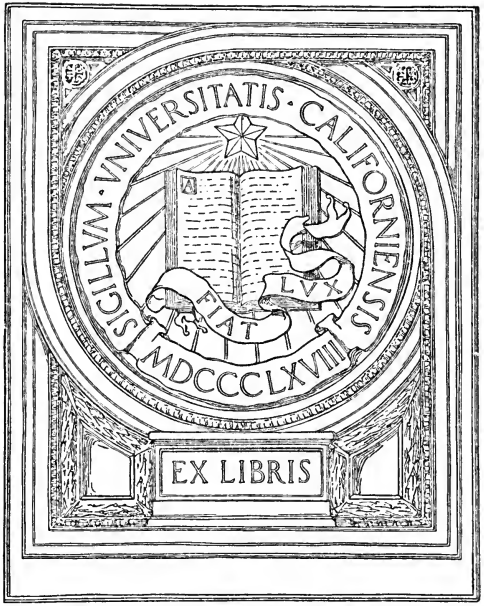
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AIRCRAFT IN WAR AND PEACE

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From "Aeronautics." *By courtesy of C. Uchter Knox, Alton, Hants.*

ZEPPELIN L-Z III. OVER LINDAU HARBOUR, LAKE CONSTANCE, NEAR THE FRIEDRICHSHAFEN WORKS.

AIRCRAFT
IN WAR AND PEACE

BY

WILLIAM A. ROBSON

WITH ILLUSTRATIONS

MACMILLAN AND CO., LIMITED
ST. MARTIN'S STREET, LONDON
1916

TO

D. R.

PREFACE

In this short book I have attempted to convey, in plain non-technical language, a general idea of the conditions under which aircraft is playing its part in the War, and also to indicate the chief directions in which it is developing.

To the general public the War has revealed, in a startling manner, the wonderful potentialities which aircraft, and aeroplanes in particular, possess as weapons of war. But although there is at last plenty of enthusiasm for Aviation, there is still very little real knowledge of the vast possibilities which it offers. And, if we are to have an air force as proportionately powerful as our Navy is to-day—and it is absolutely essential that we should—a better and wider understanding will be most necessary. To-day, for instance, people do not fully realise that aeroplanes, as well as airships, are still in their infancy, in spite of the extraordinary achieve-

ments which they have accomplished. Then, again, aircraft is at present regarded as being almost entirely for use in warfare, although, as a matter of fact, it will be of the utmost value for civil purposes in times of peace.

I do not pretend that my book is in any way complete. Indeed, to attempt to be complete on the subject of Aviation is inevitably to be incomplete, so swiftly does it progress. My intention has been to make a brief survey of Aviation in its present-day position, and to show how important it is that in future it should receive a great deal more attention than hitherto.

My sincere thanks are due to Mr. J. H. Ledeboer, A.F.Ae.S. (Editor of *Aeronautics*), and to Mr. G. J. Pass for kindly assisting me in the correction of proofs. I also wish to thank the Editors of the *Sunday Times*, *T.P.'s Weekly*, *The World*, and *Cassell's General Press* for their courtesy in permitting me to use, in a few instances, material embodied in articles appearing in their journals.

WILLIAM A. ROBSON.

LONDON, 1916.

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AIRCRAFT IN WAR

CHAPTER I

WAR WITH AIRCRAFT

Aviation has abolished the old methods of warfare, and introduced entirely new conditions, to a far greater extent than any other science.

In addition, no other great discovery was brought into military use with anything like such astonishing rapidity as that of flying. Even such comparative novelties in actual warfare as the high-explosive shell, the submarine, and the motor-car—to name but a few—have all been developed gradually, sometimes through the experience gained in other wars. In consequence, they are factors which great armies and navies are at any rate accustomed to use, and, to a certain extent, protect themselves against. But aviation was so new, strange, and unaccountable, that it seldom entered seriously into the calculations of military experts, until the arrival

of the War suddenly revealed its tremendous possibilities, and upset the theories of all but a few who had hitherto been regarded more or less as cranks.

