady,

regular production which is maintained in France. The building of machines teaches lessons which are invaluable. What English manufacturers have not yet been able to acquire, is the confidence, and intimate knowledge of their business, which only come from a healthy state of demand and supply.

The details of the War Office contest have already been so fully discussed that it is only necessary, here, to refer to their principal features. One of the most important requirements is that the aeroplanes should be able to carry a live load of 350 lb., in addition to their equipment of instruments, and raise this weight, as well as sufficient fuel for a four-and-a-half hour's flight.

A three-hour's non-stop flight, fully loaded, will be required. Machines will also be called upon to maintain, for an hour's voyage, a height of 4500 feet. They will, in addition, have to ascend to an altitude of 1000 feet, at the rate of 200 feet a minute.

These requirements are certainly hard to fulfil. A machine, very greatly in advance of anything yet produced, will be needed to pass through such ordeals successfully.

As regards speed, the competing aeroplanes will need to attain a rate of fifty-five miles an hour, when fully loaded. Another requirement is that they should plane down to the ground, in a calm, from a height of not more than 1000 feet, and traverse a horizontal distance of not less than 6000 feet before touching ground. They will be called upon to rise from long grass, clover, or harrowed land in a distance of 100 yards, when fully loaded.

The silencing of engines is to be regarded—and quite rightly—as an important advantage. Minor points are that machines must be easily dismantled; that parts must be interchangeable; and that the observer's view, from a machine, must be as unobstructed as possible.

The importance of this interesting contest, to be held in England, cannot be over-estimated. It will be a revelation, to all concerned, as to the capabilities of the modern-type, war machine, and should open up a new and satisfactory era in military flying in this country.

NOTE

The aerial programme of the War Office, for the year 1912-13, is dealt with on pages 181-187.

SIXTH SECTION WAR AERO-

PLANES AT THE PARIS AERONAUTICAL EXHIBITION, DECEMBER, 1911

I. Latest-type military monoplanes—Two-seated, reconnoitring machines—Single-seated, high-speed aircraft.

At the Paris aeroplane *salon*, which marked the close of the aeronautical season of 1911, a striking display of war machines was made. The year, as has been indicated, was full of progress; and the result of all the experience gained was clearly seen in the aircraft exhibited, and particularly in the military monoplanes staged.

As a type, the two-seated scouting machine, capable of high-speed flight for several hours, when carrying pilot and observer, was most interestingly represented. Many difficulties had been overcome in connection with this machine—primarily that of affording the observer a fairly-unobstructed view of the land below. In early-type military monoplanes, the spread of the wings had curtailed seriously the reconnoitring officer's scope of vision. But, in the monoplanes seen at the Paris show, the wings had been so set back, and the observer's seat so arranged, that it was possible for him to secure, when in flight, a thoroughly practical, bird's-eye view of the country below him.

Another problem solved, was in regard to engine-power. In the first instance, with fifty horse-power "Gnomes," two-seated monoplanes had been underengined; and their flying capabilities had suffered in consequence. But the machines built towards the end of 1911 were equipped with seventy horse-power "Gnomes," and—in some instances—with motors of a hundred horse-power. The result was that a reserve of power was obtained, to say nothing of a very desirable increase in speed.

As regards the landing-chassis, a somewhat weak point with early-type, two-seated monoplanes, an improvement was observable in the machines constructed towards the close of the flying season of 1911. Not only had the landing gear been strengthened, but—in many cases—simplified as well, which meant a commendable lessening of head resistance, when in rapid flight. But, in this regard, military critics did not admit that they were altogether satisfied—even by the machines seen at the Paris show. A stronger, more rough-and-ready chassis

is demanded; but it must be remembered, in fairness to existing military monoplanes, that they succeeded, in the French trials, in landing upon, and rising from, ground which was fairly rough.

So far as personal comfort is concerned, a point certainly worth consideration in long flights, the latest-type reconnoitring machine reveals interesting features. Pilot and observer are, for example, screened so far as is possible from the rush of wind. Their seats are comfortably placed. Map-holder, compass, engine-revolution indicator, and other fitments are neatly arranged. Dual control has become almost a standard device, thus enabling either occupant of the machine to take charge, while in flight, without change of seats.

Of two-seated, military monoplanes at the Paris exhibition, it is probable that the Nieuport, Blériot, and Deperdussin attracted most serious attention; and genuine interest was also aroused by the lonely prominence of one British exhibit—that of the Bristol passenger monoplane. As definite evidence of the capabilities of this machine, Mr James Valentine had, a day or so prior to the exhibition, piloted, in a flight over Paris, a sister monoplane to that which was shown.

Military authorities, who visited the Paris salon, directed very serious attention to the single-seated, high-speed war monoplanes which were on view. Here is to be found the emergence of a machine of a very definite and important type.

It was with great interest, and some surprise, during the progress of the French military trials, in October, 1911, that those interested in airmanship read of the ordering, by the French authorities, of a large number of single-seated monoplanes. The surprise, it should be mentioned, was occasioned by the fact that single-seated machines should have been purchased just at a time when passenger monoplanes were arousing most interest.

But the French military experts knew their own needs. They had mapped out, for the single-seated, almost racing-type machine, an important field of activity in war-time. They saw that, under actual service conditions, there would be definite demand for a scouting aeroplane which would make a very rapid, general survey of the position of the enemy's troops.

In such a machine, they decided, speed would be the all-important requirement; and, seeing that the survey to be made would be comprehensive, and not detailed, it was reckoned that the pilot would be able to do all that was required, thereby saving the carrying of a passenger, and enabling greater pace to be obtained.

In several of the single-seated, high-speed monoplanes, as seen at the Paris show, it is possible to attain a flying rate of approximately eighty miles an hour. In such a machine, it is intended that the officer-pilot should, in war-time, effect

[image]

MILITARY BIPLANE WITH TWO ENGINES.
This exceedingly interesting machine, which possesses especial significance from the military point of view, is equipped with two Gnome motors. One drives two propellers placed in front of the main-planes, and the other actuates a single rear propeller. Normally, both engines run at easy speed; but, should one fail in flight, the other, by being accelerated, will maintain the machine in the air. Its designers and builders are Messrs. Short Brothers.

a swift dash over the enemy's lines, and fly back, without an instant's delay, with whatever observations he has been able to make. Apart from being able to return very rapidly to Headquarters, the airman's high speed would, of course, be an appreciable factor in his favour, when subjected to artillery fire.

Such quick reconnoitring, carried out by the pilot of a fast-flying monoplane, will only be efficacious in detecting the movements of considerable bodies of troops. For detailed reconnaissance, without doubt, the two-seated monoplane, carrying its highly-skilled observer, will be relied upon—as, also, will the weight-carrying biplane, to which reference will be made in our next section.

It may now, perhaps, be permissible to summarise some of the advantages of the latest-type military monoplanes. Primarily, of course, their value lies in their speed. In war-time, some reconnoitring flights will be more urgent than others; but it may be taken for granted that, in practically all circumstances, the speedy completion of a reconnaissance will be greatly to be desired. Thus, in the eyes of a Commander-in-Chief, the fast-flying monoplane will find the highest possible favour.

A definite advantage of the monoplane's speed will lie in its ability to fly in high, gusty winds. It will, indeed, require very adverse conditions to prevent the flight of a bold and expert airman, piloting an eighty-mile-an-hour machine. This point, naturally, will have especial significance during the progress of an actual campaign.

In the forthcoming trials of military aeroplanes, to be conducted by the War Office, it is certain that powerful, two-seated monoplanes, propelled by seventy and hundred horse-power engines, will play an important part.

II. Latest developments in biplane construction—The engine-in-front, weight-carrying machine.

The varied experience of the year 1911, so far as the use of military biplanes was concerned, revealed very definite results at the Paris aeroplane exhibition in December.

The influence of monoplane construction, upon the design of many of the biplanes shown, was marked. Clearly revealed, for example, was the comparatively new school—initiated by the Breguet—in which the engine is fixed in the bow of the biplane, as in monoplane practice, and a form of body almost identical with that of a monoplane is adopted.

Such machines, seeing that they employ rear elevating planes, as do monoplanes, are biplanes only in the sense that they are fitted with two main-planes, set one above another. As a matter of fact, in regard to the Breguet—a notable representative of this type—the description "biplane" is occasionally dropped, and the machine called a "double-monoplane."

One of the practical advantages of the engine-in-front system is in regard to the possibility of a bad descent. In the event of an abrupt dive to the ground, with a machine of this construction, the engine, and strengthened forepart of the body, take the brunt of the shock. In machines where the power-plant is fixed behind the main-planes, a danger has revealed itself of the motor being wrenched from its wooden bed, and falling forward upon the pilot—with disastrous results.

Two notable exceptions to this new method of construction are those of Henry and Maurice Farman. They still maintain the system of placing engines behind the main-planes, and of setting pilots in front of them.

But the Henry Farman military biplane, as seen at the end of 1911, was a very different machine from that, for example, upon which Louis Paulhan made his flight from London to Manchester in April, 1910.

Probably the most obvious of the new features introduced was that of placing both pilot and observer in seats set upon a wooden framework, which projected in front of the main-planes. The object of this innovation was to provide a pilot, or reconnoitring officer, with the most unobstructed view possible of the ground below him. The objection to the scheme was that the exposed position made it highly probable that the occupants of the machine would bear the full brunt of the impact, in the case of a bad descent.

Another feature of the Henry Farman military biplane, which is under review, was the "staggering" of the planes. Farman adopted the plan of setting his upper main-plane appreciably in advance of the lower one. The "staggering" of planes is seriously criticised, by technical experts, on many grounds. But, in this case, Farman seems to have decided upon the system, in regard to his military machine, in order to facilitate a descent on rough ground, and also to assist the heavily-laden aircraft in getting away from the ground, and in "climbing." The biplane certainly performed meritoriously in the French military trials.

At first operating individually, but now in partnership with his brother Henry, Maurice Farman constructed, towards the end of 1911, an interesting type of military biplane. The Maurice Farman machine may be said to have come first into definite prominence when Tabutean flew for more than eight hours in it in 1910, securing the Michelin Cup.

A large machine, with extensions to its main-planes, capable of carrying a very heavy load, and of remaining in the air for a long time, but being an awkward craft in a high wind, save for the most expert pilot—in such terms, one may describe the Maurice Farman. What a skilled airman can do with such a big, slow-flying machine, has been shown by Renaux, who piloted his Maurice Farman right round the 1030-miles course of the Circuit of Europe; but there were, of course, times when the monoplanes flew in a wind which kept him in his shed. It should be stated, to the credit of the Maurice Farman, that it achieved excellent results in the French trials.

Reference has been made to the Breguet. This is a biplane of a most progressive type. Steel enters largely into its construction. It has a tapering body, with controlling planes at the tail, such as the monoplane possesses; and, in addition, it is equipped with two main supporting planes, such as characterise the biplane. These are fitted above and below the body of the machine.

Constructionally, its outstanding feature is its simplicity. Instead of a number of wooden supports between the main-planes, held in place by much wiring, the Breguet biplane dispenses with all save four struts; and these are maintained in position by a minimum of wiring.

The result, from the point of view of portability, is that a great stride forward is effected. The main-planes of the machine, which represent its bulky feature, can be unshipped in a few minutes. Nor is this all; by an ingenious system of hinging the main-planes to the body of the biplane, these planes may be turned back, after they are un-wired, and folded beside the body of the machine.

A result is thus achieved which would not have been considered possible, in the early stages of aeroplane construction. When the planes are folded at the sides of the machine, it can be made to move down a road like a motor-car, with its engine running, and its propeller drawing it forward. The steering-wheel, used when the machine is in flight, is connected with a small front running-wheel. When he is on the ground, therefore, the pilot sits in his driving-seat, and controls his craft like a motorist.

Such features as this commend themselves, as may be imagined, to military experts. The Breguet biplane possesses other original features also. The main-planes, being constructed with thin metal ribs, are flexible; and this flexibility gives the machine stability when assailed by wind-gusts.

There are several military types of the Breguet biplane. There is, for ex-

ample a machine built to carry a pilot and an observer; and another type, more powerful, which raises a "crew" of three into the air.

The latter is called by its makers the "cruiser" biplane; and it is interesting to describe how the "crew" is disposed upon it. First comes the engineer; his task is to attend to the motor. He is given a seat right up in the bows of the machine, and just behind the engine. The idea of having a man to look after the engine is, of course, an excellent one; he is able to "nurse" the motor, give it every attention, and detect at once whether it is developing any troubles.

Behind the engineer, in the long, boat-shaped body of the biplane, is seated the observer. He is free from all duties save the carrying out of his observation work. He has his maps and notebook—shielded from the rush of wind—in the body of the machine before him.

Behind the reconnoitring officer comes the pilot of the machine, with the controlling wheels placed in front of him. His attention is devoted exclusively to steering, and preserving the lateral stability of the biplane.

This division of duties upon an aeroplane is especially useful in military work; and it will, undoubtedly, become more and more a feature of war aircraft. A crew of three, upon a reconnoitring machine, represents an ideal distribution of duties. An engineer, to look after the motor when in flight, will probably become more and more of a necessity, as engines increase in power.

A machine with ample engine-power is essential from the military point of view. It not only means ability to withstand wind-gusts, but it spells, also, the power to rise swiftly.

This power of quick-rising, combined with high speed, may frequently save an aeroplane from destruction, when it is reconnoitring over a hostile force. The ability to "climb" speedily is, indeed, insisted upon by those who frame the rules for military contests.

Unknown to the crew of a war machine, they may approach within range of a concealed battery. In such a case, a shell bursting near them will probably be their first indication of peril.

Instantly, the pilot will seek to put as great a distance as possible between himself and the battery; and, as he darts off, he will "climb" as quickly as he can. In such circumstances as these a quick, handy machine would probably escape unscathed, whereas a slow-moving craft might run grave risk of being hit. In the matter of speed, a machine like the Breguet shows a very distinct improvement, as compared with early-type biplanes. Thirty-five miles an hour represented the speed of some of the first biplanes flown in France; but this was increased, before long, to forty miles an hour.

Then came specially-built biplanes, really racing craft, which caused speeds to increase from forty to forty-five, and fifty miles an hour. Now, in reference to

the Breguet, a speed of sixty miles an hour is attained.

In regard to the speed of biplanes when amply engined, it may be mentioned that Mr Cody, using a 120 horse-power Austrian-Daimler motor, has been credited with a pace of seventy miles an hour at Farnborough.

Concerning the development of big, weight-carrying biplanes, the French military authorities are now definitely credited with the intention of using such machines, in war-time, for destructive purposes. No official announcement of policy, in this connection, has been made; but the statement is current, and finds general acceptance that, in the case of a war with Germany, large biplanes would be used by France along the German frontier, for the purpose of dropping bombs upon fortifications, and frustrating any punitive flights of German airships.

In this direction, and possibly also for transport purposes, the future of the weight-carrying biplane seems certainly to lie.

Those now available for military purposes are designed to possess a maximum of lifting power, with reasonable speed, and a large measure of portability. They possess strong, workmanlike features, which specially suit them for rough service.

From the point of view of an observer, in obtaining a maximum of unimpeded vision for his work, the military biplane offers distinct advantages. But the relative value of biplanes and monoplanes in war-time, can only be established, definitely, by the carefully-noted experiences of a campaign.

III. Healthy position of the French industry—What England has lacked—Danger of neglecting home builders.

The competitive element in France, so far as aeroplane construction is concerned, has been fully aroused.

There is, indeed, every encouragement for a maker to invest his money in the production of a machine. He knows that, if he achieves a result that is satisfactory from the military point of view, he will receive definite Government support, in the shape of an order for one or more machines.

This, of course, makes all the difference between development and stagnation. From the point of view of the military authorities, the encouragement of construction has another important effect, also. It directs building into the channel which they desire it to follow—that is to say, towards the steady improvement of machines suitable for purposes of war.

By this process of placing every facility in the way of her home manufacturers, France ensures the maintenance of her lead, so far as military aeroplanes are concerned. The most talented men as designers, and the most practical men

as builders, are always busy in France, seeking to improve the machines which are at present in use.

An unfortunate position, so far as England is concerned, was revealed in connection with the preliminary announcement of the intention of the War Office to hold a military aeroplane contest. Starved for lack of any official recognition or support, representatives of the British industry pleaded for conditional orders for machines.

In the general advancement of the science, and particularly so far as costly experiments with aeroplane engines are concerned. Government apathy, in the past, has brought about stagnation—and the use, on English flying-grounds, of foreign-built machines. Will this forthcoming season show a change? It is sincerely to be hoped that it will.

France possesses the best machines to-day; and she intends to have the best machines to-morrow. She is in the best position, also, to profit by any revolutionary discovery, as applied to aeroplaning—should any such discovery be made.

The country which obtained first use of any revolutionary discovery would, naturally, be in a commanding position; and, if any such discovery is made, there is little doubt but that it will be made in France. This is what a country secures by a pioneer policy in any new science: it obtains the best there is at the moment, and practically ensures, also, obtaining the best that the future can bring forth.

The lack of anything like official encouragement has, hitherto, thrown a definite blight over aerial constructional work in this country. Clever engineers have interested themselves in the problems arising; but experimental work, in regard to aeroplaning, is notoriously expensive. With little scope for selling machines, when they have built them, British manufacturers have had no stimulus to compete with the makers in France.

Of course, there have been private orders for English builders. But these have not been certain. A series of definite orders from the Government—given just when the industry needed stimulating—would have made all the difference.

With only one or two aeroplanes actually purchased, a maker knows that certain of his expenses are covered, at all events; and, when he has disposed of three of four machines, even if his profit is small, he is encouraged to embark upon fresh experiments.

This is how the manufacturers in France have gone from one triumph to another. They have built, and sold, machines of a certain type; and, in the building of them, they have learned a number of lessons, and have seen where all sorts of improvements might be made.

Then, having transacted some genuine business, and established a factory on a satisfactory basis, they are ready, and able, to put to a practical test the ideas

they have acquired in building their first machines. This is how such world-famous makers as Blériot and Farman have been able to move forward.

What it means to a country to obtain a lead in such a new industry as that of building flying machines is shown now, almost every day, in regard to the demand which has sprung up for war aeroplanes. Many other Governments are, as has been indicated, following the lead of France in obtaining air-fleets; and, to make a beginning they have, naturally, been obliged to buy aeroplanes.

The problem has arisen, therefore, as to where they should purchase their first machines; and they have found themselves forced to go to the French manufacturers, simply because the French factories have been producing the best aeroplanes.

Thus England, Germany, Russia, Italy, Spain, and Japan have been obliged to go to France to buy aeroplanes. This has meant more money for experimental work in France. Therefore, what other nations have been doing, really, has been to help France to increase her lead, by giving her manufacturers the wherewithal to extend their researches. Thus it can be seen how important it is for a country like France to maintain her dominant position.

It is true that other nations, having made initial purchases from the French aeroplane manufacturers, will try to improve upon these machines themselves, so as to avoid spending any more money out of their own country. But in this their success is, to a certain extent, doubtful. They may study French-built machines, and may see where improvements are possible. Then they may seek to construct machines of their own. But it must be remembered that France, helped by the money which these other countries have spent with her, is progressing rapidly all the while.

The other countries, beginners in the construction of aeroplanes, are sure to make slow progress; but France, with every facility to hand, will go ahead quickly. Thus, while other countries are seeking to improve upon the machines which they have bought in France, it is probable that the French manufacturers will have gone ahead several stages further, and will be able to maintain a commanding lead.

Not only in the purchase of military machines, but in regard to aeroplanes for private use, France is reaping the reward of her go-ahead policy. Large numbers of French-built aeroplanes have been purchased by airmen in other countries. The reason, of course, is not far to seek. Patriotism is one thing, the obtaining of the best aeroplane another.

Exceptionally large prizes have been offered for aeroplane contests, and it has been the desire of all competitors to secure either the fastest or the most reliable machine, as the case may be. Therefore, following the example of the military authorities, the airmen of various countries have gone to France for their

machines, and have further swelled the resources of the French makers.

Some Englishmen of wealth and leisure have, greatly to their credit, supported and encouraged the home manufacturers in their struggle against the general apathy prevailing. The effect of their action has been apparent in the production of more than one aeroplane which has indicated, clearly, that all the industry in this country requires is steady development along the right lines.

It is often said in England that we shall, in regard to aeroplanes, follow the policy which was adopted concerning the motor-car. That is to say, we shall allow the foreigner to do all the pioneer work, and then step in, and produce a perfected machine just as well as he can.

But aeroplanes are not in the same category as motor-cars. Besides, it is not our business here to deal with the commercial aspects of the case. We are not arguing the cause of the aeroplane from the point of view of trade. The matter is one of national safety.

And this is the position. It will probably be many years hence before anyone will be able to say: "Here is the perfected aeroplane. Now we can equip factories, and standardise our output."

What will more likely eventuate, as we have hinted, is a gradually improving war aeroplane. During the years that improvements are being sought in France—and found—we cannot afford to "sit on the fence." In the matter of some commercial development, it might be possible to pursue a laggard policy, while another go-ahead country was doing pioneer work; but such a scheme is perilous in the extreme when a new and vitally-important weapon of war is concerned.

This summer, in the military trials, British makers will have a chance. Unfortunately, they have not much time in which to evolve the exceptionally efficient aeroplane which the tests demand. In this regard, without doubt, they are greatly handicapped in a contest with French manufacturers—who have all the experience of the 1911 trials at Rheims behind them, and practically unlimited resources in the shape of smoothly-working factories and financial strength.

In the matter of British engines, there will certainly be insufficient time—before the War Office trials—for any new motors of sufficient power to be built and tested satisfactorily. This is particularly unfortunate, as it will mean, in all probability, that British constructors will be obliged, whether they like it or not, to install machines with foreign motors.

Six months is not long enough for the home aeroplane industry to lift itself from its Slough of Despond. The Government's tardy recognition of the value of military airmanship cannot cause an immediate making-up of leeway. As a matter of fact, the industry in this country is bound to suffer, from its past neglect, for several years to come.

SEVENTH SECTION WHAT EXISTING WAR AEROPLANES CAN ACTUALLY ACCOMPLISH

I. Plight of a Commander-in-Chief without an aeroplane corps—The work of cavalry reconnaissance.

What can be achieved by aeroplane reconnaissance, when skilfully carried out, and conducted upon an adequate scale, it will be the purpose of this section of our book to show.

In order to appreciate the services which an efficient air-corps will be able to render, the position of a Commander-in-Chief who has no aeroplanes to help him should first be understood.

In modern warfare, operations are extended over a very wide area. Sometimes, for example, a fighting line will stretch over a frontage of many miles. This makes it increasingly difficult for a Commander-in-Chief to obtain precise and speedy information concerning the movements of his enemy.

[image]

BUILDING WAR AEROPLANES.
In this picture—taken in the Bristol works—skilled artizans are seen busy with the building of the bodies of a consignment of military-type monoplanes. Although apparently frail, these frameworks are—owing to their method of construction—immensely strong.

Cavalry scouts are, of course, sent out. They move cautiously forward, until they come into contact with the outposts which the enemy has thrown forward with the deliberate intention of concealing his intentions. The cavalry scouts

are able to report the position of these outposts; but as to what general strategic movement is taking place behind this screen they can, as a rule, provide only meagre information, if any at all.

How difficult it is to glean anything like reliable news of an enemy's movements has been indicated by that great military genius, Napoleon. Dealing with this very question, and clearly emphasising the need for such a scouting medium as the aeroplane, he wrote:—

> "Nothing is more contradictory, nothing is more bewildering, than the multitude reports of spies, or of officers sent out to reconnoitre; some locate army corps where they have seen only detachments; others see only detachments where they ought to have seen army corps.
>
> "Often they have not themselves seen the facts they report, and they have only gathered the hearsay evidence of alarmed, surprised, or bewildered people. ... If a former preoccupation exists, if there is a tendency to believe that the enemy will come from one direction rather than from another, the gathered evidence is interpreted in one sense, however little it lends itself to being so interpreted. It is thus that great mistakes are made, which are sometimes the ruin of armies and of Empires."