In fact, just as flying will, in time to come, when aeroplanes are at least as numerous as motor-driven vehicles, alter the course of our everyday civilian lives, so it has to-day, even in its comparatively undeveloped condition, revolutionised the art and science of warfare.

To state it shortly, the use of aircraft has dispelled the "fog of war." Perhaps the most outstanding result of this has been that warfare has developed into practically a series of sieges; and, when special efforts are made, they are generally attempts to break through the opposing siege-line rather than the pitched battles of previous wars.

Aircraft has two distinct functions in the present campaign; primarily, for all branches of reconnaissance work, and, secondly, as a weapon in itself. Compared to its indispensable and marvellous capabilities as a scout, the latter use of the aeroplane is not at present of so much importance, and this can be said even when bearing in mind the very valuable raids which

aviators have frequently carried out with conspicuous military success.

There is certainly no doubt that in time to come the aeroplane will be easily the most important and effective weapon which it will be possible to use ; but to-day it is the eyes of the army rather than its weapon. How tremendously powerful it may be when used offensively can be surmised.

With the advent of the aeroplane the element of surprise has practically disappeared from modern warfare, except in a few cases of minor importance. With an efficient air service, the commanding officer is accurately aware, not only of the enemy's strength in the immediately opposed firing line, but of his transports, convoys, food and ammunition supplies, lines of communication, and the approximate number of his reserves for a very long way behind the actual front. In addition to this, an accurate knowledge of the *disposition* of the enemy's troops is available. The present-day commander knows exactly what is going on behind every fortification, hill, or parapet. It is now no longer possible to bluff your enemy, by pretending to have troops evenly disposed along a certain line,

while in reality massing them along one wing and from there delivering an unexpected flank attack.

It would seem, therefore, that the chances of a decisive victory solely owing to superior strategy were hardly possible between two well-matched armies, now that, for the first time in history, war is in reality a game of chess and not one of blindman's buff; and it would thus appear that to beat your enemy you can do so only by fighting better or longer than he can, or with more munitions, without relying on the usual strategy of taking him by surprise.

This, however, is not the case; for, after all, surprise is not essentially a necessary element in gaining the advantageous strategical position which may decide the victory. As has been demonstrated several times since war broke out, by the Allies—most notably at Neuve Chapelle and La Bassée—and by the Germans on the Eastern Front, what *is* essential for success is the great speed at which a special attack must be delivered. The opposing General may be fully aware, from the information supplied to him by his air scouts, of the enemy's intentions and movements, and yet be powerless to counteract

them successfully. He may not be able to risk sending sufficient troops to meet the onslaught; he may know that it is not possible to get his forces there in time; or he may even send them there and be too late. Swiftness and mobility in an army are to-day more than ever necessary to realise to the full the enormous advantages of the aeroplane in war.

Purely as a weapon in itself—and in time to come this will be its chief use for military purposes—aircraft has not yet come fully to its own. At present, aeroplanes are too scarce in every country for an effective quantity to be used *often enough* as an offensive weapon to accomplish a victory in the widest sense of the word. To-day it is necessary for large flights of them to concentrate on a single object in order to destroy it successfully, and these large flights cannot always be spared from their supremely valuable reconnaissance work to undertake raids, important as they are; for we have to put our supply to the use which is of the greatest military value *in the long run*. When aeroplanes are made large enough to carry a much heavier weight of explosives without loss of flying and climbing speed, a handful of them will of course be able to inflict

damage on a greater military area than is at present possible even with a considerable number.

Perhaps the most important thing, from an aeronautical standpoint, which aircraft has accomplished in the War has been to establish itself firmly and absolutely. There is no longer the question of an efficient air force being a luxury, for it is now recognised as a national necessity. Its supreme importance is at last acknowledged by every one, and most emphatically by men in high official positions who are best able to judge the great part it is playing in the War.