Nothing could more definitely indicate the importance of accurate reconnoitring than the emphatic statement of this great soldier. Napoleon recognised that reliable information, concerning the doings of his antagonists, was all-important. A misunderstanding of some scouting report was, he knew, sufficient to lose the Commander-in-Chief a great action.

In any battle a Commander seeks, as has been truly said, to see what is going on "upon the other side of the hill."

The two armies are spread out, approaching each other. Each Commander has thrown forward a screen of men. These act, so to speak, as "feelers," seeking to come into touch with the enemy. Behind this screen of outposts comes the real strength of the army. Neither Commander knows how, when, or at what point, his opponent will develop his main attack. So they grope towards each other, any authentic news of a definite movement of troops being eagerly awaited.

If, as the result of any information brought him, one Commander-in-Chief can anticipate his opponent's chief move, he may—by that stroke alone—succeed in winning the battle which ensues.

Thus it is that a Commander-in-Chief sits at his Headquarters, with maps in front of him, asking himself one vital question: "At what point, behind the wide-flung screen of his outposts, is my enemy developing his main attack?"

The cavalry scouts, and the scouts on foot, do their work as best they can. They strive, as far as is practicable, to pierce the barrier of men which the enemy has thrown forward.

The task of these scouts is dangerous; it is laborious; and it is slow. It is also haphazard. But, from the fragmentary news that is brought back to him, a Commander-in-Chief has to act as best he can.

Some of his scouts succeed; others return with nothing at all. There are serious gaps in the intelligence; much of it may be contradictory. Yet upon such intelligence as this a Commander-in-Chief has acted in the past, and will have to act in the future, unless he has the aeroplane scout placed at his disposal.

II. Work of a squadron of air-scouts described—Tasks of the pilot and observer—Combined reconnaissance by many machines—Effect of aeroplanes upon tactics.

Having indicated the difficulties of the Commander-in-Chief, who has no aeroplane service at his disposal, it is now legitimate to show what can be accomplished with the aid of this new "arm."

We will imagine, for the sake of argument, that an action is imminent, and that the Commander-in-Chief is anxious to know, without delay, from what direction he may expect the enemy to mass his troops for a main attack. So he calls into consultation the Commander of the aeroplane depot. This depot—as has been explained in a previous section—will probably be established at a suitable point near the main body of the troops, and will be maintained at the spot chosen, until a move on the part of the army necessitates a change of quarters.

To the Commander of the aeroplane depot the Commander-in-Chief will explain the points, in regard to the general plan of campaign, upon which he requires enlightenment.

The Commander of the aeroplanes will make a note of what the Commander-in-Chief desires; then he will return to the aeroplane camp, and get to work. It is probable, in the ordinary course of affairs, that organised reconnoitring flights will be made, in wartime, either in the early hours of the morning, or during the evening. This will suit the convenience of the airmen by giving them the best weather conditions to work in; and it will also be satisfactory for the Commander-in-Chief to know at the beginning, and again at the end of a day's fighting, what the dispositions of his enemy are.

In the French manœuvres, and also in other experiments made, it has been shown that information, concerning an enemy's movements, is generally required in the morning and in the evening; and this applies, particularly, to news

gleaned in the early morning, soon after it is light. It is then, before the movements of the day, that an enemy's dispositions may best be noted.

A good deal of interest has been aroused, lately, in the suggestion that, in war-time, machines would be required to reconnoitre at night. It has been pointed out, in this connection, that large movements of troops are often made under cover of darkness.

That night reconnoitring is practical there is no doubt. How much an observer would be able to report, without the use of a searchlight, experience must prove. There seems little doubt but that an air-scout could descend low enough, at night, to detect the movements of large bodies of men.

When he has returned to the aeroplane camp, after his consultation with the Commander-in-Chief, the officer who is in charge of the aviation depot will seek an interview with the officer who is directly in control of the military pilots and observers. Maps will be consulted, and a general plan of reconnoitring drawn up; and, at this stage of the proceedings, the time will come to decide how many machines are to be sent out upon the scouting expedition.

This decision will be governed, very largely, by the extent of the area to be traversed, and also by the urgency of the mission. Although all news obtained will naturally be needed at Headquarters as quickly as possible, there will be occasions when the need for haste is very great. In such instances, more machines will be sent out than at ordinary times.

If he has a complete and rapid reconnaissance of an enemy's position to make, covering the entire area of operations, and not any one section of the battle-front, the Commander of aeroplanes will probably order a large number of machines to go upon the trip.

The value of numbers is self-evident. One machine, acting upon instructions, can be piloted over a narrow and previously-indicated route. It reports all that is seen, but its observations are necessarily restricted to what lies in its path.

It would be impossible, with one machine making one flight, to obtain anything like a comprehensive report as to an enemy's doings—at least not in reasonable time.

This is why, when a large area has to be covered, the Commander of aeroplanes will order out a regular squadron of machines. After a conversation with his immediate superior, the officer who is in charge of the airmen and observers will discuss with them the area which each machine shall cover.

Again maps will be consulted, and aerial routes will be laid down. It will be the aim of the officer instructing the airmen to spread out his scouts so as to present a complete report, when the reconnaissance is effected.

When the whole of the ground to be reconnoitred has thus been marked out upon the maps, each observer—who will be equipped with his own personal

map of the fighting area—will be instructed as to the course he shall steer. He will duly note this, and return to his machine.

Whereupon, the pilots will soar into the air from their camp, and speed away upon their missions. The pilot of the aeroplane will be concerned with nothing save the control of his machine. He will not need to trouble himself about the route taken, or about what is seen below.

This work will fall upon the observer, who will be placed in the machine with an uninterrupted view of the country below him, and who will instruct the pilot as to the course he shall steer, and the elevation he shall maintain.

The observer, indeed, will be in charge of the aeroplane. Upon him will rest the responsibility of the success of the expedition, from the point of view of the information to be obtained. But the work of the pilot will be important, also. Upon his skill, in manipulating the machine, will depend the carrying out of the flight, and the safe return of the aeroplane to Headquarters.

Thus the fleet of air-scouts will start upon their errand of observation. Each machine will mount steadily, until an altitude, under ordinary conditions, of between 3000 and 4000 feet has been reached. Then, at this height, they will sweep out over the enemy's lines. The altitude mentioned is generally regarded as a good height for reconnoitring work because it permits the observer a fairly-detailed view of the ground below, and places him, also, at what is considered a safe elevation, so far as artillery fire is concerned. The important question of the vulnerability of aircraft, in regard to artillery fire, will be dealt with fully in a later section.

As the reconnoitring machine moves out over the enemy, the pilot will be busy with the control of his machine. If the weather proves very favourable, his task will be a comparatively light one. All that he will need to do is to see that he is steering accurately upon the course laid down by the observer, and that his altitude remains at the level chosen. He will also listen attentively to the running of his engine, and occasionally note the number of revolutions it is making, as recorded by an indicator placed before him.

If a reconnoitring flight has to be undertaken in adverse conditions, say with a gusty, treacherous wind blowing, the task of the pilot will be an extremely arduous one. Apart from the difficulty of keeping his craft upon a proper course, he will be faced with the nerve-racking task of preventing it from "side-slipping," under the onslaught of vicious gusts of wind.

The "side-slip" which an aeroplane may make in a gusty wind is, indeed, a very unpleasant experience for those who are on board it. What happens is this: under the influence of a sudden gust, the machine heels over until it reaches an angle when forward motion is replaced by a swift, sickening slide sideways. A machine may "side-slip" in this fashion, for an appreciable distance, before the

pilot is able to regain control of it.

An example may be cited of an airman who slid down from an altitude of more than 800 feet, until he was within a couple of hundred feet of the ground. There is only one thing to do when a machine begins to "side-slip" in this way. The pilot must alter the angle of his elevating planes, so that the aeroplane dives forward as well as slips sideways. This dive adds to the machine's speed, and so checks the sideway fall; and, if his altitude is sufficient, the airman is able to regain control of his machine, and bring it back again upon an even keel, before there is danger of contact with the ground.

In bad weather, as may be imagined, a reconnoitring trip may be a serious ordeal for the man at the levers. The responsibility for undertaking a flight, in unsuitable weather conditions, will fall upon the officer in command of the aviation depot. If, for example, the wind is too high for flying, it will be his duty to tell the Commander-in-Chief so, and delay the intended reconnaissance until conditions improve.

The work of the pilot of the aeroplane, during a reconnoitring flight, has only been described so far; now we may deal with the task of the observer. He will, probably, have a busier time than the man at the levers. From the moment of leaving the ground, until the flight is finished, he will need to be on the alert.

As the aeroplane approaches the enemy's lines, he will pore over the map fixed in a frame before him. In addition to this map, he will be provided with pencil and notebook.

Thus, when any portion of the enemy's troops appear below him, his task will be perfectly clear.

He will first need to identify them. That is to say, he must be able to determine whether he is looking at infantry, cavalry, or artillery; and then he must be able to decide as to the strength of the forces that are in view.

These points determined, he will turn again to his map, so as to make sure of the actual point, on the battle line, where the troops he sees are stationed. This done, he will make notes in his book.

And so, throughout the flight, will the observation officer be busy, peering downwards; consulting his map; afterwards scribbling hastily in his notebook. If he is not quite sure what anything is that he sees below him, he will ask the pilot to circle back, so that he can make another inspection.

If the weather is perfectly clear, he may be able to instruct the airman to soar higher, and so be safer from any gun-fire from below. On the other hand, if the morning or evening is misty, he may have to take the risk of descending lower.

Each unit on the squadron of observing aeroplanes will be carrying out the same routine. Wide-spread, the air-scouts will sweep over the enemy's position.

In an hour, each air-scout will be able to traverse a distance of more than fifty miles, and nothing of importance below him should pass undetected.

In a little more than an hour, from the time of their starting away, the squadron of machines should be returning to their camp. One by one they will come gliding down, and the observation officer in each machine will present a written report to his immediate chief. This officer, when all these reports are in his possession, will seek the Commander of the aviation depot. These two officers will speedily sift out the information brought in by air-scouts, and prepare, for the consideration of the Commander-in-Chief, a summary of the whole reconnaissance.

This the Commander of aeroplanes will take with him to Headquarters, and the Commander-in-Chief, with the members of his staff, will bend over their maps, tracing the enemy's dispositions, noting his weak points, and also the positions where he may be in force.

In regard to observing the actual movements of troops, as apart from the positions of stationary forces, the work of the war aeroplane should be wonderfully effective. An air-scout may, for example, report that a section of the enemy is on the march between two points at a given time. This news may be considered, by the Commander-in-Chief, to have a very important bearing upon the development of the enemy's plan of campaign. Is this body of troops still moving in the same direction, say an hour later? This may, quite likely, be the question upon which the Commander-in-Chief may want information.

Upon hearing this, the Commander of aeroplanes will soon have two or three scouting machines on the move. There will be no difficulty about such individual work as this; and very soon the Commander-in-Chief should be supplied with the news that he requires.

Thus it is possible to outline, in a general way, the reconnoitring work of the war aeroplane. It is not necessary to emphasise again the value of information which can be borne so quickly to a Commander-in-Chief; the importance of the news which will be gleaned by the air-scouts is, indeed, self-evident.

As the result of an aerial reconnaissance by many machines, well-organised and successfully carried out, the Commander-in-Chief should be supplied with information which could not possibly be acquired in any other way, and which should tell him where the enemy was, and what they were doing, only an hour before the news is put before him.

On such information, also, he can act with confidence. He need not hesitate, questioning its authenticity. On the maps before him, set forth in a manner beyond dispute, he will have the position of his foe, and the direction in which the chief bodies of troops are being moved.

Nor is this all that the aeroplane can do, as has been shown. If a

Commander-in-Chief is in doubt about any movement of the enemy, during the course of an action, he still has the aeroplane at his immediate service.

There is no reason, indeed, why constant reconnaissances should not be made during the course of a battle. Suppose, for example, that a heavy attack has been made upon the enemy. It is sought to know whether such onslaught has had its full effect. Is the enemy falling back? This may become a question of great urgency, as it may govern a Commander-in-Chiefs next offensive move. Here is a task in which the air-scout can reveal his worth.

Rising high, and flying over the enemy, he should be able to determine whether a retreat has begun, and should bring back this information to Headquarters with a minimum of delay. A definite instance of the use of the aeroplane in this connection was, it may be remembered, given in the French manœuvres in Picardy, when Lieutenant Sido was able to inform his Headquarters that the enemy was in retreat, after an important action.

If his aeroplane service is efficient, and there is no delay in obtaining news, a Commander-in-Chief should be receiving constant intelligence, concerning the movements of the enemy, during the progress of a battle. It may be extremely important, for example, to know that the enemy is bringing up batteries to a certain point; or that a hill, or other point of vantage, is to be abandoned. From first to last, indeed, the aeroplane should be of the greatest use.

But, as has been shown before, it will not be so much a case of the number of aeroplanes used, as of the organisation behind them. In this lies the crux of the situation. Unless pilots and observers are absolutely competent, and ready for their work, the results obtained cannot be satisfactory.

The influence of the aeroplane scout upon military tactics will, undoubtedly, be marked. The German school, for example, advocates a strong, determined advance—not caring so much what the precise dispositions of an enemy are, but seeking to envelop him, and deliver one quick and crushing blow.

French military tactics, on the other hand, are more strategical—more prone to play a waiting, watching game, and make a master-move after the battle scheme has, to a certain extent, revealed itself.

What has been called "the fog of war"—that is to say, the meagre information regarding an enemy's movements, which is all that is available if aeroplanes are not used—suits the German method of blunt, dogged, hit-or-miss advance. Lack of information is not advantageous, on the other hand, to the carefully thought-out French strategy.

What the advent of the air-scout does is to help the Commander-in-Chief, who is able to make subtle, deeply-planned moves, in which precise information is essential, and to discount a blind, crushing use of numbers.

III. Other uses of the war aeroplane—Surveying—Dispatch-carrying—Directing gun-fire—Transport of staff officers.

The duties so far mentioned do not, by any means, exhaust the possibilities of the war aeroplane. So far, only military reconnaissance has been touched upon. This work is, of course, of outstanding importance; but an air-corps could, during a campaign, be put to many other tasks, all of them of genuine utility.

Take, for example, the work of discovering the nature of the country over which an army is about to operate. This is a task which is extremely important. But, hitherto, the process of obtaining such information has been painfully slow—painfully slow, that is, when compared with the way the aeroplane will be able to carry out the work.

Here, indeed, will be an ideal opportunity for a long-distance flight. In a three-hour, non-stop journey, a machine should be able to survey at least 150 miles of country, and return with reports of the utmost value.

How important this aerial survey-work will be is instanced by Major J. N. C. Kennedy, who, from his experience in the South African war, states that such disasters as Spion Kop could not have happened, if there had been aeroplanes to fly over and observe the country beforehand.

Here, then, is another practical use for the aeroplane. A squadron of machines, flying ahead of an army on the march, will be able to return with accurate news as to the position of roads, railways, rivers, and bridges. Such information, received in good time, may prove of exceptional value to a Commander-in-Chief.

Apart from general survey work, also, the air-corps will be able to execute highly-important orders in locating the position of an enemy's supply trains, magazines, and depots.

Thus it can be seen that there will be practically constant use for war aeroplanes during a campaign—apart from their potentialities as weapons of destruction, concerning which notes will be written later.

So highly does he rate the work of aircraft in wartime, for reconnoitring purposes, that the director of the military aviation service of the French army has declared: "Aeroplanes, carrying a steersman, observer, and combatant, will eventually supersede cavalry for scouting purposes."

In this regard, it is interesting to note the opinion of a famous German military expert, who says:—

> "They (aeroplanes) will collect much information which would never be accessible to cavalry, and, above all, they will do it over long distances, and in a much shorter time. It is a defect of cavalry reconnaissance that the knowledge which it yields has necessarily, in the great

> majority of eases, been long overtaken by events. No small gifts, on the part of the General, are necessary to infer, from what was ascertained many hours previously, what is actually the existing situation. The possibilities of error are very great."

Here is another striking tribute to the value of the war aeroplane. What this German expert was particularly impressed by, after observing a series of tests of aeroplanes for reconnoitring, was their wonderful speed, as compared with any other means of obtaining information.

The point he makes, in this connection, is highly important. Not only will the aeroplane scout bring back news which it would be impossible to obtain by the use of cavalry, but he will place this news in the hands of a Commander-in-Chief while it is fresh, and of the fullest importance, and not many hours old—as the intelligence brought in by other methods of reconnaissance generally is.

Another extremely useful function of the aeroplane, during a campaign, must not be forgotten. This is its use as a dispatch-carrier. In this regard, a light, swift machine will be found of utility. No ordinary obstacle will hamper it. The fact that the country is mountainous, or that there are awkward rivers to negotiate, present serious problems for the dispatch-rider, who sets out to carry a communication from point to point on horseback. In many cases, indeed, it becomes impossible to send a dispatch across country.

But the aeroplane dispatch-carrier will think nothing of such difficulties as these. Over precipitous country, and across mountains, he will fly without hindrance; and he will be faced with no problems concerning the fording of rivers. As straight as an arrow, from point to point, he will carry his message, and at a pace in excess of that of the express train.

The fact that skirmishing parties of the enemy are dotted about, between his starting-point and his objective, will not perplex him either, although it would prove a serious embarrassment to the dispatch-rider who used the land when in transit.

Instances of the practical value of dispatch-carrying, in time of war, are readily forthcoming. A distinguished cavalry-officer, Colonel Grantham, supplies one, for instance. In the Chinese war, he recalls the plight of two columns which were advancing, about twenty miles apart, to deliver a combined attack. The country dividing them was mountainous; parties of the enemy were also moving about on it. The result was that, for several days, no message could be got through. This lack of communication made the scheme of a joint advance very difficult to carry out. Had an aeroplane dispatch-carrier been available, in such circumstances as these, he would have linked up the two columns in a twenty-minute flight, irrespective of all that lay below him.

It is, of course, frequently necessary, during the progress of a battle, for Generals commanding various sections of an army to report to the Commander-in-Chief. Here the dispatch-carrying aeroplane, on account of its speed, will be of the greatest value.

[image]

WEIGHT-CARRYING WAR BIPLANE.
By Fitting "extensions" to the upper main-plane of the machine, as seen above, it is possible to achieve sustained flight with two, or even three occupants—or, should necessity arise, with a pilot and an appreciable load of explosives! The actual machine photographed is a Bristol, flying over the Brooklands aerodrome.

What can be done, in the way of long-distance dispatch-carrying, has been demonstrated most effectually by Captain Bellenger, a well-known French military airman. This officer, while stationed at the Vincennes air-depot, received instructions to carry a dispatch, as quickly as possible, to the military flying school at Pau. This represented a distance of 450 miles. Starting early one morning, Captain Bellenger reached Pau in seven hours sixteen minutes of actual flying. While *en route* he made three halts to replenish his petrol tank.

Recent tests in France show that quickly-assembled, single-seated monoplanes will be extremely useful, in actual military operations, in co-operating with artillery, by giving aerial directions as to gun-fire.

Upon occasions when the effect of long-distance fire is unknown to the gunner, an aerial observer, ascending to an altitude of several thousand feet, will be able to detect what mischief the shells are doing, and suggest—either by wireless telegraphy or by messages dropped from his machine—corrections in the gunner's aim.

Another field of practical utility for the aeroplane, during an action, lies in the quick transport, from place to place, of staff officers. Horses, motor-cars, and motor-cycles have, hitherto, been employed for this purpose. But the aeroplane is infinitely their superior in the matter of speed.

Roads may be blocked with troops, or transport waggons, thereby holding up, temporarily, the passage of any motor-cars or motor-cycles. No such hindrances affect the aeroplane. With such reliable passenger-carrying machines as are now available, staff officers will be able to flit from point to point on a battlefield, with a minimum of delay. This will prove an extremely valuable addition to what may be termed the conveniences of war.

It is legitimate, at this juncture, having illustrated the uses of an aeroplane in time of war, to picture, briefly, the contrast between two Commanders-in-Chief, one of them possessing an up-to-date fleet of war aeroplanes, and the other without any such aid. Prior to an action, the one who has an aeroplane corps sends out his machines upon a general reconnaissance. As a result he is, in an hour or so, in possession of all the information he requires concerning the enemy. He is able to calculate where his antagonist's main blow is to be struck; and he is also able to estimate the weak points in his opponent's fighting line.

The Commander who is without aeroplanes sends out his cavalry scouts, in the time-honoured fashion, and relies upon news from outposts. What information he thus obtains is bound to be many hours older than that, concerning his own movements, which is in the possession of the enemy. Furthermore, it leaves many questions of urgency altogether unanswered. But, unsatisfactory though his knowledge of his opponent's intentions is, the Commander has to grope forward. A certain blind doggedness actuates him; it is a case, more or less, of hit-or-miss.

Now, were his opponent in a similarly fumbling state of mind, it would not matter so much. But, thanks to his aeroplanes, Commander No. 1 has his opponent's dispositions and movements carefully marked upon his maps.

Thus the two armies come into conflict. One Commander-in-Chief knows everything; the other knows practically nothing. What is the result likely to be? One strikes swiftly and surely, aware of the precise strength opposed to him. The other fumbles blindly in the dark.

EIGHTH SECTION WIRELESS TELEGRAPHY AND PHOTOGRAPHY AS AIDS TO AERIAL RECONNAISSANCE

I. First tests and successes with wireless telegraphy—Difficulty of equipping an aeroplane with transmitting

plant.

In the descriptions of the uses of an aeroplane in war, which have been set forth in previous sections, nothing has been said concerning an adjunct which now promises to have an importance quite overwhelming upon future operations with aircraft.

This has reference to the use of wireless telegraphy. It was thought, at first, that any employment of this marvel of science, so far as aeroplanes were concerned, would be hopeless. The fact that the aeroplane is suspended, so to speak, in mid-air, with no earth communication, made the problem of equipping it with wireless particularly difficult.

But the value of a wireless message, from a flying machine, has always been recognised; and so most careful experiments have been made to devise an apparatus. In addition to the difficulty of transmitting messages from an aeroplane, there was the important question of weight to be considered. It was seen that any apparatus, made to be carried upon aircraft, must be extremely light; and, at the same time, it was essential that it should be of a small and convenient size, so that it could be stowed away somewhere in the proximity of the pilot's seat.

It was in America, in August, 1910, that the first success was obtained. An aeroplane ascended with the necessary transmitting mechanism on board, and with a long aerial wire trailing behind it, weighted with lead, from which the wireless messages were radiated. The apparatus was crude, and unsatisfactory from many points of view, but actual signals were received, from the aeroplane, by a station on the ground.

Only the most simple messages were attempted, and the aeroplane flew round in fairly close proximity to the receiving station. As a matter of fact, the best results reported, in connection with this series of tests, was a message transmitted from the aeroplane when it was 500 feet high, and which reached the receiving station from a distance of about a mile.

This result was distinctly encouraging. It showed that wireless telegraphy, as applied to the aeroplane, was not impossible; and it had the effect, also, of stimulating interest in other countries, and of setting many clever brains to work.

It was in the following month (September, 1910) that a series of experiments were begun in England. Salisbury Plain was the flying ground chosen, and Mr Robert Loraine, a well-known actor who had become prominent as an airman, was the pilot of the machine with which the tests were made.

The aeroplane employed in the experiments was a Bristol biplane, fitted with a "Gnome" motor; and the designer of the wireless transmitting mechanism used was Mr Thome Baker, a well-known electrical expert. After a number of tests, he had produced a transmitter which only weighed about 14 lb., and which

could be fixed, quite conveniently, behind the pilot's seat.

Mr Baker was also able to abolish the long trailing wire behind the machine, which had been used in the American experiments. Such a wire, it was recognised, was a bad feature of any equipment. Apart from the obvious clumsiness of such a device, it offered a danger of becoming entangled with the rapidly-revolving propeller of the machine, and so causing an accident. Mr Thorne Baker obviated this difficulty, in his tests, by twining his aerial wire round the wooden supports between the main-planes of the machine.

Another long wire, the receiver, was stretched between posts on the ground; and then Mr Loraine ascended, and began to circle round and round the aerodrome. For transmitting purposes, he had a little key strapped to his knee, and operated it with his left hand—his right hand being engaged, of course, with the controlling lever of his machine.

Again, as in the American experiments, only the simplest messages were attempted. They were, however, quite distinctly heard. At first, the signals were not received over a distance of more than half a mile, but it was soon found possible to increase the distance between transmitter and receiver to approximately one mile. At this distance, the dots and dashes telegraphed were distinctly read by Mr Thorne Baker, who received them—as is the custom with wireless telegraphy—through telephone ear-pieces.

Following these tests, Mr Thorne Baker set himself the task of perfecting his apparatus; and a very interesting experiment was planned, in December, 1910, in connection with the De Forest cross-Channel aeroplane prize.

Lieutenant H. E. Watkins, one of the competitors, consented to take up a transmitting apparatus with him, on his cross-Channel flight, so that he might endeavour to keep in touch with a steam-tug, in which his friends intended to follow him from Folkestone to the French coast.

The transmitter which Mr Baker prepared for this experiment was more powerful than the one used in the Salisbury Plain tests, and some conclusive results were expected from this oversea flight. Unfortunately, however, Lieutenant Watkins was delayed by bad weather, and a series of trifling accidents, and so was unable to start upon the flight. The wireless test had, therefore, to be abandoned.

After this, it fell to the lot of America to make the next move of any interest. Lieutenant Beck, a young officer-airman engaged in military experiments with aeroplanes, took up a transmitter with him, and was able to send messages to a special receiving station, over a distance of quite two and a half miles. This, naturally, was regarded as distinct progress. The messages were clearly read; and there now seemed no difficulty, with better transmitting mechanism, in increasing the distance over which the signals were sent.

II. French triumphs with wireless telegraphy—Messages sent over a distance of thirty-five miles.

In the meantime, as may be imagined, France had not been lethargic in dealing with this subject. The French military authorities had, from the first, recognised that wireless telegraphy, if it could be applied reliably to the aeroplane, would greatly increase the utility of aircraft in time of war.

At several of the French military aerodromes, at the beginning of 1911, experiments were in progress, and clever civilian electricians were called into conference by the authorities. But only meagre news leaked out as to what was actually being done.

Before the end of January, 1911, however, definite results had been obtained. Mr Maurice Farman, a brother of Mr Henry Farman, who had built an excellent biplane for military use, ascended at the aerodrome at Buc, and sent a wireless message back to the flying ground, when he was passing over the countryside quite ten miles away.

This was a highly-important result, and promised to place the wireless outfit on a practical basis, so far as war purposes were concerned. Further tests were made at Buc, and the radius over which messages could be transmitted was soon increased from ten to fifteen miles.

At this juncture, the French military authorities took the matter in hand with renewed vigour, and the energies of the scientific staff were directed towards still further increasing the transmitting power of the apparatus installed.

An improved transmitting mechanism, weighing about 55 lb., was built and fitted to a biplane at the beginning of July, 1911; and Captain Brenot, a prominent French military airman, was given the task of thoroughly testing this device. He was able to do so with remarkable results.

While flying between St Cyr and Rambouillet, he succeeded in getting into touch with the wireless installation fixed upon the Eiffel Tower in Paris. The distance was one of at least thirty-five miles.

Captain Brenot did more, also, than transmit a mere series of dots and dashes. He spelt out a complete message while flying, and it was correctly received by an operator of the Eiffel Tower wireless station. This historic aerial message was as follows:—

> "Captain Brenot, conducting experiments in aeroplane with wireless telegraphy, to the Minister of War.—Flying between St Cyr and Rambouillet. We beg to present our sincere regards. We are above the forest of Rambouillet, at a height of 1640 feet."

Nothing could have been more dramatic, in its way, than the receipt of this message in Paris from an aeroplane, fitted with wireless telegraphy, thirty miles away; it demonstrated, conclusively, that an aeroplane, when equipped in this way, was an absolutely-revolutionary weapon of warfare.

Since then, French tests with wireless have been steadily going ahead, and improvements have been made. The results obtained are now more certain; and it has been proved, beyond doubt, that the wireless message from an air-scout will play a very prominent part in future military operations.

III. Practical uses of wireless upon aeroplanes—England's lack of effort.

How wireless telegraphy will aid the military airman may readily be seen. It will, in the first instance, be a remarkable time-saver. Instead of returning to Headquarters with a brief and urgent report, the observation officer in an aeroplane will be able to transmit it instantaneously, while still flying on his course. In the case of machines not equipped with a wireless installation, a reconnoitring flight will need to be followed by a return journey to the aeroplane camp. Then the airman's message will have to be brought along to Headquarters. Thus there will be some delay, although this can, of course, be reduced to a minimum by sound organisation.

But the fitting of a wireless apparatus will obviate, at one stroke, all delay occasioned by a machine flying back from the district over which it is reconnoitring, by the descent at the military camp, and by the conveying of the news to Headquarters.

It is not likely, however, that every machine will be fitted with a wireless outfit. In an aerial reconnaissance under ordinary conditions—made, say, during the early morning or evening, to show the general disposition of an enemy at a specified time—it will be sufficient if the airmen return to their starting-point, and the news is brought to Headquarters in the ordinary way. There will not, in such cases, be sufficient urgency to justify the use of wireless messages.

But, under many circumstances which will arise during war, a machine which can flash back frequent messages, without losing the time of actually flying back with them, will be of almost inestimable value.

Let us take, for example, the position of a Commander-in-Chief who is in the act of delivering a heavy attack, and wishes to know, from moment to moment if possible, how the onslaught is being withstood, and if there is any tendency on the part of his enemy to retreat. In such a case a special aeroplane, fitted with wireless, would be dispatched, to fly in circles over the fighting area; and a

portable receiving apparatus would be moved up close beside the point where the Commander-in-Chief had stationed himself. In this way, news could be received in the form of a constant stream of messages.

This is only one instance of the practical utility of wireless telegraphy from an aeroplane during wartime; many others, naturally, present themselves. In the course of a battle, the officer commanding aeroplanes should always have, ready for an emergency, one or two machines which are equipped with wireless. Thus, immediately any point arises regarding a movement of the enemy, upon which the Commander-in-Chief desires speedy enlightenment, a machine can be sent off without a moment's delay; and the information, once obtained, can be flashed back by wireless a second or so after the observation officer has made his reconnaissance.

During a series of military experiments with wireless telegraphy, carried out in France during August and September, 1911, the possibility of directing the fire of artillery, by means of messages from an aeroplane, was investigated. Ascending from a fortified position, which was supposed to be besieged, aeroplanes, equipped with wireless installations, made circuits over the country, in the immediate neighbourhood, and sent back messages to their Headquarters, describing with complete accuracy the position of concealed batteries, which were assumed to be carrying out a bombardment.

Aided by this intelligence, the gunners of the besieged position would, in actual warfare, have been able to direct a telling fire upon their hidden enemy. It would be possible, also, in such circumstances, for the aeroplanist to remain aloft during the firing, and actually direct the gunners in their aim by means of wireless signals.

Taking into consideration such possibilities as these, an eminent French military expert has observed: "The aeroplane, without wireless telegraphy, is a sufficiently wonderful 'arm,' altering all our preconceived notions concerning warlike operations. And now comes this new marvel. It is almost impossible to calculate what the effect of wireless signals from an aeroplane, during a battle, will be. This much is certain. The use of machines so equipped will play a revolutionary part in any action. Upon their skilful handling, of course, much will depend. Unless a Commander-in-Chief has accustomed himself to their use, during peace manœuvres, and unless the officers operating the transmitting mechanism, and those receiving the messages, are well-trained and thoroughly accustomed to their work, the best results are not likely to be obtained."

Naturally, in this connection, the question arises: what is England doing? The reply cannot be anything but disappointing. The privately-conducted experiments of Mr Thorne Baker, previously mentioned, represent practically all that has been done to perfect wireless telegraphy for aerial use.

So far as the authorities are concerned, civilian suggestions of co-operation, towards obtaining improved apparatus, have not been received in an encouraging spirit. From the small army airship, "The Beta," wireless trials have, it is true, been carried out once or twice; and some unambitious experiments with biplanes, at the Royal Aircraft Factory, were reported in April, 1912. But no practical outfit has been devised.

As a matter of fact, this question of the application of wireless telegraphy to aeroplanes provides a very striking illustration of the evils of our backward policy. Immediately there was an opportunity of using wireless successfully, the French military authorities were able to take advantage of the situation, and carry out adequate tests. This was because their organisation was what it should be, and because they had men and machines ready to be used in any experiments required.

Our backward position told against us inevitably, when this new adjunct to the aeroplane came along. We had insufficient machines, and not enough men. It was, as a matter of fact, more than sufficient for us to make anything like a show in ordinary flying work, without being required to go a stage further, and experiment with wireless.

Thus the lesson can be forced home. France has taken up this new aid to aerial reconnoitring—is perfecting herself in it, and accustoming her officers to its use. We have not begun to work with it yet. We are thus a definite stage behind, and shall remain so, unless a real effort is put forth to make up leeway.

By the time we have come to the stage of adopting a wireless installation upon aeroplanes, France may be busy with some new, and even more important, phase of flying.

As the military expert quoted above remarks, with perfect truth, it is essential that adequate and realistic tests should be carried out, with such an aid as wireless telegraphy, before any really effective use can be made of it.

IV. Photography from a war aeroplane—The use of special automatic cameras.

While dealing, in this section, with such an adjunct to reconnoitring as is afforded by wireless telegraphy, it is permissible, also, to refer to the use of photography in connection with aeroplanes.

Here, once more, it is necessary to turn to France for an illustration of recent work. Ascending from the Chalons military camp, quite recently, Lieutenant Blard, an army airman, succeeded in obtaining some excellent photographs of Rheims when flying at an altitude of 4000 feet. He used a special camera.

In America, also, practical attention has been devoted to this phase of military aeroplaning. An officer, when flying in a biplane, has succeeded in obtaining good photographs from as great an altitude as 6000 feet.

The utility of photography, as increasing the powers of the aeroplane in war-time, will be considerable. In an aerial survey of country, for instance, the camera will play an important part. A series of good photographs, when pieced together, will reveal the characteristics of land from the military point of view; and, in taking photographs of fortifications, the aeroplane with a camera will find another ready use.

It is now held that all scouting aeroplanes should be fitted with a camera, to be used, during reconnoitring, whenever a favourable opportunity arises.

In the first tests made with photography from an aeroplane, an ordinary camera was used, being held, by the passenger in the machine, in the best position possible to secure a photograph of whatever object it was desired to snapshot.

But this method was seen to be somewhat clumsy. In many machines, for example, it was not possible to obtain a picture, when taken in this fashion, of anything directly below. The business of changing plates, also, was found to be an awkward one.

So it was seen that there was need for something in the nature of the automatic camera, specially designed for military work. In Germany, where great interest has been evinced in aerial photography, a camera with a special telephoto lens, operating almost like a gun, has been devised for use in an aeroplane. This machine the observer holds to his shoulder, "aiming" it at the object which he wishes to photograph, and making the exposure by the pulling of a trigger.

In England, where private enterprise has outstripped any official action, Mr Thorne Baker has devised a very ingenious camera. This is suspended below the aeroplane, in such a position that it points directly downwards; and the whole operation of the camera is automatic.

The airman or observer puts the machine in action by pressing a button. This causes a photograph to be taken of whatever the aeroplane is passing over at the moment. Then, by means of another piece of automatic machinery, a plate is changed for a fresh exposure. Such a camera as this will, undoubtedly, prove of very considerable value as an adjunct to survey work with an aeroplane.

At the end of August, 1911, several military officers in France carried out special tests with aerial photography. They made flights over fortresses, for example, and secured excellent pictures. Tracts of country were also photographed, as were troops on the march.

The result is that photography has joined wireless telegraphy, in the French air-corps, as a definite aid to aerial reconnoitring.

[image]

WAR MONOPLANES "VOL PLANE."
In the above picture, a two-seated, military type Bristol monoplane is seen descending, with engine stopped and propeller motionless, from a reconnoitring flight. Pilot and passenger are plainly discernable.

NINTH SECTION DEVELOPMENT OF ALL-WEATHER WAR AEROPLANES

I. Flights in thirty-five-mile-an-hour winds—Arguments of sceptics—What the great contests of 1911 proved.

Reference has been made to the fact that, as soon as engines became reliable, and airmen gained confidence, winds of an appreciable velocity were successfully combated.

But even now, despite the strides which the aeroplane is making towards becoming an all-weather machine, those who belittle it from the military point of view, and uphold an official policy of inactivity, are found ready to argue that the heavier-than-air machine is still purely a fine-weather craft. Such an attitude is governed, not so much by deep-rooted conservatism, as by ignorance.

The fact is that the wind-flying capabilities of an aeroplane have been improved to an altogether remarkable extent. So far as an average can be struck, it may be said that, at the present time, a war machine can be operated, and can carry out useful work, in a wind blowing at the rate of from thirty to thirty-five miles an hour. Higher winds are, as has been said, occasionally combated; but

this represents, approximately, the maximum for practical purposes to-day.

Some military critics, when such facts as these are adduced, raise the point that such "air-worthiness" as this is not sufficient. The complications of war are already so great, they declare, that a Commander-in-Chief is not justified in increasing his responsibilities by saddling himself with a squadron of aeroplanes, when the machines will be inoperative should a high wind spring up.

"Enthusiasts do not seem to realise this point," a military critic has observed, in regard to the general question of aeroplane reliability. "A commander of troops would, almost, be more hampered than helped by an air service, were it only possible to use it one day, and then not the next, and so on. He would rely upon it, you see, and then it would fail him just at some critical moment. I know it may be said, in answer to this, that even if only occasional use can be made of aeroplanes, it is worth while to equip an army with them, because, if they succeed in their object once in six times, they may alter the whole course of a battle. But it must be remembered that a very considerable organisation has to be built up, if an aeroplane service is to be of any real use. The already huge impedimenta of an army has to be added to; and this, alone, is a very serious point. On account of the unreliability of the air service, also, cavalry scouts, and other scouting agencies, have to be employed, just as usual. The position is, really, a somewhat unsatisfactory one. For days on end, if the weather is bad, the aeroplanes may be inoperative."

This view is, of course, an unduly pessimistic one.

Having regard to the capabilities of present-type aeroplanes, the occasions upon which war machines would be windbound would be very rare. It is reliably estimated, in fact, that aeroplane scouts would be able to render good service on 80 per cent, of the days of the year.

It might happen that a boisterous wind, rising in the morning, would prevent the air-scouts from working at midday, or during the afternoon. But, even during a generally unfavourable spell of weather, a shrewd Commander of aeroplanes should be able to snatch an hour's lull in the wind, probably in the early morning or evening, and get his machines to work.

Either a morning or evening calm, during a period of gusty winds, is generally experienced; and, in any such lull, so rapid is their work, the aeroplanes should be able to acquire what information is necessary, and be back again at Headquarters, before any hazardous rising of the wind takes place.

In this way, it should be possible to manipulate the service, even with existing machines, so as to make it of practical value, upon almost every day of a campaign; and the fact that one hour's work would probably be sufficient for a reconnoitring flight, is the important factor of the situation to be remembered.

The point to be made in this connection is this: those who have studied the

progress of aeroplaning, and realise the wonderful strides which have recently been made, see quite clearly that, even under unfavourable conditions, a war machine should be able to give a very good account of itself.

This fact will not be admitted, however, by those who still maintain the attitude that the aeroplane is a fair-weather machine, and will never be anything else. Their prejudice will not permit them to read, as they should, the lessons of recent events. They magnify failures, and ignore successes.

For such a negative policy there was, at first, some excuse, although scepticism, at the dawn of a new industry, is the reverse of helpful. When aeroplanes were in their crudest stage, they provided plenty of material for the cynic. In those days, pilots spent most of their time in their hangars, tuning up obstinate engines; and it was a case, as one humorous pioneer put it, of flying "a mile a month."

The prevailing spirit of scepticism was well revealed in the attitude taken up by many people in connection with the prize of £10,000 offered by *The Daily Mail* for the flight from London to Manchester. To imagine that such a feat would be accomplished was regarded as ridiculous. And yet, practically at the first attempt, the flight was made. Then came the second £10,000 prize by the generous and far-seeing proprietors of *The Daily Mail*—this time for a 1000-miles aerial tour around Great Britain, in which rules were introduced to make it incumbent upon pilots to complete the whole course upon one machine.

Here was a leap, indeed. From 180 miles to 1000! Could it be done? Could such a reliable aeroplane be found? These were the questions asked; and, in this connection, one significant fact may be mentioned. It was this: even some of the experts—men thoroughly well acquainted with the industry—were doubtful as to whether this prize would be won. They knew, of course, what giant strides were being made. But, still, so severe was the ordeal, they had their doubts.

What a triumph this great contest was for the aeroplane will be fresh in any reader's memory. Flying neck and neck round the 1010-miles course, Beaumont and Vedrines astonished the world by the certainty of their aerial progress.

Calculations as to when the race would finish had been made beforehand. Reckoning the very highest speeds it would be possible to attain, and assuming an entire absence of mechanical troubles, it was estimated that the winner would complete the circuit at a certain hour on a specified morning; and the winner, Beaumont, was only four hours longer, in completing the course, than the most favourable estimate had allowed him.

Even the most enthusiastic supporters of the aeroplane were astonished by this feat. In flying, which was spread out over several days, and involved aerial journeys over most difficult country, Beaumont and Vedrines made light of every adverse condition. In Scotland, they combated winds so violent that

their machines danced and plunged in the air, and occasionally "side-slipped" for many feet under the treacherous impulses of unexpected gusts. But, when they were begged to wait a while, and give the weather an opportunity of improving, these two champions resolutely took their seats in their monoplanes, and flew on. The lesson, from the military point of view, was overwhelmingly important.

Not only did these two men fly with the regularity and speed of express trains, but they both performed their wonderful feats on machines which were unchanged throughout. This represented the real progress. In previous contests of a similar nature, in which long distances had been traversed, there had been no restriction at all as to the number of machines used.

The result had been, therefore, that makers of aeroplanes, naturally anxious to see their representatives win, had dotted spare machines all over the route; and, in one instance, a competitor used as many as three aeroplanes before completing one long-distance race.

The point we are immediately concerned with is this. A certain number of days, chosen a long time ahead, were set apart for this 1000-miles race round Great Britain; and upon these days it was flown. Beaumont and Vedrines proceeded from stage to stage, flying to schedule, and making light of adverse weather. The climatic conditions, as has been said, were not ideal. When the time came to leave Edinburgh, for instance, so powerful a wind was blowing that it was not reckoned, even by practical men, that the pilots would be able to get away.

But, to the amazement even of officials, the two monoplanists soared up, and deliberately fought the wind. While flying on to the other stopping-places in Scotland, also, both men passed through heavy storms of rain; and again, contrary to expectation, they did not descend, but battled on. The result was that, when this wonderful air race was at an end, both men were justified in describing their monoplanes as all-weather machines.

What this performance, and others, have demonstrated is this: at the present moment, although admittedly experimental, the aeroplane is sufficiently well able to combat adverse weather as to make it a highly-useful weapon of war.

II. Value of high speed, when combating a wind—Constructional difficulties of a hundred-mile-an-hour machine.

It is unwise to regard the capabilities of the present-type aeroplane as representing, in any way, a limit, or a standard of achievement. What the machine built to-day can perform, the aeroplane of to-morrow will, assuredly, be able to

improve upon; and so progress will be recorded, until something in the nature of a perfected aircraft is evolved.

As a matter of fact, there is practically no stage, in connection with any forms of manufacture, when a builder can say: "Here is a machine incapable of improvement." Take, as an example, the motor-car. The luxurious, six-cylindered machine appears to represent what may be termed "the last word"; but small improvements are constantly being made, and thoughtful manufacturers still see new avenues of progress.

So it is in regard to the wind-flying capabilities of an aeroplane. Thirty to thirty-five miles an hour represents, as has been said, a fair maximum for the strength of wind in which a machine can be navigated at the present time. But this will not exist long as a standard; improvements in the speed, and in the general stability of machines, are being made from day to day.

The result of this progress in manufacture will be that the aeroplane will be navigable in higher and higher winds. Forty-mile-an-hour winds will, before long, cease to prevent regular flight; and it is the view of eminent designers and builders that it will be possible for the aeroplane to remain aloft in winds blowing at the rate of more than fifty miles an hour. It is hoped, in fact, that machines will, eventually, be able to live in any wind save such a raging gale as drives big steamships to port.

Already, certain definite lines of improvement suggest themselves to the makers of aeroplanes. In combating a high wind, failing any device to provide an aeroplane with automatic stability, high speed is found to be of the greatest aid. But there are difficulties in connection with the attaining of high speed, as will be shown later.

An illustration of the value of high speed, in overcoming the wind, was giving at the Rheims flying meeting in the summer of 1910. Morane, testing a monoplane fitted with a motor of a hundred horse-power, attained a speed of quite eighty miles an hour. Travelling at this rate, he found that he was able to pass close behind other machines, despite the rush of wind from their propellers. Had he been flying a slower machine, this "back-draught" would, inevitably, have caused him to capsize.

Speed, also, was what helped Beaumont and Vedrines, when they were fighting adverse winds in the Circuit of Britain. Beaumont's monoplane had a speed of a little over sixty miles an hour; and that of Vedrines was a trifle faster. Had either of these airmen been piloting a slow-flying biplane, he would have been forced to descend, seeing that his machine would have become unmanageable in heavy gusts.

Speed, therefore, is the aim of most manufacturers. They see that the aeroplane must, if it is to compete commercially with land or sea transit, provide

a means of locomotion more rapid than any which at present exists; and they recognise, also, that speed offers—at any rate at present—a solution of the problem of all-weather flying.

But there are, as has been hinted, difficulties in the way of large increases in speed. Two hundred miles an hour through the air is, frequently, cited as the ideal to be aimed at. So far, with a specially-built racing machine, a speed of approximately a hundred miles an hour has represented the maximum attained. Such machines are, however, more or less "freaks"; the best results obtained with ordinary machines being from sixty-five to seventy miles an hour.

Higher speeds still might be thought to be merely a question of increasing horse-power. But other considerations enter into the question. A high-speed machine has, it must be remembered, to start away from the ground, and land again at the end of a flight; its actual passage through the air is not the only point to be considered.

With a racing monoplane, for example, the small size of its supporting wings, and the slight camber upon them, necessitate its moving over the ground at a very high speed before it can obtain the necessary "lift" to get into the air; and then comes the question of returning to the ground again. These fast machines will only glide at comparatively high speeds.

A problem arises, therefore, as to the landing chassis which will withstand the shock of high-speed landings—that is to say, on anything save perfectly smooth ground. Apart from the question of the skill of the pilot, in effecting a safe descent at such high speeds—and this is a factor seriously to be reckoned with—the running-wheels and skids of a machine will not endure the strain of a landing on anything like a rough surface.

Thus, were speeds to be pushed, say, to a hundred and fifty miles an hour, under present conditions of flying, and with any existing method of building landing mechanism, accidents would be likely to happen, when airmen came to the point of effecting a descent.

Also to be reckoned with, is the question of increasing the structural strength of machines in order to meet the wind pressure of very high speeds.

III. Variable-speed aeroplane—Plans for constructing aircraft of this type—Advantages of such a machine.

As regards the problem of a fast, and yet reliable aeroplane, which is an especially important one from the military point of view, seeing that machines will need to operate over all sorts of country during a campaign, the view is now taken, by eminent manufacturers, that something in the nature of a variable-speed aircraft

will need to be devised.

If this can be evolved, it certainly promises a solution of the problem. What the question resolves itself into, as can be seen, is this: there are very distinct limits to the rate at which it is practical to move across the ground on preparing to soar, and also to the speed at which it is feasible to return again to earth.

The variable-speed machine seems destined to meet these difficulties, and makers are busy with plans for the building of aeroplanes of this type. The immediate aim is to produce, if possible, an aeroplane with a maximum speed approaching, say, a hundred miles an hour, and a minimum speed of about thirty miles an hour.

In this way, adequate use would be made of the air as a speed medium and, at the same time, it would be possible to effect satisfactory landings on fairly rough ground, as well as on smooth surfaces. For the production of such a variable-speed machine, several designs have already been prepared; but, as yet, each awaits the ordeal of a practical test.