For, although a distinction has been drawn between aircraft as it is to-day, and as it will be when it is perfectly developed, it must above all be remembered that, generally speaking, our arms can even to-day only act effectively and successfully with the assistance and co-operation of aircraft. When Mr. Lloyd George visited an aeroplane factory a short time ago, in thanking the workmen he said, " The more of these machines you can turn out the better it will be for our brave fellows in France. It is the only way we can detect the hidden gun emplacements of the enemy. Those splendid airmen and observers find out exactly where the

trenches and the guns are, and then our artillery gets to work, and when they have smashed away defences, our infantry will turn the Germans out of the trenches."

One thing has been demonstrated to this country in particular, and that is the altered conditions which now concern us as an Island Power. We realise clearly, although it is not so easy to do so, that aircraft knows not the division of land and sea; that the air is the domain of all. In that respect alone it is perhaps well for us that the War came when it did; for it has shown us the methods which a nation will have to adopt in the future to preserve its power and safety.

It is true, of course, that our Navy will always prove a source of the greatest strength to us, and that sea power will, to a certain extent, remain what it is; but we now see that, just as we must always have a strong fleet on the sea, so we must have a proportionately strong one in the air.

It is not easy to realise what real fighting in the air means; that is to say, a battle, not between two or three aeroplanes, but between two or three hundred or between two or three thousand. In the domain of the air there are no geographical advantages, no mountains, rivers,

valleys, cliffs, woods, towns, fortresses or railways; no boundaries, fortifications, frontiers or limitations. No retreat is possible, and no escape, between well-matched aircraft. In the future, we can see from this present War, the force that conquers the upper air conquers all beneath it. And although there will always be a land army, it will be as auxiliary to the air force, as is the flying corps to the land army to-day; for the great battles, with their consequent results and issues, will take place in the air.

These few remarks regarding the altered conditions which now prevail, and the developments which it is clear must proceed from the present campaign, are intended to show that the possibilities of aircraft cannot only be judged from its actual performance in this War itself; for some people do not apparently realise the very immature stage from which aviation has still to emerge. The War came far too soon, as it were, for the science in general, for aviation was no more ready for war than was this country prepared for it.

We can now pass on to the wonderful achievements which aircraft has performed since that memorable August in 1914, and to the conditions which surround it in the War.

CHAPTER II

WHAT BRITISH AIRCRAFT HAS DONE

EVERY branch of our Navy and Army has throughout the war maintained the best traditions of its history. But British aircraft has established its own tradition during the campaign; and the Air Services have made a reputation which to-day stands unrivalled, not only for continuous hard work, but for almost consistent success in the face of the most arduous difficulties.

It is really somewhat difficult to appreciate the significance of all that the Royal Flying Corps has achieved at the Western Front. The whole existence of our Army, and everything that it has to accomplish, is directly or indirectly dependent on the efforts of the Flying Corps. In every operation, great or small, in every attack, in all the early successful rearguard actions, the Corps has played a conspicuous part. From the

very beginning, when it saved the British Expeditionary Force from being cut up in the retreat from Mons, the Flying Corps showed the stuff it was made of, and after only two months of war Sir John French was able to write that " . . . the British Flying Corps has succeeded in establishing an individual ascendancy which is as serviceable to us as it is damaging to the enemy."

It is extremely instructive to examine one or two aspects of the campaign, in order to realise fully the direct and definite material influence which the war in the air exerts on the fortunes of the armies on their several Fronts.

Consider first the movements on the Eastern Front, when Russia was passing through a very critical period, and it was uncertain not only whether her armies would be surrounded and destroyed, but whether the Germans would be able to penetrate into Central Russia. It was common talk that our Ally was badly in need of munitions; but while everybody was quick enough to explain that the Russians were short of field-guns and shells, rifles, machine-guns, howitzers, and so forth, scarcely any one pointed out that they were very short of aeroplanes, although it was perfectly plain that Russia's

bad position at the time was to a large degree due to her lack of aeroplanes and to Germany's possession of a good supply. Because people were under the impression that Sikorsky was a Russian, apparently it followed for them that Russia had in consequence a good supply of military aeroplanes. Of course, even Germany's supply of aeroplanes on the East Front was only adequate as compared to Russia's. So many machines to the mile of Front were not at any time used in the East as in the West. Considering the vast length of the former, this is only to be expected. It is worth while to add that Russia could never have recovered as she has done if her supply of aeroplanes had not increased considerably after her worst reverses; but for a long time she was hopelessly handicapped by this tremendous disadvantage, and her early successes against the Austrians are explained in part by the fact that Austria had no more aeroplanes than Russia herself possessed at that time.