One plan, for example, involves the altering of the angle of incidence of the planes, while a machine is in flight. The angle would, that is to say, be made steep for slow flight, and flatter when high speed was required. Another device aims at obtaining variable speed by a process of reefing the planes of a machine. This would be done by reducing, or rolling up, the rear extremities of the plane surfaces.

According to this system, a machine would have its slowest speed when its maximum amount of sustaining surface was in operation, and would fly faster as the pilot gradually brought into play the reefing process.

A third scheme which is suggested deals with the telescoping of the plane-ends of a machine, thereby reducing the lifting surface.

Of these methods, the one most favoured, having regard to its practicability, is that of slightly altering the angle of the planes; and several manufacturers are already busy with experimental machines of this type. It appears likely that actual tests will, before long, be attempted with an aeroplane thus equipped.

For military work, a variable-speed machine promises to be exceptionally useful. The high speed would be employed in weathering a gusty wind, or in moving rapidly to any desired locality, when about to carry out a reconnaissance. Then, when a detailed observation was being made, the slowest speed would be adopted, so as to give the observer plenty of opportunity of studying what lay below him.

The production of a practical machine, embodying the principle of variable speeds, is now held to be merely a question of time, and of careful experiment. Therefore, the promise of the immediate future, particularly as regards the military aspect of flying, is most hopeful—both from the point of view of wind-flying,

and of reliability.

One by one, indeed, the objections against the military aeroplane are likely to be overcome, until a machine is an accomplished fact which will meet all practical requirements.

IV. Power-plant of aeroplanes—Fitting two engines to obviate involuntary descents.

While writing of aeroplane development, mention should certainly be made of engines. It has been shown, already, what a wonderful step forward was made with the introduction of the revolving "Gnome." This engine will operate with the reliability of that fitted to a motor-car; there are other types of engine now achieving thoroughly good results; and they promise to do better in the future. From the point of view of propulsion, therefore, the future of the aeroplane appears assured.

One great objection of sceptics, in regard to the power-plant of aeroplanes, has been that, should an engine fail, a machine is compelled to make an involuntary descent. In answer to this criticism, advocates of the aeroplane have pointed out that motors are becoming more and more reliable, and that such stoppages are already reduced to a minimum.

It is now seen that it will be possible to prevent involuntary descent, when flying across country, by equipping aeroplanes with a reserve powerplant.

One of the most interesting experiments, in this regard, is being carried out by Mr Horace Short, the aeronautical engineer of the Royal Aero Club.

Mr Short produced, in September, 1911, a biplane fitted with two "Gnome" engines. One, placed in front of the machine, operated a couple of tractor propellers fitted before the main-planes. The other, installed at the rear, actuated a single propeller. The machine was designed so that one engine would drive it at a speed of about thirty-six miles an hour; while, if both were employed, its pace would increase to more than fifty miles an hour. In actual tests, most encouraging results were obtained with this machine, and Mr Short is now perfecting this type of twin-engine biplane.

By equipping an aeroplane with two engines, working independently of each other, the danger of an involuntary descent, on bad ground, is obviated.

Should one engine stop, the pilot can keep himself in the air with the other.

In such a machine as this, which might be described as a "safety" aeroplane, the weight of the additional engine is, of course, a consideration, but in cases where exceptional reliability is required—say, for example, when a most urgent dispatch has to be taken across country from point to point in military

operations—a dual-engine machine will probably be used.

Consideration of such facts as have been cited in this section show that aeroplanes, for military work, have an almost unlimited field for improvement. Therefore, any nation which neglects war machines now, on the argument that they are unreliable, is pursuing an extremely foolish policy. If feats such as have been recently accomplished are possible, with machines built with wood, wire, and canvas, what will not be achieved with the stronger, speedier, heavier aeroplanes, such as are already being constructed?

Sceptics there are, of course, who may be found ready to say that the aeroplane will never be made reliable; but their contentions are being proved to be wrong from day to day. Already, with the simplest possible apparatus, a remarkable stage of efficiency has been reached. And now the aeroplane promises to embark upon a new era of construction.

Wood is being replaced by metal; and extreme lightness is no longer the insistent demand. Aeroplanes are being built for general, everyday use.

From the military point of view, the aeroplanes at present available have drawbacks. There is, indeed, room for vast improvement. Greater strength, greater reliability, greater portability—these are the aims that makers have in view; and they will, without doubt, be realised.

The War Office tests this summer will teach manufacturers many a useful lesson.

TENTH SECTION THE TRAINING OF ARMY AIRMEN

I. French thoroughness—An expert's tribute—Sound training all-important.

It is now possible to deal with one of the most important considerations in connection with military aeroplaning. This concerns the training of pilots and observers at the military flying schools.

France is devoting herself energetically to this work. Germany, now

equally "keen" upon military aviation, is establishing schools in all suitable places. Russia is convinced that the right policy is to create a large and efficient corps of airmen. So is Austria, Japan, as representing earnest progress, is not only training men at home, but is sending a large number of officers to the various schools in Europe.

As has been set forth before, in another connection, but should be emphasised again here, the true policy as regards military flying, in the present stage of development, should be: "Test all new machines that are introduced; maintain a fleet sufficient to meet any emergency which may arise; and, above all, train men with the object of acquiring a far stronger corps of pilots and observers than any present situation demands."

[image]

MAPS FOR MILITARY AIRMEN.
Photo, M. Roe.
The French authorities are busy with the preparation of a complete set of "air maps" for the use of the military pilots, when flying from point to point. A section of one of these maps—which are coloured—is illustrated above.

Here, at any rate, is the clear-cut policy both of France and Germany—a policy which Russia is beginning to imitate, and a policy, also, that Japan is following.

Having toured France quite recently, an expert thus describes the activities at the French flying schools. "Those who are not directly in touch with the various Government departments cannot estimate how many airmen there are at work. Flying schools seem to be springing up everywhere. Depots are being established all over the country. Officers are flying from place to place every day. To see a military machine, carrying a pilot and observer, passing swiftly overhead, is now quite a common sight. Orders are being received almost daily at the military camps, instructing a machine to set forth upon a reconnoitring flight, or to carry a dispatch from one camp to another.

"It is the thoroughness, and the business-like way in which this work is done, that are so impressive. An order for a reconnoitring flight is received. Promptly the officer and his observer prepare themselves. The aeroplane, properly tuned up, is all ready, and is quickly wheeled from its shed. They mount to their places, and are away.

"Directly afterwards, perhaps, another machine is ordered out. In the early

days of flying, one was prepared for a delay of several hours when an airman set out upon anything like a long flight. His engine had to be tuned up with laborious care; there were a hundred and one details that had been forgotten, and had to be put right after the machine had been brought out of its shed. Now, contrast this wearisome delay with the promptitude of the French officer-airmen. There is no feverish rush and bustle at the commencement of a flight. The propeller is turned; the motor fires at once; and the machine takes the air.

"This, of course, is the direct fruit of training. This familiarity with machines, and with the routine of flying, is the reward which France is already gaining for her devotion to military aviation, and her unsparing efforts to make her service thoroughly efficient.

"The way in which the aeroplanes are kept in trim, and the cool, alert manner in which they are handled, come as revelations to a man who has only seen the machinery of flight as it is in operation at an ordinary flying school. Particularly is one impressed by the skill, and good organisation, among the engineer-mechanics at the military stations.

"The use of the aeroplane, for purposes of war, necessitates a vast amount of training for every unit engaged in the aerial work, and, without such training, nothing in the nature of real success can be attained."

This tribute provides an indication of the practicability of the military training now proceeding in France. Efficiency is, indeed, the constant watchword. Operating with a war weapon that is new and strange, the French military authorities have already worked wonders; and their success is due to the organisation they have been able to introduce at their flying schools.

Very carefully considered, in every way, is the course of instruction through which an officer-airman is called upon to pass. The aim is to make him proficient in every respect. For military purposes, it is not sufficient for an officer to be, say, a fine "fancy" flyer, and ignorant in regard to engines, or a skilled engineer and an indifferent pilot. He must be a thoroughly all-round man.

II. How the military airman is "schooled"—His course of instruction described.

The novice who comes to the French military schools is given a course of general tuition. He is first brought to study flying in its broad aspect, and not as regards detail. This period of general "schooling" may last for two or three months, during which the beginner makes it his business to study aeroplanes, and their motors, very carefully. He acquaints himself, for example, with the method of control employed in the various machines.

Then, as regards motors, he has much to occupy him. He will take an interesting engine like the "Gnome," for instance, and make himself thoroughly conversant with all its details. The value of such preliminary work is often shown subsequently when, perhaps, an officer may be stranded some distance from Headquarters with a jibbing engine.

Instead of being helpless in such circumstances, his previous period of tuition stands him in good stead, and he is able to run over his motor with an expert eye, and so discover the little defect which may be causing all the trouble.

Apart from the "Gnome," there are other makes of engine in the aviation school to which the pupil may direct his attention, with good results. Thus the novice acquires a general knowledge regarding aeroplanes and their motive power, and prepares himself for the second stage of his tuition.

This resolves itself into a series of flights, which end in his taking control of an aeroplane himself. But, first of all, he takes his place in the passenger-seat of a military machine, and is piloted round the aerodrome by an officer-instructor of proved skill. For his first few flights, the beginner merely sits in the machine, and accustoms himself to the novel experience of being in an aeroplane.

This first acquaintance with flight generally proves confusing. The engine of an aeroplane makes a din which is trying to the novice. Then the pace of the machine, when it moves across the ground, and the rapidity with which it soars in flight, are confusing, also.

It is, therefore, a sound policy to allow a beginner to make several trips with an experienced officer, before he attempts to control a machine himself. By so doing, the pupil has an opportunity of getting over his first bewilderment, and contrives to be in a fairly cool and collected frame of mind when his turn comes to assume control of the levers.

After several trial journeys have been made, and the novice is no longer embarrassed by the strangeness of his position, he is allowed, by his instructor, to exercise temporary command over the aeroplane while it is in flight. This is accomplished by means of a dual control; a set of levers are before the pilot, and another in front of the pupil.

The former, after warning his charge to be ready, relinquishes his hold upon the levers, and the pupil takes charge of the machine. The instructor, of course, keeps a keen eye upon the behaviour of the machine; should the pupil make an error, the pilot is able to rectify it before there is any chance of an accident.

By this admirably practical system, a pupil can be led to a satisfactory state of proficiency without risk, either to himself or to his instructor. After he has controlled the machine, for a spell, during straight flights, he is given the opportunity of making a turn in the air.

This operation requires the exercise of skill and judgment. Apart from mov-

ing the rudder, or rudders, which send the machine round, the pilot needs to operate his "ailerons," or wing-warping device, as the case may be, in order to "bank" the machine over, and so facilitate the turning movement.

As soon as he shows sufficient skill in controlling an aeroplane, while with a pilot, the pupil is given an opportunity of flying by himself. As a rule, his previous tuition has been so valuable to him that he finds little difficulty in performing a solo flight, and so prepares himself for the obtaining of his certificate from the French Aero Club.

This certificate of proficiency is obtained by making a series of flights before official observers, and in maintaining a certain altitude, while so doing. A descent has also to be made with the engine of the machine stopped, so as to demonstrate the pilot's ability to effect a *vol plané*.

In the case of a civilian airman, the passing of this test is considered sufficient evidence of his ability to control a machine; but, as regards French military airmen, a greater degree of proficiency is required. Therefore, when he has acquired his Aero Club certificate, the officer-airman has to prepare himself for another ordeal.

The French military authorities demand that he should make a long flight across country, that he should remain in the air for a couple of hours without descending, and that he should demonstrate his capabilities by piloting his machine in a fairly-high wind.

After this, he is regarded as a man well qualified to study the actual work to be undertaken by an airman in war-time. The next stage, as a matter of fact, is in learning to observe over a given tract of country.

In this test of his skill, a superior officer indicates for him an aerial route, which covers a fairly-wide district in the vicinity of the air-station. The pupil flies over this, and, on his return, presents a report upon what he has seen while in the air.

This report—which deals with roads, railways, and the general characteristics of the country—is examined by his chief, who points out in whatever way it might have been improved, probably in the direction of military precision, or in the statement of more detail. Then the pupil flies over the same, or another route, on another day; and so on.

No pains are spared to make him acquainted with his work. It is an axiom, at the French schools, that a pilot should be so accustomed to flying that the actual manipulation of his machine becomes mechanical. When such skill is attained, the airman is free to devote his mind to whatever work is on hand; but such a state of proficiency can only be acquired in one way—and that is by constant flying.

After he has become accustomed to observing from his machine while it is

in flight, the pupil is set a variety of other tasks, at the discretion of his instructors. He is, for example, detailed to fly across country from point to point, bearing a message, and to return with another dispatch. Cross-country journeys, from one flying school to another, are also encouraged.

In this way, by actual practice in the manipulation of his machine, and in the carrying out of tasks such as he would be set in time of war, the pupil gains skill and confidence, and eventually becomes a thoroughly well-trained and proficient member of the air-corps.

III. Rules for training—Dummy aeroplanes—A pupil's first "hops."

Some admirable hints, as to the methods which should be adopted in teaching airmen, have been given by foreign military experts.

An officer of great experience, for instance, declares it essential that the pupil should first devote himself to a theoretical and practical apprenticeship in regard to aeroplane motors. He should, he also declares, be called upon to detect the reason for any stoppages intentionally caused by the instructor.

This officer also advocates the driving of motor-cars, at high speed, as a useful preliminary stage for intending military airmen, holding that such rapid driving gives a man a judgment of pace and distance which he would not otherwise possess.

It is contended, also, by other authorities, that ascents in free balloons are of value, as a preliminary to actual aeroplaning. Such ascents, in the opinion of these experts, help a man to gauge heights, and so prove of value to him in subsequent tests with aeroplanes.

While doing a brief course of ballooning, the officer can, it is pointed out, study the contour of the ground below him, and can also make himself acquainted, to a certain extent, with the use of maps and compasses. He may also practise aerial photography.

What other practical authorities have found of value, and what they recommend as a stage in the tuition of an officer-airman, is a day or so during which a pupil takes the driving-seat of a military machine, and practises—on the ground—the manipulations which he would have to make were the aeroplane in actual flight.

When the novice is thus in the driving-seat, it is suggested that an instructor should put him through a regular lesson—asking him, for instance, what manipulations of his levers would be necessary to effect a turning movement.

Such a plan is, undoubtedly, of value. Preliminary work of this kind, con-

ducted by a pupil while on the ground, in order to accustom him to the handling of a machine, before actually taking the air, is encouraged at many civilian schools; and, to facilitate such practice, several ingenious machines have been devised. In one of them, the pupil sits in a wooden framework, which is balanced on a pivot, and is equipped with a forward elevating plane, and "ailerons."

When the beginner is ready for a spell of practice, the machine is turned, so that it faces the wind. Then the pupil takes his seat, and grips his levers. The balance of the machine is such that any gust has a tendency to make it tilt over from side to side, or tip forwards or backwards. If he is quick enough, the pupil can check these overturning influences by movements of the controlling planes. Thus he obtains, without risk to himself, or the danger of damaging an aeroplane, an insight into the general principles of control.

Also emphasised by many experts, is the value of a stage in military training which has already been described—that in which a pupil is taken, for a series of passenger flights, by an expert airman. During these flights, of course, the novice is learning many practical lessons.

Other authorities advocate, as a definite stage in a pupil's course of training, an exercise which has not previously been touched upon. This entails arranging a machine so that it will move along the ground at a high speed, but will not ascend. The beginner should be allowed to manipulate such a machine for a day or so, running it up and down the aerodrome. Such a period of "rolling," as it has come to be termed at the flying schools, should be sandwiched between the pupil's flights as a passenger, and his first attempt at solo work.

The first of these "rolling" tests should, it is held, be undertaken with an instructor. When he can control a machine perfectly well on the ground, the novice has learned a very useful lesson. In this "rolling" work, he becomes accustomed, also, to operating his engine controls, and shakes off the confusion that the noise of the motor so frequently occasions.

The pupil's first solo flights should be nothing more than short jumps off the ground, made while moving along in a straight line. At the flying schools, these attempts at flight, on the part of novices, are described as "hops"; and, when performing them, the beginner resembles a young bird which is first trying its wings. He flutters into the air for a yard or so, and then descends again—not always elegantly.

"Hopping" practice, if systematically carried out, obviates the breaking-up of many a machine, because it teaches the pupil how to make a descent. Landing is, it may be pointed out, the chief difficulty for the beginner. He can usually get into the air all right—sometimes, more quickly than he desires. The problem is how to return to earth again, making a correct descent.

When a man learns to ride a bicycle, the inevitable tendency, which he

displays, is to overdo the balancing movements. The result is that he swerves abruptly from side to side, and frequently comes to grief. The same mistake is, to a great extent, made by the novice in flying. He jerks his machine off the ground with an over-abrupt operation of his elevating plane, and he sometimes descends with a disconcerting dive.

It is not until he has been practising for some little time, that a pupil obtains what has been described as the "feel" of his machine. What happens, really, is that he suddenly obtains a sensitive touch upon his controlling levers; and then, instead of obeying his instructor without appreciating exactly what he has been doing, he begins to act for himself—with the commencement of that feeling of sureness which reveals the expert.

From "hops," according to expert ruling, the military pupil should proceed to straight flights of gradually increasing length. This recommendation presupposes the possession of an aerodrome of ample size. Nothing is, as a matter of fact, more important than a commodious aerodrome for purposes of instruction.

The selection of a ground which is cramped, or in a bad position, is very poor policy. Unless he has plenty of manoeuvring space, a pupil acquires a feeling of nervousness, which is sometimes disastrous. Under the influence of it, when he first assumes sole control of a machine, he is occasionally induced to make mistakes which result in the wrecking of machines.

A wide, flat, perfectly-unobstructed space is the ideal. When he brings his machine out upon such an aerodrome, the novice is inspired with a confidence which is half the battle. He feels he has not got to do things in a hurry; he knows there is plenty of room.

As soon as straight flights can be accomplished, the pupil should, it is held, be set the task of learning to "bank" his machine over, and make circles. The thoroughness of the pupil's tuition, up to this point, should stand him in good stead. He knows his motor; he knows his machine; he is familiar with his controls; he is not flustered when he is in the air.

All such points count enormously—added to the fact that we assume the aerodrome he is practising over is a good one. In such cases, the pupil should be able to make wide turns in the air without any trouble at all.

Afterwards, the budding airman should learn to fly high. "Climbing" is what experienced airmen call it. Here, again, the requisite for success is a pupil's confidence in himself, and in his machine—is inspired by the stages through which he has previously passed.

As has been quite rightly stated, the airman's need, before he attempts anything in the nature of high flying, is to feel perfectly at home on his machine. He must have no anxiety as to any possible mistake in his controlling movements; he must not be worrying about his engine. In a word, he must have a perfectly-

undisturbed mind.

This mental state is brought about, of course, by feeling perfectly competent to deal with any emergency, should it arise. By the time he has reached the high-flying stage, any pupil should—if he has been thoroughly trained—begin to experience a feeling of "one-ness" with his machine.

IV. Cross-country flights—The *vol plané*—Difficulty of first observation tests from an aeroplane.

"Only when it is possible to control a machine with safety, and without anxiety, at a height of 600 feet, should the military airman attempt to fly across country."

This declaration, made by an acknowledged authority, is a perfectly sound one; and, so far as the military flying schools are concerned, it represents a rule now almost generally adopted.

A most necessary step, before setting forth on a cross-country flight, is to master the art of effecting a safe and steady *vol plané*. The airman, when he is on a cross-country journey, must be ready at any moment for his engine to miss-fire, and perhaps stop. With the reliable motors now obtainable, this is not likely to happen, as has been shown; but engine failure is still a contingency for which the pilot must be prepared.

We will suppose, for the sake of argument, that a military airman is flying at an altitude of 1000 feet, across an average country. Suddenly, with a splutter, his engine ceases to work. If he is dexterous, he is not nonplussed. With a movement of his elevating plane, he tilts the aeroplane upon a downward glide, and comes sweeping towards the ground. Experience tells him just what is a safe gliding angle; he does not pitch his machine too far forward, nor does he make his angle so fine that there is any chance of the aeroplane losing way, and so becoming unmanageable.

As he glides down in this fashion, with perfect control over his machine, although it has been deprived of motive power, he looks about keenly to select a suitable landing-place. He is not forced to keep gliding straight ahead. He can, if he elects, turn either to right or left; and it is possible to make a half-circle in the air, while gliding down, and so land upon some spot which lay beneath the machine at the moment the engine stopped.

Therefore, granted that fairly-normal country lies below, the airman should have plenty of time, from an altitude of 1000 feet, to select a landing-place, and make a fair descent upon it.

If a pilot knows, thoroughly well, the kind of country he is flying over, and no difficulty presents itself in finding a landing-place, he can fly comparatively

low, if he prefers to do so. By this is meant an altitude of perhaps five or six hundred feet.

If the country is difficult, however—that is to say, if fair landing-places are not easy to find—it behoves the airman to attain a considerably greater altitude. Over unfavourable country, from the landing-point of view, an experienced pilot will maintain a height of 2000 feet, or more. He does this because, should his engine fail him, he will have plenty of time to pick out—from a considerable area of country around him—some fairly-suitable descending-point.

In the flying contests held last summer, the most expert pilots, such as Beaumont and Vedrines, flew across country at an altitude of about 3000 feet. What influenced them, in doing so, was the knowledge that any wind that is blowing is generally most steady at such altitudes.

Once he is able to fly across country, without worrying at all about the control of his machine, the military airman is ready to take up the practical tasks which await him. One of the most interesting experiments, which he will be asked to carry out, is to fly over bodies of troops on the march, and test his powers of observation. It is one thing, of course, to see troops below him, and another to render an accurate report as to their strength and formation.

One of the most expert of French military airmen describes, very interestingly, how a reconnoitring officer seeks to render accurate his observations of troops; and his remarks go to prove, very distinctly, that nothing but unremitting practice will create a reliable air-scout—a contention which is made by all experts upon this subject.

The strength of columns on the march—when seen from the bird's-eye view of an aeroplane—should, says this officer, be estimated by comparison, on the airman's map, with the length of the road along which they are marching.

Massed formations of troops should, he adds, be determined according to the open spaces separating the various units. From the airman's point of view, other clues to the strength of an enemy are the number of waggons, the number of mounted officers (in the case of infantry), and so forth.

It will be seen that, although the elevation of an aeroplane gives the observer a unique advantage, reconnoitring from an altitude of, say, 3000 feet is by no means easy work; the point of view is strange, and new rules have to be made, if reliable information is to be forthcoming.

With adequate practice, of course, an observer becomes remarkably quick in estimating the import of what he sees below him. Details, which would mean nothing to the novice, frequently tell him the whole story.

Thus a novice becomes, in time, a thoroughly-expert airman, capable of carrying out, satisfactorily, all the tasks that are set him. To encourage military pilots at their work, the French authorities have very wisely instituted a special

scale of pay—or, rather, an arrangement of bonuses—for flights effected.

Naturally, such practical encouragement is greatly appreciated by the officers who take part in the air service. The work is arduous, beyond all question, and the men who are engaged upon it now are pioneers. All that they discover, through dint of enthusiastic and self-sacrificing work, is to the benefit of those who follow in their footsteps. Therefore, they richly deserve all the practical aid that can be given them.

V. Finishing work at French schools—Practical tests—German thoroughness—Energy of English officers.

Having described the instructional work at the French flying schools, it may be interesting to show how practical tests are carried out—almost every day—to prepare the officer-airmen for the duties which they will be called upon to perform, in time of war.

As has been mentioned, the French authorities have now organised flying schools, and air-depots, in many parts of the country; and, when any general movements of troops is being made, the officer in charge of the nearest aviation centre is frequently ordered, by a message from Headquarters, to carry out some special aerial manœuvre.

[image]

THE PILOT'S SEAT.
Photo, M. Branger.
In the illustration above is seen the driving seat of a military-type Blériot monoplane, with the airman's map, in its case, fixed immediately before him.

One example of this excellent system is sufficient. Not long ago, a fairly large body of troops was manoeuvring between Rheims and Chalons. Seeing an opportunity for a practical test of aeroplane efficiency, one of the Generals engaged in the operation sent a message to the officer in charge of the air-depot at Chalons, requesting the services of four airmen, without delay.