The significance of aircraft's part in the war was never demonstrated so strikingly as it was in an almost unnoticed incident connected with the successful British advance south of the La

Bassée canal. Two days before this great attack took place the Germans announced—as was mentioned and contradicted in the British official communiqué—that the British had undertaken an offensive south of the La Bassée canal and had been repulsed. Apart from the German motives in announcing this falsehood, it clearly shows that German aeroplanes had observed the preparations and massing of troops at certain places, preparatory to the great push forward. The success attending our offensive is plainly consistent with the statement that the disappearance of the element of surprise in modern warfare does not mean the withdrawal of strategical advantage in attack. In the case in point, the Germans were warned of the coming attack by their aircraft, but they were unable to move sufficient reinforcements to the threatened points in time to resist it.

The very high praise which Sir John French bestowed on the Royal Flying Corps and its work on this occasion, in an Order of the Day, was thoroughly well deserved. For weeks preceding the actual day of the offensive, our aviators had exerted every effort to clear the air of German machines, and in the month of September

1915 alone there were about two hundred and forty duels in the air, in almost every instance of which the enemy's machines were either chased off, forced to descend, or destroyed, without loss to us. However, the work of our aviators did not end there by any means. What was the good of the hailstorm of shells which we fired as the opening note of the attack, unless those shells were going to strike home in the German trenches? To this purpose, therefore, our Flying Corps officers applied themselves to the task of directing our artillery fire with even greater disregard for danger and more persistence than ever. In addition, they succeeded in destroying many vital points in the enemy's lines of communication.

For the success of every venture in modern war, it is essential that a partial supremacy in the air should be gained, although without this a *temporary* advantage may sometimes be obtained at enormous cost. Aerial supremacy is obviously of the utmost importance, operating as it does in two directions; that is to say, every increase in air power on one side means a proportionate decrease in the air power of the other side.

It is not too much to say that, viewing the campaign from the beginning, the British Flying Corps has almost consistently maintained an ascendancy over that of the enemy. Before showing just what that ascendancy means, a few words may be said regarding air power as it exists to-day.

Air power differs from sea power inasmuch as it is not ubiquitous. The British Navy, for example, has obtained absolute command of nearly all the seas and trade-routes in every part of the world, whereas at present it is only possible for even the strongest air fleet to command the air to a strictly limited extent, owing to the all-round scarcity, or comparative scarcity, of aeroplanes. The most that can be done is to distribute aeroplanes behind an army, and, if these aeroplanes and their pilots are superior to those of the enemy, they will defeat, or more probably frighten off, the enemy's aircraft from those parts. When, as at the West Front in the present campaign, the opposing line is so close that keeping hostile aircraft away from your own lines also means keeping it away from the enemy's lines, it can be realised how extremely important this measure of air power

shows itself to be. Although it would, of course, be far more effective and satisfactory actually to destroy or capture the enemy's aeroplanes rather than only to frighten them from approaching the sphere of action, the latter is also extremely valuable, and, after all, is the principle on which our sea power is maintained. But another difference in this respect must be noted between air and sea operations; for, while the German Fleet is securely bottled up in the Kiel Canal, German aeroplanes, even if they may not care to venture within striking distance of British or French aircraft (when over either our own lines or over the German lines) still remain free to be used in various other directions, either at another Front, or for performing raids and other operations which can be carried out without coming too near our airmen.