The summons was quite unexpected, as it was intended to be; but the military school was not unprepared. Within a few minutes of the receipt of his instructions, the officer commanding the aeroplanes had detailed four lieutenants for service. Their machines were made ready, by the mechanics, with practically no delay at all; and, in less than half an hour, the officers were in the air, and on

their way to the point where they had been instructed to report themselves.

They arrived at the appointed place without hitch or delay, and immediately received orders to reconnoitre specified tracts of country. They were quickly in the air again; and each of the four air-scouts was able to carry out his task with complete success.

Returning to their starting-point, the four pilots duly presented their reports, made out according to the system in vogue. They were then informed that their work was, for the time being, at an end. Whereupon all four took their seats in their machines again, and flew back to the aviation camp.

The point to be emphasised, in this connection, is that the manœuvre was carried out by four scouts. Had one, or even two, performed these flights, it would not have been so noteworthy. But the fact that four machines could make a series of test flights, without prearrangement, and yet without mechanical breakdown of any kind, provides a convincing tribute to the reliability of a well-built military machine.

When no specific reconnoitring flights are on hand, officers from the various French schools are frequently instructed to leave Headquarters in the early morning, and make as long an aerial tour as possible before nightfall, traversing a specified route, and returning to their starting-point.

Such tests as these, of course, demonstrate the reliability of aeroplanes and engines, and also the skill and endurance of the pilots.

One officer, for example, started away early in the morning, and succeeded in flying for a distance of 250 miles between St Omer and the Belgian frontier. A military observer accompanied him; and brief reports, describing the country surveyed, were sent back by means of carrier pigeons.

This flight—typical of many now being performed—occupied practically the whole day. Descents were made, occasionally, to replenish petrol and oil tanks, the aeroplane being followed, on its pilgrimage, by motor-cars laden with fuel and spare parts.

Motor-car gangs, equipped with all material likely to be necessary in connection with a breakdown, are now in readiness at the French air-stations; and they will play a highly-important part when aeroplanes are employed upon active service.

Mention has been made of the thoroughness of the German War Office in regard to military flying schools; and, while citing practical instances, it may be interesting to extract an item from the German general programme.

In one batch, during the summer of 1911, seventeen officers were selected to undergo a special flying course at Doeberitz. These courses lasted a specified number of months, and the officers were drafted from one class to another according to their state of proficiency.

The adequacy of the training, given to the German officer-airman, is revealed in the practice flights which are attempted, immediately the pilots have obtained full control over their machines. Here, for example, is a typical reconnoitring trip. Two young airmen left the Doeberitz aerodrome, and flew over a distance of 400 miles, weathering two severe storms while upon their aerial journey.

The machine they employed was a military-type, weight-carrying biplane, and they took it in turns to steer. Their tour lasted several days; and, in one flight, extending over three and a half hours, they traversed a distance of 149 miles. Motor-cars, bearing spare parts, kept in touch with the airmen; the whole undertaking was admirably organised, from the military point of view.

It is in work like this, of course, that definite progress is made. In connection with such long reconnoitring tours, a German officer of experience has placed upon record the view: "However good you may imagine your organisation to be, a practical test will generally reveal at least one or two false links in the chain; and, of flying, this is truer than of anything else. Once an air-corps is proficient, actual war conditions should be represented as frequently as possible. This will polish up the entire system, and make each unit sure of its work. Unless reconnoitring tests, carried out on a practical war basis, are frequently made, it is idle to assume that your corps is ready to do any valuable work during a campaign."

There is no need, at any rate, to impress the wisdom of this observation upon the French military authorities. Whenever a long reconnoitring flight is accomplished, from one of the flying schools, the officer who is acting as observer is instructed to send a concise service telegram to Headquarters, describing the journey that has been made.

It may be interesting to reproduce the text of such a message, in order to show the business-like way in which the French air-work is carried out. This was a telegram, for example, received in Paris in connection with a typical practice flight:—

> "Lieut, in command aeroplane 11 to War Office. Lieuts. Cammerman pilot. Vullieume observation officer. Left Mezieres 7.10 a.m. Passed over Vervins, Guise, St Quentin, landed north of Amiens at 9.55 a.m. to inquire direction aerodrome. Landed aerodrome 10.30 a.m. Voyage difficult owing mist, which frequently obscured ground. No incident."

Messages, such as this, are now being dispatched and received daily, in connection with the flights organised at the French flying schools. The dispatching of such telegrams is, of course, only a detail of the general work; but it is one of

those items, nevertheless, which needs practice to make perfect.

In the arrangement of non-stop flying tests, the officers in charge of the French schools leave no stone unturned to promote the efficiency of their pupils. As a contrast to long tours, lasting several days, continuous flights, involving a return to the aerodrome before descending, teach an airman useful lessons.

Three instances of such non-stop flights, selected more or less haphazard from the reports received, from day to day, in connection with French military aviation, are sufficient to indicate what excellent work is being done. They are appended:—

"A lieutenant flies with an observer, without descending, over a prearranged course of 100 miles. The flight lasts two and a half hours.

"A lieutenant, carrying a special observation officer, remains in the air for three hours fifteen minutes.

"A lieutenant, taking up a captain as observer, flies for 125 miles, non-stop."

It is by means of flights such as these, carried out regularly, and without ostentation, that the French air-corps obtains the efficiency which is the admiration of those who are in a position to realise what complete organisation means.

As regards England, it should be mentioned that the few officer-airmen who have, so far, been permitted by the authorities to study military flying, have done their utmost to perfect themselves in the art. They are making experimental flights, whenever possible, and are becoming thoroughly competent.

They have proved indeed, beyond question, that England has the right material. All that is wanted, as has been pointed out again and again, is practical encouragement. As a matter of fact, both in "dash" and judgment when flying, British pilots have shown that they need fear no foreign competition.

The cool nerve which is possessed by the English officer-airman was revealed, in a most striking way, by an experience, while flying, which befell Lieutenants Reynolds and Barrington-Kennett—two of the most ardent officers of our Air Battalion.

The adventure occurred while the two airmen were reconnoitring in Cambridgeshire during the autumn of 1911; and it possesses a unique interest, inasmuch as it affords an example of the most remarkable escape from death yet chronicled in connection with the aeroplane.

The two pilots, flying separate machines, were reconnoitring from a temporary aviation camp during the evening, and were passing across country at an altitude of a little less than 2000 feet. The weather was oppressive—a thunderstorm threatening.

Suddenly a violent wind, the forerunner of the storm, began to sweep across country. So powerful was this wind that it tore roofs off sheds. Lieutenant Barrington-Kennett, flying a little lower than Lieutenant Reynolds, felt the force

of the wind first; his biplane tossed and rolled ominously.

Pointing his machine earthwards, and keeping his engine running at its full power, he began to descend as rapidly as possible. But the wind increased in violence, to a remarkable extent. The biplane gave a sudden leap into the air. Then it dropped sheer for many feet. The airman was flung upwards from his driving-seat, and came into abrupt contact with the lower part of his upper main-plane. Then he was jerked back again, coming down half in, and half out of his seat, and smashing the side of it. Fortunately, however, he was able to grip the lever actuating the elevating-plane and "ailerons," and so maintained control of his machine until he made a hurried landing in a field.

Lieutenant Reynolds had an experience far more alarming. Apart from the fact that he was flying higher than his companion, the machine he was piloting was a military biplane fitted with weight-carrying extensions, which made it more difficult than an ordinary machine to control in a wind.

When the first gusts struck him. Lieutenant Reynolds sought to follow the other pilot's example, and make a descent. He had actually come down from 2000 feet to about 1500 feet, when a sudden and overwhelmingly powerful rush of wind caught the biplane, and turned it completely upside-down.

As the machine swung helplessly over, entirely beyond its pilot's control, Lieutenant Reynolds had the presence of mind to switch off his engine. This probably prevented the biplane from rushing pell-mell to destruction. The next thing that the young airman remembers was clinging desperately to the edge of the lower main-plane, having been swung abruptly out of his driving-seat—which was now above his head.

Upside-down, and beyond any possibility of control, the aeroplane began to fall to the ground, which was more than 1000 feet below. It would appear that nothing but a miracle could save an airman under such circumstances as these; and Lieutenant Reynolds, certainly, regarded his chances as being slender.

But, extraordinary as it may seem, the extent of his injuries, in this 1000-feet fall, were a sprained ankle and a general shock; and this is how the miracle happened. The big biplane, being very lightly laden, did not fall sheer to the ground, but came fluttering down like a box-kite. At first, after overturning, it dived a short distance, tail-first; then it came to a halt, and floated down for a second or so, following up this manœuvre by a forward dive, and another period of floating.

Lieutenant Reynolds continued to cling grimly to the lower plane; and the machine came down in a field, still upside-down, and with its running wheels thrust up in the air. At the actual moment of striking the ground, the aeroplane was fluttering, and not diving. This was fortunate for the pilot, as the biplane came in contact with the earth without any great violence.

Many a man's nerve would have been shattered by such an experience, but this was not the case with Lieutenant Reynolds. He was soon flying again, as though nothing had happened. There is, therefore, reason for stating that England has the right material among her few military airmen.

ELEVENTH SECTION THE COST OF WAR AEROPLANES

I. Why manufacturers charge high prices—Cost of experimental work—Building of trial machines.

A decidedly interesting question is that of the cost of aeroplanes. It represents a consideration, also, which is of practical importance from the military point of view.

So far, the price of any aeroplane of a well-known make has been high. An ordinary-type biplane, for example, fitted with a "Gnome" engine, has been selling for approximately £1000. A monoplane of established repute, built to carry a pilot alone, has been listed at £900.

A military-type biplane, capable of carrying three men, has been selling at something like £1200, and a reconnoitring monoplane, for two occupants, has been priced at a figure in excess of£1000. There has, as a matter of fact, been good reason for manufacturers to demand high prices for their machines.

The expenses of a builder of aeroplanes are extremely heavy. His business is not at all like any ordinary commercial undertaking. He does not merely build a machine, and then sell it. He has costly researches to undertake, and wearisome and expensive experimental work to carry out.

Let us take a typical example. A prominent manufacturer in France designed a monoplane, which embodied improvements upon existing practice. Having the facilities of a well-equipped workshop, he speedily put his ideas to a practical test, and commenced the building of a machine.

This occupied some weeks, during which time, of course, the builder had the wages of his engineers to pay. Then, when the machine was ready for tests,

he had to hand it over to his professional aviator—another well-paid employee. The monoplane was taken to the private flying ground which the manufacturer found it necessary to rent; and here, for a week or so, first experiments were carried out, the wages of the aviator being augmented by those of a regular staff of mechanics.

The result of the trials was that, after securing useful data, the monoplane was irretrievably wrecked, in landing after a flight. Whereupon, the manufacturer had to face the expense of building a second machine, embodying further improvements suggested—and going through the whole routine again.

This he did, devoting several weeks of his men's time to constructing the new machine. Once more, when it was finished, the professional aviator took it in hand. This time, after an even shorter career than the first machine, the monoplane was broken up. Again, however, improvements suggested themselves; and so the maker embarked, patiently, upon the construction of a third model.

To cut a long story short, this process of evolution went on until six monoplanes had been built, each one more reliable in action than its predecessor. It was only, in fact, when a seventh machine stood ready, that the manufacturer considered he had a flying machine he could offer to prospective purchasers, as a safe and improved type.

In fixing the price that he should ask for this new model, the manufacturer was guided, naturally, by the outlay that had been necessary in perfecting it. It would have been unreasonable, under such circumstances, for the purchaser to expect to buy the machine at a figure which represented a small profit for its builder, over and above the actual cost of production of that one model. Having spent thousands of pounds upon his experiments, the manufacturer was obliged to recoup himself, by charging a high price for his goods.

Another factor would also govern price in such circumstances as these. The manufacturer would have no guarantee as to selling any fixed number of machines. In the case of a new motor-car, for instance, the machine is standardised; and, if it is a good one, a large number are sold. This, naturally, reduces the price per machine.

But, in the case of this new monoplane, even if it is the best produced at the moment, the question of the number to be sold is an unsatisfactorily vague quantity. After only two or three have been disposed of, for instance, another machine may be put upon the market which is a few miles an hour faster; whereupon, the aviators who are intent upon winning speed prizes quickly devote their attention to the new machine.

As may be imagined, therefore, what with enormously-heavy first costs, and a doubtful sale even when a good machine is produced, the manufacturer of aeroplanes has no alternative but to charge a high price for the machines he does

succeed in disposing of.

Let us consider, for a moment, the experience of such a famous manufacturer as M. Louis Blériot. It was in 1906 that he began experimenting with monoplanes, entirety at his own expense; and he was spending money lavishly on new machines, and devoting a vast amount of time to the problem, until the summer of 1909. Apart from the money he spent, and the aircraft he broke up, he risked his life, on many occasions, in attempting to fly on machines which were entirely experimental.

It was estimated, indeed, that—before this famous airman and constructer flew the Channel, in July, 1909—he had expended a fortune upon aerial research work. It was perfectly legitimate, therefore, that he should endeavour to recoup himself, for all his time and expense, when a sale did spring up for his machines.

It has not been a case, since then, of producing machines of a standard type. Directly he had perfected the simple, low-powered monoplane upon which he crossed from France to England, M. Blériot began experimenting with a more powerful machine; and so he has been engaged ever since.

In his works in Paris, for example, M. Blériot employs a skilled staff of draughtsmen, who are busy every day upon designs for new machines. He must keep pace with his rivals, and he must meet the growing demands of the military service. Faster and more reliable machines are demanded every day, and strenuous efforts must be made to fulfil these demands. Therefore, the expense of running an aeroplane factory is exceptionally high.

These facts are interesting, as they explain why "a few bits of stick and canvas, and an engine," as an aeroplane has been described, should cost as much as £1000. It is not so much the wood, and the canvas, and the engine that the purchaser is paying for, as the months, and perhaps years, of patient toil and ceaseless expense, which have gone to the production of a practical machine.

High prices are charged for aeroplane engines. Here, again, the same causes are at work. Most costly are the preliminary expenses connected with the production of a new petrol engine. In the case of the famous "Gnome," for instance, many thousands of pounds were spent upon a series of experimental engines, before a reliable model could be obtained.

II. Economy of a large military order for machines—The incidental expenses.

The idea has been conveyed, by the previous notes, that the aeroplane is an expensive machine. So it is, at present, so far as the private purchaser is concerned—although its champions are already prone to point out that a first-class flying

machine does not cost more than a high-powered, luxurious motor-car.

When the aeroplane is regarded as a weapon of war, however, it should not be considered expensive. It is, in fact, remarkably cheap, particularly when compared with the cost of other forms of armament.

The prices, previously quoted, as representing the cost of the best makes of aeroplane, have been for individual machines; and this introduces a point which is greatly in favour of any War Department, when it seeks to equip itself with a number of aeroplanes. Through placing orders for a batch of machines, instead of buying one here and there, any Government should be able materially to reduce the price of any make.

Grant, for the sake of argument, that a country decides to provide itself with a fleet of a hundred war aeroplanes. The policy, in such a case, would be to look round, at the beginning of any flying season, and make a selection, say, of the three types of machine best suited for the tasks arising in military work.

It would certainly not be wise to buy a hundred machines all of one type, although, by so doing, the price for each machine could be more reduced than in the case of splitting up an order between several manufacturers. But such a policy of having "all one's eggs in one basket" would not be judicious—or fair to the industry as a whole. Government policy, in this regard, should be to support as many manufacturers as is reasonably possible, and thus ensure the industry maintaining a healthy position.

Orders placed with a number of makers would be necessary, in fact. But, even with such a distribution as this, a considerable saving of expense could be made. Expert estimates have been given as to the cost, per machine, of a hundred war aeroplanes, all ordered at the same time; and a reasonably exact figure places the average price, for each machine, at £600.

This represents a very definite reduction upon the price of a single machine; and it also indicates that, in the future, when aeroplanes are bought in even larger numbers, for war purposes, the cost of each machine will become an almost insignificant item—insignificant, that is to say, when compared with the cost of other forms of armament. When a thousand machines can be ordered, and built at one time, for example, the cost per machine will be enormously reduced.

There should be no outcry, indeed, as to the cost of war aeroplanes. The Admiralty embarks, without question, upon the construction of a great battleship, although it knows that each huge craft will speedily become obsolete. This money is not grudged; it is for the defence of the country.

The same attitude should be taken up as regards the creation of a fleet of war aeroplanes. They, too, have become essential weapons.

War aeroplanes are, in their own sphere, quite as important as battleships. And the contrast between the two weapons, in the matter of price, is extraordi-

nary. For the price of one Dreadnought it is, indeed, estimated that a fleet of a couple of thousand aeroplanes could be created.

An enthusiastic advocate of the war aeroplane puts this matter of cost very forcibly. "It is as nothing," he declares. "A vote of a few hundred thousand pounds would place the whole air service on a sound basis, so far as England is concerned. The net cost of each aeroplane, in a squadron, is an absolutely insignificant item of expense, when we reckon what we are spending, in other ways, on our Army and Navy. One aircraft represents only about twice the amount spent in making one of the great shells fired by our biggest naval guns. It is this astonishing cheapness of the aeroplane, having regard to its revolutionary work, which is the surprising factor of the situation. It will mean, of course, that flying machines will be used, eventually, in huge fleets."

Naturally, the purchase of a hundred machines does not represent the total outlay, in connection with the establishment of a well-equipped air-corps. An organisation must be built up round these machines, and there must be men not only to fly them, but to keep them in a state of efficiency; and there is the need, also, of housing the air-fleet.

The question of providing sheds for a fleet of machines is an important one. Aeroplanes must be well housed, or their depreciation is rapid. Whatever sheds are provided must, apart from being strong and weather-proof, be portable as well.

Under the same heading, also, should come the workshops—some of them portable—necessary to cope with repairs and renewals in connection with machines. This, too, is an important item, as first-class repair work is an essential feature in the organisation of any air service.

An estimate of the money that should be expended upon sheds and repair-shops—for a fleet of a hundred aeroplanes—places the amount at £20,000. Money should not be stinted in this direction; good sheds, and efficient repairs, should both tell their tale, when the aeroplane is used in a campaign.

[image]

PILOT AND "OBSERVER."
Photo, M. Roe.
The above photograph shows a military-type Breguet biplane, as used in the French manœuvres, with pilot and observer in their places.

Now it is necessary to touch upon the question of military flying grounds,

and the expense incurred in keeping them in proper order; also the sum of money necessary to provide a sufficient number of motor transport lorries for the air-fleet. As has been explained, the plan generally adopted is for an aeroplane to be transported from point to point on a lorry, and followed by a repair-car.

In regard to the English trials of war aeroplanes, a point is made—in connection with the size of the packing-cases for machines—of the possibility of transporting aircraft by railway in time of war. Undoubtedly, under favourable circumstances, this would provide a rapid method of bringing up machines from a distance.

Under the headings of the expenditure upon flying grounds, and the provision of motor-lorries to follow aeroplanes, and act as transport waggons, a reasonable estimate of the sum to be expended—in connection with a fleet of a hundred machines—is £20,000.

The sum of £100,000 should be sufficient, not only to purchase a hundred war aeroplanes, but to equip the corps with sheds and repair-shops, and also to maintain flying grounds, and provide an adequate number of motor-lorries.

This amount allocated for machines and incidentals, a Government would find itself face to face with the question of providing officers and men for the air-corps. Pay for this corps should, it is considered, be represented by an annual sum of approximately £60,000.

III. Question of renewals—General cheapness of an air-corps, as compared with other forms of armament.

A point of considerable importance, in regard to an air-corps, concerns the money which should be put aside, each year, for the provision of new machines. One eminently practical authority, Colonel J. E. Capper, reckons that, in connection with a fleet of a hundred aeroplanes, an allowance should be made for the purchase of forty new machines each year.

Upon this question of renewals there is, however, diversity of opinion. The contention is made, for example, that a Government should be prepared, at the commencement of the flying season, to relegate all its previous year's machines to the schools, for the use of pupils, and purchase a new fleet of up-to-date craft for use in war-time.

Such a drastic step, however, should not be necessary. It would be advisable, of course, to weed out a number of machines, from time to time, for the reason that they become obsolete; and such machines should, as suggested, find a place at the schools for the use of beginners.

The exact number of new aeroplanes which it should be advisable to buy, in

any one year, must be governed, very largely, by the process of perfection which goes on. For the next year or so, it is probable that an allowance for renewals will need to be a heavy one. Afterwards, as the rate of improvement becomes slower, the purchase of new machines will represent a lighter item.

A good reconnoitring biplane, say of the flying season of 1911, is not likely to become obsolete in 1912. A new machine will probably fly farther and faster, and carry more weight; but the 1911 biplane will still be capable of useful work, and need not be relegated to the scrap-heap. It will behove a Government, of course, to equip itself with as many new-type machines as possible; and an estimate of forty new machines a year, in connection with a fleet of a hundred, is by no means unreasonable.

This, of course, presupposes a logical process of development, with an improved type of machine appearing from year to year. Should a revolutionary discovery be made, the plans of all nations would be altered. It might then become necessary, in the interests of national safety, to "scrap" a whole fleet of aeroplanes, in order to make way for the type which had made them obsolete.

But the unexpected production of an aeroplane, immeasurably superior to existing models, is not anticipated. Already, it is true, the way can be seen to make many improvements upon present-type aeroplanes; but, in regard to such a difficult problem as that of aviation, the testing and perfecting of any new device, however simple, cannot be hastily carried out.

One other consideration, in regard to the running costs of a fleet of machines, now presents itself. This concerns the allowance to be made for the general upkeep of the aeroplanes, and for such items as the provision of petrol and oil. Here an expert computation places the figure—for an air service of a hundred machines—at a sum of £16,000.

It is possible to arrive at a summary of the cost of the purchase and upkeep of a fleet of a hundred machines. First would come the expenditure of £100,000 upon the aeroplanes themselves, and incidentals; and then the Government would need to be ready to spend another £100,000 a year upon the upkeep of the corps.

Such estimates as this go to reveal the inadequacy of the grant made by the British Government for the year 1911-12. As has been previously mentioned, the actual sum devoted to aeroplaning, dirigible ballooning, and the upkeep of the Air Battalion, has been £85,000. Owing to the costliness of airships, only a small portion of this sum has been devoted to aeroplanes. There is no chance—with such a grant as this—of mapping out an adequate programme for aeroplane work.

OUR AERIAL PROGRAMME FOR 1912-13

While the greater portion of this book was already in the Press, and too late for classification or detailed comment, the Government's programme in regard to Naval and Military Airmanship, for 1912-13, was duly announced.

The appended summary of the official scheme is from the Memorandum, concerning the Army Estimates, issued by the Secretary of State for War:—

"Sufficient experience has now been gained in military aviation to warrant advance on less tentative lines; and after careful consideration by the Committee of Imperial Defence, it has been decided to establish at once a joint Army and Navy School of Aviation at which officers of both services shall be taught to fly, before proceeding to the separate Army and Navy establishments at which they will be exercised in the more specialised requirements of their respective services.

"A site for the school has been selected on Salisbury Plain, and the purchase of the necessary land will be completed at the beginning of April. Building, to plans which have been already prepared, will be pressed forward rapidly, and it is hoped at a very early date to have accommodation at the school for officers and men, instructors and mechanics, as well as the necessary sheds for aeroplanes and workshops for their repair and adjustment. Provision has also been made on an extended scale for purchase of aeroplanes and other necessary equipment for the school.

"Officers of both services will be employed on the staff of the school, and its expenses (other than cost of land) will be shared between Army and Navy votes.

"The Estimates further provide for continuing the experimental and other work of the Army aircraft factory, for further buildings required for airships, for an addition of personnel to Army establishments for aeroplane work, and for a considerable number of aeroplanes as a first instalment of the equipment of the Field Army.

"The total provision for the above services made in these estimates compares with that made in 1911-12 as follows:—

—	1912-13	1911-12
Establishment of Army personnel for aeronautical work	£25,000	£20,000
Premiums to officers gaining pilot's certificates	£3,000	—
Staff of new school	£5,000	—
Aeroplanes, stores, and materials for factory and school	£161,000	£85,000
Buildings, including Army share of school buildings	£38,000	£26,000
Land for school	£90,000	—
Less Admiralty contribution to general expenses of school	£322,000	£131,000
—	£14,000	—
Increased provision	£308,000	£131,000
—	£177,000	

For a full statement of the Government's aerial programme, it is not possible to do better than reproduce the speech (as printed in *The Times*) which was made by Colonel Seely, Parliamentary Under-Secretary of State for War.

Colonel Seely, explaining in the House of Commons the official scheme for the forthcoming year, said:—

> "He now came to what was called aviation, though he hoped that that detestable word would vanish from the English language. With regard to the defence of the country, the Prime Minister had appointed a committee, of which Lord Haldane was the chairman. That committee settled broad principles and entrusted the making-out of the complete scheme to a technical committee, of which he acted as chairman. This committee was at work during the whole of last recess, and pre-

pared a scheme which the full committee had accepted in all parts except the details as to pay. The scheme had that morning been approved by the Prime Minister, and would now be carried into effect.

"There was to be one flying corps, embracing soldiers, sailors, and civilians—all who could fly and would take the obligation to serve this country in time of war in any part of the world. No man would hold executive rank in the flying corps unless he was himself an expert flyer. The present Air Battalion would cease to exist, and part of it would be absorbed in the new organisation. The corps would be one corps, and as far as possible all the officers would be paid and treated alike. In a purely land war the whole flying corps would be available for land warfare, and in a purely naval war for naval warfare. The headquarters would be near Nether-Avon on Salisbury Plain, where a large tract had been purchased at a cost of about £90,000. In the first instance accommodation would be provided for sixty officers at the school at any one time. There would be three terms of four months each, and it was proposed to pass through a hundred and eighty officers in each year. If an officer wished to join the flying corps he had first to get the consent of the military authorities, then to be passed by the doctor, and afterwards obtain his Royal Aero Club certificate at a private aerodrome. It was not proposed to use the central school for teaching officers to fly. They would learn the elements of the art elsewhere and go to the flying school for the more advanced course. After receiving the Royal Aero Club certificate, and before presenting themselves, they would receive £75 which it was believed would cover the cost. This arrangement had already been in force some little time; he believed between twenty and thirty officers had received the £75. Afterwards officers would be attached to the central air school, and would go through a course of four months. They would learn progressive flying, mechanics and construction, meteorology, observation from the air, flying by compass, photography from the air, signalling, and types of warships of all nations. After this course the officer of the air-corps, whatever his origin, would either join the military wing or the naval wing, or go straight to the reserve. The military wing would consist of seven aeroplane squadrons, each containing twelve aeroplanes and a suitable number of officers for flying. There would be an eighth squadron, consisting of balloons and kites. The naval wing would have headquarters at Eastchurch. The numbers had not yet been finally settled, but they would be considerable, and would be increased.

In the reserve there would be two classes—the first reserve consisting of airmen who performed so many flights across country in each quarter and received a retaining fee, and the second reserve consisting of those who did not enter into this undertaking, but would be available in time of war. Both the Army and Navy wings of the aircrops would always be on a war footing, and the peace and war establishments would be the same. The Army aircraft factory would cease to be called by that name, and would become the aircraft factory for the whole flying corps. Its functions would include experiment and building experimental machines, making repairs to machines where that was thought desirable, sometimes building machines, though that would not be its primary duty, and training in expert knowledge the numerous mechanics who would be required for this new service.

"The scheme involved the purchase of a hundred and thirty-one aeroplanes. He was not sure they could all be bought this year, though the obstacle was not expense. The first seventy-one had been sanctioned already. The orders for a great many of them had gone out, and the others were in process of negotiation. Not so many had been ordered from British manufacturers as could be wished, but that was because the technical members of his committee realised, and in this they had the full approval of the whole committee, that the first essential was efficiency and safety. In many respects France had gone a long way ahead of us in both those matters. The Government could not buy British machines at the price of human life, but no doubt this difficulty would soon be overcome, for a great many of the best brains were undoubtedly at work making the aeroplane not only more speedy and efficient, but safer.

"The risks the officers would run would be very great. The insurance rates were very high. But it was some consideration to know that in France they had enormously increased the safety of learning to fly. One school had covered 160,000 kilometres without accident. It was to be hoped the risks would be reduced, but they would still be very great, and he trusted the House would not grudge the expense involved in making adequate payment to officers, and giving an adequate scale of pensions in the event of their being seriously injured. (Cheers.) The military wing required at once to fly these aeroplanes a hundred and thirty-three officers, the Navy a number not yet fixed, but thirty or forty at once, and the reserve a number which would depend on the progress of our science in the near future. They had not

> got the hundred and thirty-three military officers. No doubt many officers would volunteer. It could only be hoped that they would learn to fly with as little accident as possible. It had been settled that the officers should learn to fly at private flying schools, first, because it was desirable to encourage private effort; and, secondly, because they thought there was less risk of accident in the initial stages if this method was adopted. It was a method which had been largely followed in France, and it had obvious advantages. It was greatly to the interest of the owner of an aerodrome to avoid accident. When officers had learned the elementary art of flying they would go to the central flying school."

This official announcement of policy, as revealed above, unfortunately comes too late for more than the briefest criticism in these pages.

All that can be said, indeed, is that the scheme prepared, while certainly representing a stride forward in comparison with the previous apathy of our authorities, is still inadequate when contrasted with the activities of either France or Germany.

In France close upon £100,000 has been subscribed, by an enthusiastic public, to augment the million which the Government will expend; Germany has increased an original vote to the tune of £100,000.

Our scheme can only be regarded as a beginning—and, in several respects, a disappointing one, seeing that, at the end of the present flying season, both France and Germany will, inevitably, have still further increased their already long lead.

Agitation for a more ambitious aerial programme in England must not, indeed, cease; this 1912-13 scheme is not sound enough to relieve public uneasiness. We are lamentably behind; and adequate steps have not, even now, been taken to bring us on anything like a level with foreign rivals, despite the fact that the aeroplane has been proved to be an absolutely revolutionary weapon of modern war.

NOTE

Amplifying the official statement of policy previously quoted, the authorities issued, on 12th April, 1912, a fuller explanation of their aerial programme. But it throws no very clear light upon the immediate future; and, although it deals with plans which are ambitious, it is disquietingly vague concerning the all-important question of finance.

The official design is, it is stated, to form seven aeroplane squadrons, each comprising twelve aeroplanes; and, to man this air-fleet, a force of 364 pilots and observers will be required. In addition, there will be forty airmen who will be trained,

specifically, in the duties of naval airmanship.

But the facilities actually provided—as apart from paper schemes—are still so meagre that it will only be possible, during this year, to train a very small proportion of the corps set forth above. Thus it is to be feared that, at the end of 1912, our position will continue to compare, most unfavourably, with that of either France or Germany.

We are more than a year behind, and seem likely to remain so.

TWELFTH SECTION PROBLEM OF ARTILLERY FIRE AND THE AEROPLANE

I. Conflicting opinions as to an aeroplane's vulnerability—Experiments which have been carried out.

So far, the military aeroplane has been described as a reconnoitring or dispatch-bearing craft, carrying out its important work, in time of war, without any interference save that brought about by adverse weather conditions.

But there is an aspect of the case, so far as actual service conditions are concerned, which will—according to many vehement critics of the aeroplane—nullify the utility of an air-scout, and make expenditure upon fleets of machines largely a waste of money.

They affirm, in a word, that well-directed artillery-fire will prove so deadly that no aeroplane will be able to live through it, and that any reconnoitring machine, which ventures over an enemy's position, will be destroyed with the greatest ease.

On the other hand, there is an equally definite statement by staunch advocates of military flying. They declare, emphatically, that artillery-fire, when directed against aeroplanes, will prove a negligible quantity. No point, indeed, arouses more controversy than the problem of the vulnerability of the aeroplane to artillery or rifle-fire.

The question is a moot one, and it is bound to remain so until the coming

of a war in which aeroplanes are employed in fair numbers; but nothing could be more ill-advised than a policy which stints aeroplane development, because it is *believed* they will be destroyed by gun-fire.

As a matter of fact, tests which have been made up to the present time are in favour, not of the gunner, but of the aeroplane. This fact is, however, frequently ignored by the artillery experts. They adhere to their view, and the airmen to theirs. "Aeroplanes will be swept away when they come into the danger zone," declare the champions of artillery. "Nothing of the sort will happen," retort the advocates of the aeroplane.

It is probable that an unbiased reader will prefer to take a view rather midway between these two, and be willing to grant that, while some aeroplanes are likely to be "winged" by skilful gunners, the greater proportion of them will, on account of their height and speed, escape being hit.

Since the aeroplane has demonstrated its unquestionable value as a reconnoitring craft, special guns have been made in order to combat it. These have long range, and are designed to fire vertically into the air. Many tests have, also, been made with kites and balloons, to reveal the ease, or otherwise, of striking an aeroplane in flight.

As regards these experiments, the opinion among experts is again divided. Artillerymen do not hesitate to say that they prove their case—which is, of course, that the aeroplane is a vulnerable target. Aeroplane enthusiasts combat such suggestions; and so the controversy goes on.

One fact stands suggestively revealed; wise countries, despite assertions that artillery will blow aeroplanes to pieces, are buying more and more machines, instead of curtailing their orders.

France and Germany, for instance, which have carried out more tests than any other countries in regard to the vulnerability of aircraft, are determined to increase their fleets of aeroplanes.

This, surely, should tell its own story. It is unusually impressive, as a matter of fact, seeing that artillery experts, both in France and Germany, have been ready to declare that well-directed gun-fire will rob aeroplane scouting of its significance. But those who control constructive policy, both in France and Germany, have judged impartially; and, as a result, they have bought more aeroplanes.

The difficulty, in carrying out tests of gun-fire, as directed against aeroplanes, is to obtain artificial conditions which shall, even roughly, approximate to those which would prevail in actual war. So far, it has been clear that, in all tests which have been carried out, conditions have been in favour of the gunner. But, even so, the results obtained have been inconclusive—to say the least of it.

Let us take, for purpose of illustration, one of the experiments conducted in France. In this a large box-kite was employed. It was allowed to ascend, in

a strong wind, until it flew at a height, in regard to its size, which represented, approximately, the target which would be represented by a scouting aeroplane.

Then it was towed past a battery of artillery. Twelve shots were fired at it; and, out of the dozen, one hit was recorded. This was not a good result, from the gunner's point of view. In this test, too, conditions favoured the men at the guns.

To begin with, they expected their target, and knew from which direction it would appear. In the second place, the target was, in comparison with an aeroplane, moving much more slowly than the flying machine would have done; and, in the third place, the kite was towed in a perfectly-straight line, and was not pursuing an erratic course, as an aeroplane would certainly do—in the efforts of the pilot to escape being hit—were it under fire. And yet, even with these points in their favour, the gunners achieved but one hit in a dozen shots.

It is possible to cite another instance, in this connection—that of a series of tests carried out, in American waters, from a warship. Here, again, the target was a box-kite, and it was flown above the vessel at an altitude of about 800 feet. Ten blue-jackets were then formed up upon the deck; and they fired three volleys at this representation of an aeroplane. The bullets, in the first two volleys, all went wide of the mark. In the third, however, the box-kite was hit.

Here, again, although conditions favoured the riflemen, they failed to obtain satisfactory results. During the three volleys, the box-kite was flown at an unvarying height. This was a point very greatly in their favour.

In actual warfare, had they been firing at an aeroplane, the machine would, probably, have been travelling at a speed of sixty miles an hour or more; and it would, therefore, have presented a different range, at each volley fired.

Another experiment, carried out from an American battleship, is also of interest. In this case, a plunging kite was sent up to a specified height, and 160 rounds were fired at it with rifles. Although the kite swung about a good deal, it did not vary its altitude. In connection with this test—in which picked shots were employed—40 hits, out of the 160 rounds, were recorded.

As a result of the tests recorded above, and of others less interesting, the Secretary of the United States Navy was led to make the pronouncement that no aeroplane could, with any degree of safety, approach nearer than 1000 yards of a position protected by rifle-fire.

As opposed to this view, the opinion of experts at the Hythe School of Musketry is that it would be more or less a waste of ammunition to attempt to "wing," with rifle-fire, an aeroplane 3000 feet high. In the practical work of the aeroplane in Tripoli, machines flying less than 2000 feet high were not damaged by rifle-fire.

The point to bear in mind, in this connection, is that an aeroplane flying 3000 feet high, and at a speed greater than that of an express train, would, in-

evitably, prove a very difficult target. The airman would appear suddenly, and quickly go out of view again; and he would alter his height, and course, so that a perplexed gunner—needing to fire quickly, or not at all—would find the range constantly varying.

[image]

MILITARY AIRMAN'S REPORT.
Photo, M. Branger.
After descending from a reconnoitring flight on a Blériot monoplane, in the French manœuvres, the pilot seen above is imparting details of what he has observed to another officer.

Quite recently, a famous military expert has pronounced the opinion that high-angle gun-fire would have no great potentiality against fast-flying aeroplanes.

Amplifying some tests first carried out in France, have come a series of more recent experiments, in which the conditions imposed have been more disadvantageous to the gunners. The result has been a striking testimony to the invulnerability of the aeroplane. For example, kites have been towed by motor-cars at a speed actually representing the flight of fast monoplanes. Gunners, when firing under such fairly realistic conditions, have failed to secure anything like a satisfactory percentage of hits.

Tests on a somewhat similar scale have, also, been carried out in Germany; and, here again, the artillery has not distinguished itself. In Germany, also, small balloons have been used as targets. These have been set free, and have been permitted to ascend to a certain height, before being fired at. In connection with these experiments, a fairly-large percentage of hits was recorded. This was due, no doubt, to the fact that there was no erratic movement to be allowed for—the balloons moving on an easily determined line.

These target tests, as can be seen, represent conditions which are quite artificial. It is possible to take, for the sake of comparison, the practice indulged in by gunners at coast defences. Targets are towed at specified distances out to sea, and then the gunners pound away at them. Such practice is good, of course. It accustoms the men to the handling of their guns; and it certainly improves their marksmanship.

But now contrast this target practice with a sudden attack, in war-time, by hostile torpedo craft.

Here will be no mechanically-moving target, at which to take a leisurely

aim. Instead, there will be the rush and tear of war. Marksmanship, under such conditions, is a very different thing to quietly-conducted practice firing. And a similar argument—only with greater force—applies to shooting at aeroplanes in war-time.

Among distinguished students of this problem of gun-fire and the aeroplane is Colonel J. E. Capper, who was, for seven years, in charge of the aeronautical work of the British Government. His view is that artillery, however well-trained, would have very great difficulty in firing accurately at a fast-flying machine.

An instance which Colonel Capper gives is this: if the range of a gun is 5000 yards, an aeroplane, moving across it at a speed of fifty miles an hour, would be in range for less than 3 1/2 minutes. During this period of 3 1/2 minutes, the gun would need to travel across an angle of 60 degrees, altering its range down to 4330 yards in the first 1 3/4 minutes, and increasing it again to 5000 yards in the next 1 3/4 minutes.

To do this would be an extremely difficult task, even if the aeroplane, while flying past, made itself the easiest possible target; that is to say, if it flew steadily at one level, all the time, and moved directly across in front of the guns. But an airman would, naturally, seek to make himself as difficult a target as possible. He would, therefore, constantly alter his altitude by movements of his elevating plane; and he would, in addition, steer erratically from side to side.

How confusing this would be for the gunner may easily be imagined. Apart from the speed of the aeroplane, which would, as shown, only permit him a brief opportunity of firing at it, he would be faced with the fact that range, elevation, and direction of the elusive target would constantly be altering. In addition, he would probably be called upon to make allowance for a wind, when aiming at the machine.

Apropos the rapidity with which a modern-type machine will come into the range of a gun, and disappear again, an incident in some minor manœuvres held in France is of interest. On this occasion, a special gun, designed to shoot at aircraft, and mounted upon a motor-car, was taken out with the troops. Suddenly, an aeroplane appeared in sight. It was flying straight towards the troops, which were on the march. The special gun was called for; but, before it could be brought into action, and trained upon the aeroplane, the latter had gone completely out of range. This illustration shows what an unsatisfactory and elusive target an aeroplane is bound to be.

II. Shrapnel shell—Question of hitting a vital part of the aeroplane—Difficulty of identifying friend or foe.

It is generally agreed, among artillery experts, that shrapnel shell should form a suitable projectile to be fired against an aeroplane. The shrapnel is, indeed, a particularly-deadly missile. This shell consists of a metal case, containing a sufficient amount of explosive to burst it, when the fuse explodes the charge. This fuse can, of course, be set so that the shell explodes at any given distance from the gun which fires it.

Inside the metal case, or shell, is a charge of bullets. When the shell bursts, these bullets fly out from it, ready to spread destruction over an appreciable area. Should a shell burst in close proximity to an aeroplane, for instance, the scattering charge would, it is anticipated, break struts and stays, and possibly hit the pilot, or some vital part of his machine.

But, granting the deadly nature of a well-aimed shrapnel shell, there are several points to be considered, before we can imagine it bringing an aeroplane to the ground. In the first place, there is the question of the timing of the fuse. This must be done, of course, with absolute accuracy; and the gunner must aim his weapon at a point in front of the aeroplane, as it flies across his view. This represents a matter for nice calculation, being determined by the speed of the aeroplane aimed at, the speed of the shell, and the distance of the aircraft from the gun.

Thus, when he is firing at a sixty-mile-an-hour monoplane, passing swiftly through the air, several thousand feet away, a gunner must obtain his range without delay, set his fuse accurately, and aim his gun with the greatest care. And, all the time, his target will be moving as fast as an express train, and perhaps making erratic twists and turns in the air.

It is not surprising, in view of such circumstances, that one of the greatest of military experts has declared that an aeroplane, flying at sixty miles an hour, and at an altitude of from 3000 to 4000 feet, will present an exceptionally-difficult mark, even to the most skilled of gunners, equipped with special weapons.

It does not follow, even should a shrapnel shell be exploded successfully in the vicinity of an aeroplane, that the machine will be brought to the ground. There is still the question as to striking a vital part of the aircraft. It should be remembered that the greater portion of the target which a machine exposes to gun-fire is represented by its planes; and these could be pierced by many bullets before their efficiency was affected.

Thus, a number of bullets from a shrapnel shell might strike an aeroplane without producing any result. What would be necessary, would be to hit the airman, or place a shot in some vital part of his machine. Damage to a working part of the engine would, for example, bring the machine down. So would injury to radiator, petrol tank, or propeller. A bullet might, also, break an important stay—or cut a controlling wire. In such a case, the machine might fall, and be

wrecked.

The point to be made, which is of importance, is this: it does not follow that, even if an aeroplane were hit, it would be brought to the ground. Many bullets from a shrapnel shell might, as has been shown, strike a machine in flight, without having any effect upon it at all. This is certainly a factor in favour of the aeroplane.

A fact to be considered, also, when the problem of aeroplanes and gun-fire is under review, is the distance at which aircraft are visible from the ground. In ordinary weather, and under normal conditions, it is generally estimated that a reconnoitring aeroplane should be sighted when it is about three miles away.

But, even in clear atmospheric conditions, the aircraft is an elusive object to locate. Even when one is expected to appear, from a certain direction, and all eyes are fixed upon the sky, awaiting its advent, it is frequently almost at its destination before anyone locates it.

More difficult, as can be imagined, is the task of sighting an aeroplane when it is not known from what point of the compass it is likely to appear. And yet this, of course, will be the position of the gunner in war-time. A hostile aircraft may loom up from anywhere—even from over his own troops. It will be possible for a reconnoitring machine to ascend to a great height, and conceal itself in low-lying clouds. From these it will be able to descend swiftly, effect a rapid reconnaissance, and then "climb" again until lost to sight.

In such circumstances, the artilleryman will need to be phenomenally handy with his gun if he is to note the approach of so cunning a scout, and "wing" him before he has slipped out of range.

A point which has been referred to before—but which artillery experts are prone to ignore—is the skill a military pilot will be able to exercise, in avoiding fire from below. In many cases, during a reconnaissance, the observer should be able to obtain all the information he seeks without once coming within range of the enemy's guns.

Naturally, the aeroplanist will never fly intentionally over artillery, or court infantry-fire. Long-distance observations will often be possible, giving the gunner no chance of using a shell; or, if it is necessary to come fairly close to troops, for a detailed piece of reconnaissance, the airman will swoop down, and as speedily get clear again.

When he knows he is likely to be within range of any of the enemy's guns, he will pursue an erratic course. Therefore, the gunner, when he does obtain a chance of firing at a machine, will find his target darting about in disconcerting fashion.

A point arises as to establishing the identity of an aircraft, when it is sighted during time of war. Machines will fly flags, indicating their nationality, but these

flags are not likely to be seen at any great distance. Therefore, if an artilleryman detects an aeroplane, approaching at an appreciable altitude, it will frequently be impossible for him to determine whether it is friend or foe.

That it is, obviously, a machine of a particular type, or make, will not help the artilleryman, because aeroplanes of all forms of construction will be employed, in connection with the various armies. The fact that it may be flying over from behind him, as though it had risen from his own lines, will prove nothing, as a hostile scout might have made a wide detour, and so approached the enemy from the rear.

This difficulty as to identifying friend or foe is likely to prove a real one in time of war, particularly when a large number of machines are in the air; and, exactly how it will be met, is not easy to see.

Having reviewed the position, so far as the aeroplane and gun-fire are concerned, it is possible to form more or less definite conclusions concerning the subject. In the first place, one point is clear: extreme views are unwise in regard to such a problem as this. What tests so far carried out have proved, if they have proved anything, is that there are two points of view.

Artillery experts, who declare that every reconnoitring aeroplane will be blown to pieces before it can carry out its work, are obviously wrong; so, too, is the enthusiast who affirms that guns will be altogether useless when directed against airmen.

What it is possible to deduce, from the generally-inconclusive experiments recorded, is that the balance of testimony—so far as it can be estimated—is in favour of the aeroplane. As a matter of fact, the reasonable view to take is that, when a squadron of aeroplanes deliberately sets forth to reconnoitre an enemy's position, a certain percentage of machines will be hit by gun-fire, and brought to the ground.

Exactly what that percentage will be is a moot point; experience alone can tell. But the tests already described suggest, very plainly, that the percentage should be low.

The skill of the pilot in avoiding fire will be an important factor in the question—as already mentioned. An over-daring airman may quickly find himself in danger; a careful, cautious man may do all the work required of him without giving hostile artillery a chance to get in a shot.

Level-headed officers, who have practical experience in military flying, do not anticipate, for a moment, that the aeroplanes which ascend in time of war will escape scot-free.

"Casualties there are bound to be." The words are those of an expert of international repute. "Risks will be taken knowingly, according to the value of the information which is required. War is not a kid-glove affair. Large squadrons

of aeroplanes will be used; and, apart altogether from the question of the loss of life, the destruction of a small proportion of machines will not affect the utility of a corps. The position, in a nutshell, is this: the news that an aeroplane can obtain is so vitally important that the risk of men, and machines, will be considered amply justified."

This much appears certain. No artillery-fire, however skilfully directed, is likely to nullify the effects of aeroplane reconnoitring. Machines will be hit; lives will be lost. But the value of the aeroplane's work will lie in the number of machines employed. If fifty are sent out upon a reconnoitring flight, and if some of them fall victims to the enemy's gun-fire, a sufficient number will return to impart, to a Commander-in-Chief, the information he seeks to obtain.

The only sensible policy, for any nation, is to do what France and Germany are doing. Both these countries are developing war aeroplanes; and they are also building, and experimenting with, special guns for the destruction of aircraft. While you cannot destroy an enemy's air-fleet, the obvious policy is to cripple it as much as possible; and, recognising that no gun-fire can altogether prevent the aeroplane from doing its work, the equally obvious thing to do is to obtain an efficient fleet of machines, as well as batteries of guns.

THIRTEENTH SECTION DESTRUCTIVE POTENTIALITIES OF WEIGHT-CARRYING AEROPLANES

I. What a modern-type machine can raise—Load of two men, and explosives.

In previous sections, the reconnoitring capabilities of the war aeroplane have been dealt with; but there is now another, and an increasingly-significant aspect of its work. This lies in its power of destruction.