It can be realised that it is extraordinarily difficult to achieve even that measure of air power which is possible under present conditions, and the fine work of the Royal Flying Corps in accomplishing a partial but decided supremacy cannot be valued too highly. But it must be added that our ascendancy in the air cannot be, and has not been, positively and

permanently fixed to our advantage, as in the case of our sea supremacy. There are too many constantly changing factors for that. In fact, the degree of our supremacy fluctuates considerably, now growing weaker, now stronger, although as a whole it has strengthened immensely with every month of war.

The reasons for this fluctuation are various. For example, when a large portion of the German Army was transferred to the East for the Russian adventure, many of the best German aeroplanes went with it; so, for a time, the Royal Flying Corps had the air almost to itself. Then again it varies with the production of more powerful and improved aeroplanes on each side; thus, when the Germans first brought out their "battle plane" with a two hundred horse-power engine, for a short period we completely lost our ascendancy, which for the time being was transferred to the enemy.

However, with the exception of a few intervals, we have undeniably maintained an ascendancy in the air; and in order to show how marked this has been, a quotation may be made from another despatch written nearly a year after the outbreak of war and selected

from the many in which Sir John French paid tribute to the Flying Corps: "The Royal Flying Corps is becoming more and more an indispensable factor in combined operations. In co-operation with the artillery in particular, there has been continuous improvement both in the methods and in the technical material employed. . . . During this period (two months) there have been more than sixty combats in the air, in which not one British aeroplane has been lost. . . . In spite of the opposition of hostile aircraft, and the great number of anti-aircraft guns employed by the enemy, air reconnaissance has been carried out with regularity and accuracy."

This clearly shows that if an absolute dominance of the air is impossible, a comparative one is perfectly feasible.

The scope of our ascendancy comes under three heads:

1. Reconnaissance.
2. Directing Artillery Fire.
3. Bomb-dropping.

In the case of scouting, it means that day after day the commanding officers are able to receive a supply of increasingly accurate infor-

mation as to the enemy's movements and whereabouts, due to the observers becoming more and more familiar with each particular part of the country from above. In directing artillery fire the advantage obtained is equally great. To be able to fly for hours at a stretch "spotting" for the gunners below, and signalling the results to them, until the gunfire is so directed that every shell strikes home, is obviously of the greatest possible value. In bomb-dropping the ascendancy enables flights of our aeroplanes to travel long or short distances into the enemy's territory, to drop their bombs, and to return in safety, though, occasionally, with the loss of a raider. As a matter of fact, the total number of casualties in our flying services during the War has been surprisingly low, and less, in proportion to the distance flown, than in time of peace.

Our aviators prove a great hindrance to the enemy's aeroplanes, for they not only bring down or chase off those attempting reconnaissance over our lines, but they also attack hostile machines which have been deputed to direct the artillery fire of the German batteries. And, as any one can see from the official *communiqués*,

the enemy has carried out extraordinarily few raids of any note whatever in the Western theatre of war.

Aerial supremacy in war is almost entirely based on the following qualifications: A sufficient supply of effective aeroplanes; efficiency in regard to care and repair of machines; the quality and numbers of the flying corps *personnel*.

Dealing first with the question of aeroplanes, there is one definite outstanding fact: that the finest pilot is almost useless in war unless he is provided with a really good machine, the flying and climbing speed of which must at least equal, if not excel, that of any machine in the possession of the enemy. Nothing has been shown to be so essential in an aeroplane for war purposes as effective climb and effective speed, the one as much as the other. Climb and speed mean as much to an aeroplane as guns and knots mean to a ship, and it is a scientific certainty that the fastest ships with the biggest guns will win the day, although this allows that superior strategy and better gunnery can secure victory even for an outclassed ship under adverse circumstances.

These conditions are reproduced in the air, where the fastest flying and climbing machine will, other things being equal, destroy a slower opponent in combat, unless outwitted by superior strategy. But strategy is just what plays an eminent part in the air, and superior strategy has been the cause of many victories for British aviators.