In its early stages, the aeroplane could, only with difficulty, raise its pilot

from the ground; any weight-lifting was out of the question. But, with the development of engines, and the efficiency of machines generally, the carrying of appreciable burdens has come within the range of practical politics.

A biplane can be constructed, at the present time, which is capable of raising a pilot, an engineer, and a load of explosives, and of flying, thus loaded, for several hours without descending.

Not long ago, it was predicted that a fleet of weight-carrying aeroplanes might be able to leave foreign soil one day, fly over London, drop a quantity of explosives on the city, and return—by way of the air—whence they came.

When this prediction was first made, it was generally considered in the nature of an impossible dream. But, nowadays, it has ceased to be a wildly-improbable undertaking. With aeroplanes such as could be built at the present time, an expedition of this character could, as a matter of fact, be carried out.

But the aeroplane must first be perfected as a scouting machine. Afterwards, may come its application as an offensive weapon. To ignore the destructive aspect of military flying is, however, foolish.

Foreign countries realise such possibilities; already, tentative experiments are being made. When reckoned singly, aeroplanes have an insignificant value as engines of destruction; but, when bomb-dropping machines are employed in large, well-organised squadrons, a different situation arises. It is in regular fleets that attacking machines of the future will, almost certainly, be employed.

It was in 1909, after his cross-Channel flight, that M. Louis Blériot declared: "Before long, military and naval aeroplanes will be able to carry explosives of the deadliest nature." This shrewd man saw what lay in the future. At the time he spoke, a flight of an hour's duration, by a machine carrying only one man, was an achievement; but, nowadays, a heavily-laden machine can remain aloft for a number of hours.

Bomb-dropping mechanism, to facilitate the discharge of a missile from an aeroplane, has been devised. The bombs are contained in a chamber beneath the aeroplane, and pass thence into a tube, which is pointed towards the ground. By pressing a button, conveniently close to his driving-seat, the airman is able to release a series of bombs over a given point. Missiles in the form of carefully-weighted arrows have also been employed—the explosive forming the head of the arrow, and the projectile being released from a special form of sighting mechanism. With this apparatus, fairly good practice has been made, from heights in the neighbourhood of 500 feet.

The experiments so far made, in connection with dropping bombs, show that considerable practice is necessary before accurate aim is possible. In actual attacks in warfare, however, absolute precision would not always be an essential. A detachment of machines would probably pass, one after another, over a given

position, raining down missiles as they swept by. The aim would be made as accurate as possible, of course; but the telling nature of the attack would be, not in the chance of individual bombs reaching any precise mark, but in the fact that a large percentage of the missiles would be calculated to do damage over a given area.

Among experts in France and Germany, who are now paying keen attention to this question of a destructive war aeroplane, it is considered that an incendiary bomb would work great havoc in wartime. The possibility of employing some such bomb as this was suggested by Lord Charles Beresford, after he had witnessed the demonstration organised by the Parliamentary Aerial Defence Committee in May, 1911. He foresaw that aeroplanes might be able to drop cylinders of some highly-inflammable spirit, ignited by a sensitive fuse, and calculated to cause an instant and violent conflagration.

As a matter of fact, it has already been realised that several types of bomb are likely to be employed in aerial warfare, according to the targets which are aimed at. In an attack upon supply stores, for example, an incendiary bomb may be used, so that the contents may be set on fire, and destroyed; and the same kind of missile will probably be dropped upon dockyards, arsenals, and magazines.

For the destruction of bridges, for the attack upon troops on the march, and for the bombarding of encampments, some special form of explosive shell may be used. Definite choice of such a shell has not yet been made; but here, again, experimental work has already been commenced abroad.

In England, realising the importance of this question. Sir Hiram Maxim has recently been engaging himself with the production of a 100-lb. aerial projectile likely to create a maximum amount of damage when striking the ground.

Aerial bombardment, if systematically carried out, will certainly add another terror to modern war; and the question is sometimes asked whether nations have a right, according to the agreements of the Hague Convention, to employ such a means of attack. The position, so far as the last convention was concerned, was that certain nations, notably France and Germany, did not become signatories to a rule, proposing that aerial bomb-dropping should be disallowed.

Such a practical airman as M. Vedrines is enthusiastic regarding the offensive powers of a modern aeroplane, when skilfully handled. His view is that a large and well-organised squadron of weight-carrying machines should be able to render almost useless a fleet of ships.

Naval men would, no doubt, regard such a statement as being an exaggeration. The aim of an aeroplanist, when directing his bomb against a moving ship, would frequently be inaccurate, they claim; and they also affirm that an aeroplane would not be able to carry bombs sufficiently large and deadly to do much damage, even if one did, occasionally, reach its mark.

But here the argument is based upon the possible use of one machine, and not of a fleet. One aeroplane, dropping a few bombs on a fleet of ships, would naturally produce an insignificant result. But what of the results achieved by several hundred, and perhaps of a thousand? In such a case, there would not be one bomb to contend against, but a volley of missiles.

M. Vedrines, whose opinion was quoted above, is a believer in the speed of the aeroplane, as aiding its powers of attack. In regard to a possible war between France and Germany, he has declared that, within an hour of the declaration of such a war, a corps of French airmen could be over the frontier, attacking, with their bombs, all great railway junctions and forts on German soil.

The rapidity with which an aeroplane onslaught can be made should, indeed, prove one of the most important features of aerial warfare. Destructive machines may fly from their Headquarters, deliver an attack fifty or a hundred miles away, and—their ammunition exhausted—return quickly to their base for more, and so be ready to renew the attack.

II. Effect of aerial bombardment upon cities and troops—German tests.

It was after a seven years' study of military aviation, as Commandant of the British Government Balloon School, that Colonel J. E. Capper declared emphatically: "The necessity has arisen for every warlike nation to have a sufficient aerial fleet, armed and equipped for offensive warfare."

His advice, however, was not adopted—at any rate, not by the War Office. No steps have yet been taken to estimate the value of an aeroplane as a destructive instrument, despite the fact that France and Germany are keenly alive to the possibilities of a large number of weight-carrying machines.

In Germany, at the present time, secret tests and experiments are being made, and the construction of special machines undertaken. Meanwhile, we fumble along. If a war broke out to-morrow, it is true that destructive work by aeroplanes, on anything like a large scale, would not be undertaken.

But what about the day after to-morrow—or rather next year? Every day, the general efficiency of the aeroplane is being improved, and its radius of action increased. Practically every day, also, foreign nations are adding to their air-fleets. Already the art of employing aircraft in fairly large numbers has been learned. Machines for destructive work can now be built—and are being built; and yet we are content, as yet, to do nothing.

Sufficient warning has been given. Colonel Templer, an officer identified with the first Government aeronautical work undertaken in England, has de-

clared: "It is conclusively proved that the aeroplane is a machine for carrying out attacks in warfare. We must, therefore, be prepared not only for defence against bomb-dropping aeroplanes; we must be prepared, if necessary, to use them."

Another military expert of high repute, speaking of the havoc that a hostile air-fleet might work, by an attack upon the Thames Valley between Hammersmith and Gravesend, has observed: "This whole fifty miles of concentrated essence of Empire lies at the absolute mercy of an aerial machine, which could plant a dozen incendiary missiles in certain pre-selected spots."

The point to be considered, in this connection, is this: such an aerial attack is no longer a vague possibility. It was only the other day, while discussing the destructive capabilities of modern-type aeroplanes, that a famous constructer showed how—if a large fleet of machines was marshalled together—it would be possible for an enemy to drop a couple of hundred tons of explosive matter upon London, suddenly appearing from across the Channel by air, and as flying quickly back again.

[image]

TRANSPORT OF WAR AEROPLANES
Photo, M. Roe.
In the manner depicted above—and also by means of motor lorries—were military aeroplanes transported from point to point during the French manœuvres.

What such an aerial attack as this would mean has been pictured by Lord Montagu of Beaulieu. Suppose London was thus assailed, from the air, at the beginning of a war, he says: What would the result be? Imagine the Stock Exchange, the chief banks, the great railway stations, and our means of communication destroyed. "Such a blow at the very heart of the Empire," declares Lord Montagu, "would be like paralysing the nerves of a strong man, with a soporific, before he had to fight for his life: the muscular force would remain, but the brains would be powerless to direct."

When delivering an attack upon a city, a squadron of aeroplanes engaged in such work would, declare military experts who have specially studied the problem, probably sweep over the principal buildings in a long line, dropping bombs as they flew. Then they would wheel round, and return over the same area, again releasing a certain number of missiles. The disastrous effect of such an aerial bombardment, carried out systematically by a large number of machines, may readily be imagined.

Although, as has been mentioned, German experimental work, regarding the value of aeroplanes for punitive work, has been kept very secret, the result of one interesting test, at least, has become known. In this case, a squadron of dragoons was specially employed to give realism to the experiment.

The squadron was directed to move a certain distance away from one of the German air-stations, and then camp for the night. This was done. Then two army airmen, flying biplanes, set off to deliver a night attack upon the encampment. Beneath their machines, they carried a bomb-dropping apparatus such as has already been described.

Locating the bivouac by its fires, the two airmen stopped their engines, and planed down silently from a considerable altitude. Neither of the aeroplanes was seen, by the dragoons, until it was right over them. Then the attacking airmen released a stream of dummy bombs, which fell all about the camp-fires. Immediately they had done so, and before the dragoons had recovered from their surprise, the pilots started their engines, and disappeared again into the darkness.

Seeing that it was purely experimental, and that neither officer-airmen was skilled in such work, the result of this mock attack was surprising. Had actual war conditions prevailed, and had the bombs been real ones, death would have been scattered through the bivouac, the horses would probably have stampeded, and a general scene of confusion would have ensued.

And this is a most important point: so swift and unexpected was the night attack that the machines only came into view just at the moment they were releasing their bombs. This would probably have meant that, in warfare, they would have escaped without an effective shot being fired at them.

By such tests as these, regarding which, as a general rule, nothing becomes public, the German military authorities are obtaining data that is invaluable concerning the destructive potentialities of the war aeroplane. Apart from the actual damage done by such a night attack as has been described, there is its moral effect to be considered—and this point is regarded as an important one by foreign experts.

Nothing, they think, could be more harassing or wearying for troops, during a hard campaign, than to be attacked, night after night, by squadrons of aeroplanes. Incessant watchfulness, and consequent loss of rest, would be involved, and a general feeling of uneasiness would be occasioned.

It is now considered feasible to carry a light machine-gun upon an aeroplane, and to use it effectively. With such guns, skilfully handled, it is considered that attacks could be delivered upon reserve troops, upon artillery trains, upon the horses of guns in action, and upon troops when on the march.

Considerable experience, in handling a machine-gun on an aeroplane will, probably, be necessary before accuracy can be obtained; but military men, who

are most competent to speak, see no difficulty in equipping an aeroplane with such a gun, and in obtaining satisfactory results.

In conclusion, it may be taken that the offensive possibilities of the aeroplane grow, from day to day. Machines are built to fly faster, and to carry heavier weights. In future, so far as the question of this destructive work of machines is concerned, it will be necessary to reckon air-fleets not in hundreds, but in thousands.

At the moment, as has been said, the reconnoitring machine is engaging most attention; but an aeroplane for destructive use is being kept well in mind, none the less. Its appearance, as a weapon of war, is merely a matter of time.

What may be accomplished, by a fleet of aeroplanes bent upon destruction, has only been hinted at in this section; but it should serve its purpose—which is to show that no country can afford to ignore what the future promises in this respect.

FOURTEENTH SECTION WAR IN THE AIR BETWEEN HOSTILE AEROPLANES

I. Certainty of a combat between aeroplanes in actual warfare—Air-scouts protected by aerial "cruisers."

"The duty of an aerial fleet, armed and equipped for offensive warfare, will be to put out of action an enemy's aerial force before it can carry out its role of reconnoitring—or attacking vital points of communication."

In these words, a military authority of international repute indicates the war in the air which will, inevitably, take place in connection with any future European campaign.

His view is endorsed by another famous expert, who declares: "It is certain that the consequences of the use of aerial navigation will be to bring about, at the very outset of hostilities, a fight to the death between opposing aerial fleets."

The point that military authorities have come to recognise, of course, is this: if the flying machine is of vital importance to one side, it will prove equally valuable to the other. Therefore, the aim of one Commander-in-Chief will be to take steps to prevent his opponent from deriving full benefit from his aerial scouts.

Artillery-fire has been quoted, previously, as a means of combating the aeroplane, and destroying reconnoitring craft. But this method has been shown to be uncertain. What is considered a far more efficacious way of hampering the operations of an enemy's air-scouts, is to send up machines to meet them in the air, and either drive them off, or put them out of action.

This suggests an actual contest, in mid-air, between two hostile craft; and such aerial battles are bound to occur. The most efficacious weapons, for such fighting, experience alone will indicate; but it is obvious that the ramming of one machine by another will not be resorted to. Were one aeroplane to charge an enemy's vessel, the result would be the fall and destruction of both aircraft. Such an expedient might, of course, be resorted to as a last desperate move, say in the case where a hostile aircraft was escaping with very valuable information.

What is anticipated, in the way of a fighting aeroplane, is a machine which will carry two men, a pilot and a marksman, and be armed with some form of small quick-firing gun or rifle.

One of the experts of the French army air-corps thinks that a war aeroplane, in the immediate future, will carry a pilot, observer, and combatant. This combatant, in his opinion, should be armed with a light repeating rifle, ready to ward off the attacks of other machines.

This suggests that a reconnoitring aeroplane should be a fighting unit as well; but other views entertained are that a scouting aircraft should be accompanied by one or more fighting aeroplanes, the duties of which would be to protect it from attack.

It seems probable, in fact, that armed aeroplanes will accompany each reconnoitring machine when it is about to set out over the enemy's position. These armed craft, or aerial cruisers, will most likely circle round the scouting machine, so as to open fire upon any hostile aeroplanes which approach.

In such an arrangement as this, the reconnoitring machine would probably be a slow-flying, reliable biplane, equipped exclusively for its work of observation. The fighting machines, on the other hand, would be built for speed. Fast-flying, strongly-built monoplanes would most likely be used; and one prominent constructer suggests that such fighting units should be fitted with a gun firing a small explosive shell, something like a "pom-pom." Such a form of armament would certainly be effective; and such an aerial cruiser is likely to prove a formidable opponent.

In connection with the carrying of guns upon an aeroplane, it may be mentioned that a light machine-gun has already been fitted to a biplane; but little has been said about such tests, and nothing definite, in the way of experiments, has, as yet, been recorded.

In connection with the aerial battles that are certain to precede the land actions of the future, it is difficult to foresee, exactly, what method will be pursued by the Commanders of two rival Air Battalions. It is fairly clear, however, that each will seek to prevent a hostile aeroplane from coming within observation distance of his forces; and, at the same time, by such strategy as wide detours, each will endeavour to slip reconnoitring craft through the enemy's lines.

In the elaboration of any such plans of campaign, it is obvious that the fighting units of the air-fleet—the fast "cruisers" which will carry machine-guns—will come into speedy conflict. Combat, probably, will resolve itself into a question of manoeuvring for position; then the opponents will open fire. Marksmanship and skill in handling a machine will spell all the difference between victory and defeat. After a preliminary exchange of shots, two machines will sweep into closer range, and then one of them, "winged" by well-directed fire, will be put out of action, and will flutter away earthwards.

It is obvious that an exceptionally fast, high-powered aeroplane, capable of rising at a maximum speed, will be most suitable for hostile work against other machines.

The question has been discussed as to protecting, with some form of armour, the vital parts of aircraft for offensive work. It seems likely that some such plan will be adopted.

II. An encounter in the air—Importance to an army of an aerial victory.

It was the late Captain Ferber—one of the first military enthusiasts in France upon the subject of the aeroplane—who was asked the question: "How will a fight take place between aeroplanes?" In reply, this famous pioneer said:—

> "In the same way as all fights between birds have ever taken place. When a falcon, for in stance, wants to attack a raven, it first pursues it; and, as soon as the raven finds itself overhauled, it ascends slowly, in spirals, and the falcon starts to rise in a parallel fine. If the raven can rise higher than the falcon, it is saved; if it cannot, its resource is to drop to earth, although during the descent it is liable to be hemmed in by the falcon. Every time the falcon darts upon the raven, the lat-

> ter will try, by means of a clever side-slip, to avoid the impact. If the falcon has been dodged, there is a respite, for, carried beyond its aim, the falcon loses an elevation which it must painfully regain. The race for altitude may recommence, but now the flight is no longer doubtful; the raven will finally come to the ground, and will be vanquished. In a like manner, will aerial craft struggle."

An ability to "climb" rapidly, combined with high speed will, indeed, prove invaluable to the fighting aeroplane. If it can do so, it will undoubtedly seek to rise above an antagonist, and destroy it with a well-directed missile. If two machines are equally well-matched in the matter of rapid soaring and speed, their pilots will then exercise all possible skill in manoeuvring for position for an effective shot from whatever form of light machine-gun is carried.

The certainty that aerial fighting will precede any future battle in which aeroplanes are employed, indicates the necessity to build an air-fleet comprising several types of machines. In the first place, there will be need for an aircraft, either a large monoplane, or an exceptionally fast biplane, which will carry a machine-gun, or a gun throwing an explosive shell. This machine should act purely as an offensive unit, going in advance of other craft, and meeting the enemy's "air cruisers" in combat.

Then may come a machine to carry out the important work of detailed reconnoitring. This, as has already been suggested, should be a biplane, carrying if necessary a "crew" of three—pilot, engineer, and observer. This machine would have one object only—to obtain full and accurate information concerning an enemy's movements.

Protected by one or more "cruisers," it would probably ascend to a great height, and seek to slip by the enemy's aerial line of defence, or make a wide detour and approach the foe from an unexpected direction.

A third type of machine should, it is held, be used for swift, comprehensive survey work. This machine, carrying merely its pilot, would be a monoplane so speedy that it would frequently be able to elude the pursuit of any armed craft, and so escape destruction.

This problem of aerial warfare is now very much in the minds of those who are concerned in the military flying work of France, Germany, and Russia. Quite recently, for example, one of Russia's chief advisers, in the matter of war aeroplanes, declared: "It is now clear that future wars will be begun in the air, and that nations will be best prepared that are well-equipped with military aeroplanes." This statement, bearing out others previously quoted, shows how general is the view that aerial fighting will play a prominent part in any application of the aeroplane to actual war conditions.

Apart from the "cruiser" type of machine, previously described, it is suggested by many experts that a fighting aeroplane, carrying a heavier gun or guns—a sort of aerial "Dreadnought," in fact—should be constructed. The aim of such a machine would be to attack antagonists at long range.

Provided that they could vanquish aerial foes, these armed aeroplanes would, no doubt, turn their attention to the bombardment of fortifications, and land forces; and, the resistance of an enemy being crushed, the air-scouts would be free to fly where they pleased.

Thus a reverse in the air would prove a very serious matter indeed, for any army. The Commander-in-Chief would have all his plans laid bare by the unhampered movements of the enemy's aeroplanes; and, at the same time, he would be unable to obtain any data concerning his antagonist's dispositions. This, of course, would be apart from the damage that attacking aeroplanes might effect by bomb-dropping and machine-gun firing.

Many experts, indeed, are found to declare that a defeat in the air would be followed by a reverse on land. It is clear, at any rate, that great importance will attach to this aerial fighting.

A machine regularly equipped for aerial warfare has yet to be introduced—but it is merely a question of time, and probably a short time at that, before such a machine is built and tested.

The handling of such fighting aircraft will have to be learned, also the best modes of approaching and attacking a hostile aeroplane. Experimental machines will have to be built, and flown, and as effective manœuvres as possible carried out. But it will be a great war, of course, which will teach the real lessons concerning the offensive possibilities of the aeroplane.

Until then, of course, much must remain more or less theoretical. But it behoves great nations to beware of these grim potentialities of the new "arm."

FIFTEENTH SECTION VALUE OF THE AEROPLANE IN NAVAL WARFARE

I. Machines for coastal and high-seas work—Question of flying in winds.

The work of the aeroplane, when co-operating with land forces, is all-important, as has been shown; and another field, just as useful, lies in the utilisation of air-scouts in naval warfare.

The possibilities of the aeroplane in this direction are, however, only just being realised. To the credit of France goes the first definite steps. At Toulon, the French naval authorities are keenly alive to the value of aerial scouting over the sea. Plans have been made for dispatching aeroplanes from the decks of cruisers; and reconnoitring flights from the land, over the sea, are now being undertaken.

During the present year France will spend £40,000 upon naval aviation, quite apart from her disbursement in other respects.

Germany is training naval airmen, and experimenting with aeroplanes for use at sea. Austria has established an experimental station. In England—since Lieutenant (now Commander) Samson rose from the deck of a warship at Sheerness—the Admiralty is credited with an ambitious programme. In America, highly-practical work has been done in the way of building aircraft to rise from the water; and, in France, the Voisins have built a machine that lifts itself from the surface of the Seine. Farman, too, is building successful hydro-aeroplanes.

From the point of view of their work in naval warfare, a very important future lies before the aeroplane. So far as can be judged at the present time, it is possible to divide naval aeroplanes into two categories: I, coastal aeroplanes; and 2, aeroplanes for use on the high seas.

The former should be stationed at harbours and other sea-coast points of strategetic importance. The latter would be carried to sea with a fleet, and sent up, when desired, from the deck of a ship.

The coastal aeroplane would be invaluable in locating the approach of some attacking fleet. A machine would be sent up from a harbour and, flying high and at a great pace, would be able to scour a wide area of water in a surprisingly short space of time. Upon sighting an enemy's fleet, the air-scout would be able to gauge its strength, and then dash back to its Headquarters at astonishing speed.

A fast-flying monoplane, acting as an observing craft, would be able to perform the work which would otherwise need the services of several cruisers, or a number of torpedo-boat destroyers.

As regards the aeroplane for work on the high seas, this should operate in conjunction with a specially-built fast steamer, or an auxiliary cruiser. Such a vessel, with one or more aeroplanes on board, would accompany a fleet. When an air-scout was wanted, it would be brought on deck and assembled, and would then be launched into the air from a special platform on the vessel's deck.

After making a reconnoitring flight, the machine would return to the parent ship, and alight upon the deck. By means of such air-scouts, the position of an enemy's fleet could first be detected, and then a careful watch kept upon its subsequent movements.

The results gleaned would be more trustworthy than those obtained from the look-out of a warship; and the field of vision would, also, be infinitely wider. What would be of great importance, of course, in connection with such aerial observations, would be for the pilot of the machine to report what he saw by means of wireless telegraphy. There is no reason why this should not be done. A well-organised service of naval aeroplanes, fitted with long-distance wireless, should, indeed, prove of vital importance.

The point has been made, by critics of the aeroplane for naval use, that the high winds often encountered at sea would limit the uses of aircraft. But, in reply to that, experienced airmen point out that, although winds at sea are high, they are also steady—far steadier, in fact, than those which blow over the land, and are broken up into eddies by passing over uneven ground.

A thirty-mile-an-hour wind, over the land, represents to-day quite as much as any airman would care to contend against, in the ordinary way; but it should be possible, with a high-speed monoplane of existing type, to carry out reconnoitring work, over the sea, in a wind blowing at the rate of forty miles an hour. The even force of the sea wind would make all the difference.

It may be anticipated, also, that this wind-flying capacity of the aeroplane, for work at sea, will rise from, say, forty to fifty miles an hour, as the speed of machines is increased. There is, indeed, every chance that a naval aeroplane will be able to give a good account of itself—even under adverse weather conditions.

II. Interesting tests—Machines for rising from water, and landing on a ship's deck.

In America a number of interesting tests have been made with aeroplanes for naval use. It was in this country that Mr Eugene Ely, a skilled airman—who has since, unfortunately, met with his death—first demonstrated the practicability of alighting upon, and rising from, the deck of a battleship.

At the time the test was made, the American cruiser *Pennsylvania* was lying about twelve miles off San Francisco. For the purpose of the experiment, a wooden platform was erected at the cruiser's stern, upon which the airman expressed his intention of descending.

Ely, flying a Curtiss biplane, left the shore in a slight mist, being guided as he approached his destination by the syren blasts of the *Pennsylvania*. When

sighted by those on the cruiser, he was flying low, quite close to the surface of the water.

The airman steered past the *Pennsylvania's* bow. Then he rose a little, and made a half-circle in the air. Smoothly approaching the vessel's stern, he stopped his engine, and settled with absolute precision upon the platform.

After a short rest, Ely added to the practical interest of his performance by rising from the cruiser's deck, and flying back to his starting-point, a field on the outskirts of San Francisco.

American naval men were naturally impressed by this performance, and also by a series of experiments which were carried out by Mr Glen H. Curtiss, the builder of the biplane which bears his name.

Mr Curtiss designed a biplane which would float upon the water on pontoons, and also rise from the surface of the water when it moved forward at a certain speed.

Considerable ingenuity was exercised in the construction of this machine. The pontoons upon which it was mounted, and which took the place of ordinary land wheels, were hollow boxes with pointed ends, made out of wood, and sheathed with thin steel.

A large pontoon, under the centre of the biplane, bore the greater part of the weight, and a smaller pontoon was set under the front of the machine; while a third pontoon, smaller still, was placed at the extreme forward end of the aeroplane, to tilt it upward when it began to move across the water.

First tests with this machine were entirely successful. When forced forward by its propeller, at a speed of thirty miles an hour, the hydro-aeroplane skimmed along with only its main pontoon on the water. Then, at a slight acceleration, it rose easily into the air, and flew off. Descents upon the surface of the water were made with equal facility.

[image]

MOTOR TRANSPORT.
Photo, M. Branger.
This picture shows how a Breguet military biplane, with its main-planes folded by the sides of its body, can be towed from point to point behind a motor-lorry.

After satisfying himself that his machine answered expectations, Curtiss carried out an instructive test in conjunction with an American battleship. Flying from a point on shore, he made a successful descent upon the water close beside

the vessel. Then his machine was hoisted on board, by means of special tackle.

To complete the test, the biplane was subsequently lowered into the water again; and Curtiss rose without difficulty, flying back to the shore.

The objection to such a scheme as this, of course, would lie in the probable roughness of the sea under many conditions of work. Were a high sea running, it is generally admitted that an aeroplane could not possibly rise from, or land upon, the surface of the water. Therefore, the sound plan, at any rate on the high seas, would seem to be for an air-scout to be launched from the deck of a ship.

An aeroplane on pontoons should, however, find many uses for coastal work. It could, for example, be housed in a shed on the water. It could then leave harbour on a reconnoitring flight, and return again, when alighting, to the smooth water inside the harbour. An involuntary descent, when over the water, would not cause it injury.

Apart from the work which it could perform as a scout, using wireless telegraphy to flash back its news to a parent ship, there are also the destructive possibilities of a naval aeroplane to be considered. In this regard, however, many experts do not consider that the potentialities of a naval aircraft would be so important as those of a machine operating with land forces.

An attack upon a warship by aeroplane would not, it is held, do much damage to the sea-craft, the contention being that the aeroplane would not be able to carry bombs sufficiently powerful to effect any appreciable damage. Another point made is that it would be exceedingly difficult for an aeroplanist to make good practice with his bombs, from the height at which he would have to fly in order to be comparatively safe from gun-fire, and also in view of the fact that both he, and his target, would be moving.

In this connection, however, there is much to be learned. It is not known, as yet, how powerful a bomb may be devised for the use of a destructive aeroplane; and, from the point of view of marksmanship with such missiles, types of releasing apparatus are now being devised which may ensure greater accuracy of aim than is at present considered possible.

A use for the naval aeroplane would be to cooperate with warships in attack upon land defences. A number of machines could be launched from the deck of the parent ship, and fly over docks and harbours, dropping incendiary and explosive bombs, and effecting considerable damage.

Another effective field for the use of naval aeroplanes should be in detecting the approach of submarines; but, in this regard, more data is certainly required.

Primarily for scouting, both from the land, and from a ship at sea, and also as a weapon of offence—if used in sufficient numbers—the aeroplane merits the careful attention of all naval authorities. In England, at the time of writing, very little has been done. A few naval officers have had an opportunity of learning to

fly, owing to private generosity, and unimportant experiments have been made.

A very large sum of money has, however, been expended by the Admiralty upon a huge dirigible balloon, 500 feet long, which, after undergoing a tedious period of construction and alteration at Barrow, met with the untimely end of being wrecked by wind-gusts before it had ever taken the air.

In January, however, it was stated, more or less officially, that the Admiralty intended to devote serious attention, during 1912, to the question of naval airmanship; but, beyond arranging for another party of officers to learn to fly at Eastchurch, Isle of Sheppey, nothing definite has, at the time of writing, been done—save that it is understood that the Admiralty has committed itself to the construction of a smaller, rigid-type airship.

For naval work, beyond doubt, the powerful, high-speed aeroplane, capable of making progress against very strong winds, and sufficiently portable to be carried in appreciable numbers upon a specially-designed parent ship, is the ideal—with another type of aircraft, larger, and with a greater radius of action, to act as a scout from land defences.

NOTE

Since the above was written, our Naval authorities have decided to train forty airmen and to purchase a dozen experimental machines, including hydro-aeroplanes of various makes.

SIXTEENTH SECTION AERIAL WORK IN THE FRENCH AND GERMAN AUTUMN MANOEUVRES, 1911

I. French successes—Proof of the value of organisation—Flights in high winds.

Previously we have dealt with the remarkable results obtained, from the first use of aeroplanes, in the autumn manœuvres in France, in 1910. Now we have an

opportunity of describing the fruits of a year's progress, as shown in the triumphs achieved during the autumn operations in 1911. Nothing could, indeed, be more encouraging to the French authorities than this one year's work.

By the time the autumn manœuvres of 1911 came along, there were eighteen military air-stations in various parts of France, and a preliminary organisation of much interest had been created. It was decided, therefore, to make a far more thorough and drastic test of the value of the aeroplanes in war than had been attempted in 1910. Thirty machines, comprising biplanes and monoplanes, and representing aircraft of the principal makes, were detailed to co-operate with the manoeuvring forces. They were divided into equal corps, and were instructed to operate with the Commanders-in-Chief of the two forces.

The importance of the results obtained lay, very largely, in the successful use of the adjuncts to the air service, which had been organised during the flying season of 1911. The military aeroplanists established their camps near the Headquarters of the troops they were serving, and collapsible sheds, for their machines, were brought up on special motor-lorries.

A striking feature of the organisation, also, was the travelling "atelier," or workshop. These vehicles, huge motor-vans, with a skilled staff in attendance, were here, there, and everywhere. Their equipment included tools capable of dealing with any break-down, large or small.

All the practice work carried out during the summer, at the various military schools, bore fruit. The airmen knew their work and their machines; the observers had made themselves thoroughly proficient in their duties; and the mechanics were quick and competent. And it is such details as these, as has been said, that spell success in aerial work.

Naturally the question arises, "What did the air-men do?" The answer may, truthfully, be made comprehensive. They did everything—everything, that is, that was asked of them. The officers of both manoeuvring forces were amazed at the accuracy of the reconnoitring reports brought in.

Another feature of the military airmen's work was represented by the adverse weather conditions in which they flew. Here was a distinct and unmistakable evidence of progress. In 1910, at the autumn manœuvres, a wind of from twenty to twenty-five miles an hour had been the limit in which pilots had cared to ascend. But, in the 1911 manœuvres, reconnoitring machines were boldly taken up in winds of as great a velocity as thirty and thirty-five miles an hour; and, in one or two cases, machines were reported to have weathered winds blowing at the rate of forty miles an hour.

From the military point of view, the actual demonstration of this wind-flying capacity of the modern aeroplane was of the utmost value. It meant that there was practically no delay in carrying out instructions. Instead of waiting, as

he would have been obliged to do, occasionally, the previous year, before carrying out a reconnoitring flight, the airman was promptly in his machine, and away—despite the fact that a strong and gusty wind might be blowing.

Another point demonstrated, beyond question, was the reliability of aeroplane engines. Pilot after pilot returned from aerial journeys without any mechanical trouble whatever; engine failure, at first so common a fault, was proved to have been almost eliminated.

It was not merely a case of engine improvement; the careful work of the mechanics, in "tuning up" the motors, had a great deal to do with this immunity from breakdown. Such a proof of reliability was, as may be imagined, of great significance to those who were gauging the work of the aeroplane purely from, the military point of view.

Practice, as has been said, permitted the observers in the reconnoitring aeroplanes to obtain significant results. A test which was carried out, purely to determine the accuracy of aerial observation, is worth describing. In this case, a fortified position, some little distance away from one of the aeroplane camps, had been largely redesigned. The officer in charge of the aeroplanes decided to call upon three observers, who knew nothing of the alterations to the position which had been carried out, to make a reconnoitring flight over the spot, and prepare rough maps showing the location of the defences. This, he thought, would provide a severe test of the accuracy of each officer's observation.

Previous to sending away the three machines upon their errand, the officer had obtained, from the Commander of the fortifications, an exact plan of the new defences; he was, therefore, in a position to check, even in details, the maps furnished by the air-scouts.

The three airmen who set out upon this special reconnoitring mission, each carrying an observer with him, approached their destination by different routes. Each, as he came near the fortified position he was to reconnoitre, flew at an altitude of more than 3000 feet—the height specified as being fairly safe from artillery-fire.

All three observers did their work, making brief notes, and rough maps, as they flew over the fortifications. One of them, using a special camera with a telephoto lens, secured a series of photographs from a height of 4000 feet.

But the point of the test was this: when the three observers had returned safely to their starting-point, their reports and maps were compared with the exact details of the fortifications, which were in the hands of the Commander of the air-corps.

The result was instructive. Without any previous knowledge of the changes which had been made in the fortifications reconnoitred, the three observers had been able to indicate, with clearness, the position of all the defences.

From their material, indeed, it was found possible to prepare a map which corresponded with that previously provided by the officer in charge of the fortifications.

The test was considered a very effective one. It showed that an aerial observer could—even when at a considerable altitude—carry out a reconnaissance with accuracy, and prepare maps which could compare favourably with those drawn up at leisure, and as a result of detailed survey work carried out on the spot.

As regards the reconnoitring flights carried out by the officer-airmen during the manœuvres, there is not a great deal to be said, for the reason that they were uniformly successful. The Commanders-in-Chief stated what they required, and the airmen carried out their orders.

With the information thus provided for them, both Commanders-in-Chief found it necessary, more than once, to alter their plans.

Not one day, but practically every day, the airmen were able to carry out their appointed tasks, and their work of reconnaissance became an adjunct which could be definitely relied upon.

II. Work in the German manœuvres—An instance of the utility of air-scouts—Reconnoitring from high altitudes.

In the German autumn manœuvres, 1911, the aeroplane may be said to have made its first practical appearance in connection with military operations in this country; and, here again, complete success marked the tests. One instance, regarding these German manœuvres, is forthcoming of the manner in which vitally-important information may be obtained by reconnoitring airmen.

The Commander of the Red forces, suspecting some definite move on the part of his enemy on a certain morning, sent out several aerial observers. They performed a successful flight, and returned quickly with the information that a large body of the Blue troops was beginning to advance against the Red right.

Taking instant action, upon the receipt of this intelligence, the Red Commander pushed forward a very large body of men to a point of strategic importance, and so was able to checkmate, very neatly, the advance of the Blue troops.

The German military authorities, although led to expect much from scouting aeroplanes, were surprised by the results which were, in actual practice, obtained. One after another, in fact, the military experts who were following the manœuvres were forced to declare that it would be almost hopeless, in future operations, to hide the movements of troops from the air-scouts of an enemy.

It was, of course, recognised that this only applied to fairly clear weather,

in which the observers could obtain their bird's-eye view of the land below them. In thick mist, or fog, it would admittedly be useless to send out air-scouts. But such weather conditions, although encountered with some frequency, do not, as a rule, last for long. After a few hours' delay, while waiting for a fog or mist to clear, the airmen should be able to carry out their work.

What actually happened, in the German manœuvres, was this: by 8 a.m. on the morning of the first day of the operations, each side had sent up its observing aeroplanes, and had obtained a concise report as to the position of the enemy's forces. This result was, naturally, claimed to be a complete triumph for the aeroplane, particularly seeing that such traps as sham entrenchments had been prepared to deceive the airmen—but without succeeding in their object.

Here, indeed, lay another illustration of the growing skill of aerial observers. In the manœuvres of 1910, when observation officers were new to their work, they had been deceived, on several occasions, by dummy entrenchments; but in 1911—a year later—they made no mistakes of this kind. Their observation powers had been perfected by innumerable practice flights—proof of the value of constant work at the flying schools.

Another feature of the work achieved in these autumn manœuvres of 1911 was particularly worthy of note, also. This was the altitudes at which the reconnoitring aeroplanes carried out their observations. In 1910, the criticism had been freely passed that the machines would have been blown to pieces, in actual war, had they passed over troops while flying so near the ground.

As a matter of fact, being so new to their work, and not having great experience in the difficult duties of aerial reconnaissance, some of the airmen in the 1910 manœuvres were, undoubtedly, flying too near the ground. A height of a little over 1000 feet, which they maintained, would, almost surely, be perilous in times of war.

But, in the 1911 operations, this was changed. The minimum height at which any of the scouting aircraft flew, when near the enemy, either in the French or German manœuvres, was 2000 feet. Generally speaking, the altitudes maintained were from 2500 to 3000 feet; and, in some cases, the airmen flew even higher than this.

This increase in altitude, so necessary in escaping an enemy's gun-fire, did not in any way affect the accuracy of the news obtained by the air-scouts. It was, indeed, proved beyond question that reports of complete reliability might be obtained from the altitudes mentioned.

Opinion was naturally divided as to the question of the vulnerability of the aeroplanes to gun-fire. But unbiased observers, noting the height at which the aeroplanes flew, and the speed at which they came into range and disappeared again, were found to declare that special artillery, however cleverly han-

dled, would have its work cut out to make anything like effective practice.

The destructive possibilities of the aeroplane were not demonstrated in these manœuvres of 1911. That, perhaps, will be left to the operations to be held in the autumn of 1912. And, still remaining unsolved, of course, is the question of war in the air between rival air-fleets.

In the case of the 1911 German manœuvres, for instance, this problem of offensive work has particular interest. Both manoeuvring forces sent out their scouts, and each side obtained detailed reports concerning the doings of the other side. The two Commanders-in-Chief were, therefore, upon an equality, so far as their aerial observations were concerned.

In actual warfare, probably, this would not have been the case. The two air-fleets would have come into contact; and it is probable that one of them would have suffered more severely than the other, with the result that its subsequent reconnoitring work would have become inferior to that of the squadron which had triumphed in the fighting.

III. Aeroplanes in actual warfare—What Italian airmen accomplished in Tripoli—Scouting and bomb-dropping under service conditions.

While referring to the operations carried out during the autumn of 1911, it is certainly necessary to refer to the first war test—made by the Italians in their Tripoli campaign—of the aeroplane as a reconnoitring instrument.

What was done in Tripoli, although not on a large scale, was, none the less, instructive; and there is little doubt but that the success achieved by the Italian military airmen, under arduous service conditions, had much to do with the decision of the authorities in England to make a definite move with regard to airmanship.

The circumstances in Tripoli were these: the Italians held the town, with their troops in a sort of half-moon formation, and with unknown forces of Turks and Arabs moving about on the desert, inland, and threatening unexpected attacks at all points.

Obviously, the business of the air-scouts was to reconnoitre as wide a tract of desert as possible, and endeavour to obtain news as to the movements, and particularly the numbers, of the enemy which menaced the Italian position.

Several Blériot monoplanes, and an Etrich monoplane, were, at first, at the disposal of the Italian Commander-in-Chief. Later on, quite a large number of machines, many of them handled by civilian volunteers, were on the scene. The scouting machines were employed to the best possible advantage. Trouble, it is

interesting to note, was at first experienced in connection with the engines. Sand from the desert worked into valves and bearings. This was one of those little practical difficulties which are only encountered under actual service conditions.

The courage of the officer-airmen, in carrying out scouting flights, was marked. They flew over the Turkish and Arab lines. Had their engines failed them at a critical moment, and they had descended among a horde of wild Arabs, there is little doubt but that their plight would have been uncommonly awkward.

Working, generally, soon after dawn, the airmen made wide, sweeping half-circles over the enemy's positions, and brought back detailed and practical reports concerning the disposition, and movements, of all the bodies of men they saw. More than once they were able to provide the Italian Commander with accurate and very valuable information regarding the sudden moving up, and massing, of large bodies of the enemy. The Italians were, in consequence, ready for an attack when it was delivered.

Hurriedly sent to the front, and working under a good many difficulties, it was, indeed, remarkable what the military pilots were able to do. They made a large number of flights without any untoward incident—beyond that of being fired on, spasmodically, by Turkish and Arab foemen.

The effect of this fire was, it is interesting to note, practically nil. The wings of the monoplanes were, it was reported, pierced more than once by bullets, but this had no adverse effect upon the machines; although, in one instance, an observer was reported to have been slightly wounded.

There was, of course, no artillery, with special guns, to test its ability in bringing down the scouting machines. Practical data, concerning what a specially-made aerial gun can do, will only be forthcoming when an army with more up-to-date equipment than that of Turkey is circled over by reconnoitring machines.

In connection with the Etrich monoplane used in Tripoli a test was made, on one occasion, with bombs. A number of small explosive bombs were carried up in the machine, and the officer-pilot dropped them over some parties of the enemy. The report, regarding these tests, was that damage had been done by the bombs; but exact details are wanting. The experiment cannot be regarded as a conclusive one, or as one illustrating in any striking way the destructive capabilities of the aeroplane.

The value of the lesson taught by the Tripoli operations cannot, however, be overestimated. Sent out to the front like any other part of the army's equipment, the aeroplanes were assembled quickly, and flown successfully by their pilots—amply justifying their inclusion in the scheme of affairs by the extremely valuable work they were able to accomplish.

What the Tripoli flying certainly demonstrated was the value of the scout-

ing aeroplane when used in difficult, or inaccessible country. In the future, when a force has to penetrate some awkward and hostile region, in which land scouting is almost impossible, and a lurking enemy has to be located, the work of an aerial reconnoitring officer will be of outstanding importance.

Rather more from this point of view, than from that of any lesson as to the value of aeroplanes in operations between two scientifically-armed European nations, should the use of machines in the Tripoli campaign be regarded.

IV. A final word—Conclusions to be arrived at—Problems outstanding.

In view of the most recent tests which may be described, the war aeroplane stands in the following position: for scouting work it has, both in 1910, and again with far greater force in 1911, proved its value in a way that cannot be denied. Its destructive potentialities, although clearly apparent, have not yet been demonstrated in a practical way. That, as has been said, should remain a matter for definite experiment in 1912.

There remain two problems which may be said to be outstanding. One of them is the effect which gun-fire will have upon the aeroplane; and the other concerns the result of the actual fighting which must inevitably take place, between hostile aircraft, when they meet under conditions of war.

As to the former, a reader may be able to judge, more or less, from what has been written in previous sections. Experiments, for what they are worth, have been in favour of the aeroplane. In the future, too, it will have increasing speed to help it. That it can fly 3000 feet high, and carry out its reconnoitring work efficiently, has been demonstrated.

The wise view to take of this question, in consideration of the most recent data, is that a certain percentage of war aeroplanes will fall victims to gunfire, but that this percentage will be a very small one, and that it will be in no way sufficient to mar the success of the work that a squadron of air-scouts will be able to undertake.

The suggestion is now made that, in order to secure some conclusive results, power-driver aeroplanes, without occupants, should be made to ascend, and be directed on a pre-arranged course, while subjected to artillery-fire. Such a method would be costly, however; but it might certainly yield remarkably interesting data.

Then there is the question of hostilities between aircraft, to which several references have been made. Here, again, theory has to take the place of practice. It is perfectly certain that, as machines cross from their own lines to those of the

enemy, engagements will take place between them and hostile craft—which will seek to check them in their aerial spying.

[image]

TRAVELLING WORKSHOP.
Photo, M. Branger.
In the French manœuvres, a completely-equipped aeroplane repair shop, in the form of a motor-wagon, followed the military airmen as they moved from point to point. One of these invaluable "ateliers" is pictured above.

That special fighting machines will be built is practically certain, also; and it is probable that, in wars of the future, engagements between these aerial opponents will precede reconnoitring work. How such flights in the air will end it is, however, difficult to predict. If some form of light explosive shell is fired, one well-placed shot will probably wreck a machine, or render it unmanageable. An aerial duel promises to be over quickly. The skill will, no doubt, lie in getting in the first shot, and in making that an accurate one.

Although, in some respects, the future is obscure, there is, upon one important point, most definite data to proceed upon. This is that the aeroplane is an instrument which will entirely change military reconnaissance.

"We are in the presence of a new and formidable science that will revolutionise warfare." So spoke Colonel Seely, Parliamentary Under-Secretary of State for War, at a special gathering of the Aeronautical Society on 18th December, 1911.

At the moment, all other problems are subservient to this: whatever its destructive powers may prove to be, and whatever may be the result of well-directed artillery-fire upon aerial scouts, no great nation can afford to neglect this new weapon.

If any country dare to do so, and others go ahead, then the nation which lags behind will stand in imminent peril in war-time. It may have a fine army, or a great fleet, but if it does not possess aeroplanes, and its opponent has them, it will be at a very serious disadvantage.

This point is no longer a matter of any supposition. It has been proved, beyond all question. It was, as a matter of fact, proved in 1910, and it was proved again in 1911. It needs no further proof. The aeroplane has shown what it can do, not in easy experiments, but under rigorous test conditions.

If our War Office buys a few more foreign machines, and makes a small stir

at our military school on Salisbury Plain, that cannot be regarded as any serious step towards making up our leeway. The whole problem needs taking in hand in a way that England has not yet done.

Military flying is not a thing to be trifled with, or played at; France and Germany realise this. In 1912 they will be spending far more money upon aviation than they did in 1911. Germany, as an instance of determined purpose, intends to amplify, to the extent of £100,000, the grant for military aviation. They will be increasing their air-fleets, gaining in experience, and preparing themselves for that use of aircraft, on a very large scale, which so many experts are ready to predict will be the ultimate development.

So, with each improvement that the aeroplane makes, the peril of inactivity grows. Not only the action of foreign nations, but the warnings of far-seeing military experts in our own country, have pointed to the danger of a policy of "wait and see."

Aeroplanes, and men constantly using them—that is what we need. Money must be spent, not extravagantly, but ungrudgingly. There must be practical encouragement.

Both in the Army and Navy it has been shown that we have men, ready and eager for air work, who win compare favourably, in point of skill and resource, with the pick of the air-corps of foreign countries.

We spend millions, willingly, upon other forms of armament. All that is required is that we should spend thousands—in the right way—upon aeroplanes.

Finally, it is possible to summarise, briefly, such points and suggestions, concerning the use of war aeroplanes, as represent the most recent pronouncements of international experts upon this difficult problem.

It is now urged that machines would need to reconnoitre at night, seeing that important movements of troops are made under cover of darkness. In this regard, although it is probable that an airman would be able even at night, by flying low, to detect large bodies of men, further data is necessary in the way of practical tests.

For a scouting expedition of unusual importance—in which the safe return of the aeroplane is a point subservient to all others—it is held that a machine equipped with a dual engine-plant ought to be used, so that, should one motor fail, the pilot could fly on with the power of the other. Experiments with machines so equipped have already been undertaken.

A subsidiary, but practical use of a weight-carrying machine, during the course of an action, is suggested in the carrying of ammunition, when urgently required, from point to point.

The silencing of engines—previously referred to—and the fitting of all machines with dual control, so that, should the pilot be wounded, the observer can

instantly assume control of the machine, are points now urged as being essential.

Protecting the vital parts of a fighting machine, with some form of light armour, is advocated; and it is emphasised that, for a scouting craft, flexibility of speed would be invaluable, seeing that, with an aeroplane capable of reducing its pace, the scouting officer should be able to amplify the detail of his observations.

By way of a final word, this much may be said: the flying season of 1912 will, beyond all doubt, yield results of the utmost significance in the further development of aircraft for military and naval use.

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