The word "effective" in the sense that it is used in the preceding paragraph cannot be accurately defined, because what is effective to-day is to-morrow obsolete, so swiftly is aircraft developed; but an effective aeroplane in war is one which will climb and fly at least as fast as any possessed by the enemy. Therefore, the fact that out of such large numbers as sixty and eighty consecutive aerial combats hardly a single British aeroplane was lost, while many of those employed by the enemy were either captured or destroyed, is a definite proof of the superiority as regards flying and climbing speed of those British aeroplanes which were engaged against the German machines; and this can be said even allowing a percentage of wins as being due to superior strategy and not to better machines.

Apart from these two all-important qualities, German aeroplanes possess higher qualifications in many respects than any other models, for they are extremely stable, reliable, and safe. German constructors for years specialised in machines with swept-back wings, designed primarily for stability, until they were practically superseded for military use by faster types; while the remarkable powers of reliability and endurance in German aeroplanes are accounted for by the wonderful aero engines made by such firms as Benz and Mércèdes, for no finer motors of the stationary type exist to-day. These engines enabled German pilots to capture almost all the duration and long-distance records before the War, non-stop flights up to twenty-four hours' length being made.

In Germany, aviation received the utmost official encouragement and support, both moral and financial, for a considerable period before war broke out; while in this country the industry was, to say the least, in the most precarious position possible, owing to the Government not being fully alive to the possibilities of aircraft. Curiously enough the result was that German constructors, full up with orders,

paid more attention to standardising existing machines than to attempting progress with new types, and when war broke out, although they had easily beaten us so far as output was concerned, several of our constructors—to whom the utmost credit is due—had, by devoting their time and money to experimenting, been far more successful in producing really fast-flying and climbing machines. This was particularly fortunate for us, because the experience of the War has shown that nothing is of such great importance in a war aeroplane as these two qualities. Everything else, even perhaps extreme aerodynamical stability, must if necessary be partly sacrificed to them. Incidentally, far more real safety is obtained for the active service pilot in that way.

It can be admitted that our machines do not possess such extraordinary powers of endurance as some of the German makes, but this is a disadvantage which is not frequently felt at the Front, because it is seldom necessary for military [1] machines to make flights requiring *very* exceptional qualities of reliability; for all ordinary every-day work, up to a maximum

[1] Specifically aeroplanes belonging to the Royal Flying Corps.

total of four or five hours' flying per day, British aeroplanes are practically as reliable as German ones. It is only some way after that the advantage possessed by the German machines in this respect begins to tell; but as no pilot could possibly stand the strain of more than four or five hours' flying a day under war conditions, if as much, this advantage is not often brought into play.

On the other hand, the direct benefit of superiority in speed and climb is felt in every flight that is made, for even when it is not used in a contest in the air, it is always invaluable for getting beyond the range of anti-aircraft guns—"Archie" or "Cuthbert," as they are called by the Flying Corps.

So far as climbing goes, rather peculiar conditions exist. The world's altitude record was made three times consecutively by German aviators on German machines (although in one notable case with a British-built engine); but what is required in war is a fast *rate* of climbing rather than only an ability to attain a great height. An aeroplane is not particularly useful on active service just because it can climb 20,000 or 25,000 feet, if it is going to take all

day to do so. Ten to fifteen thousand feet is about the limit at which aerial work of any sort is carried out, and an altitude of about 6000 the general rule for reconnaissance. Therefore machines are wanted which can attain those heights very rapidly, and so get above enemy aeroplanes in a combat. Both in this respect and in flying speed our single-seater scout is superior to anything made in Germany. The Germans have scarcely anything to touch our small fast biplanes of the "tabloid" type, such as those made by the Sopwith, Bristol and Martinsyde firms.

What has to a certain extent occurred in the War has been the reliability of German aeroplanes against the speed of the best British machines. And there is no doubt that the advantage has been with us, in spite of the fact that the speed of German aeroplanes has greatly increased in proportion, since the commencement of the War.

Since the beginning of the campaign we have, of course, enormously increased our output of military aeroplanes, and there has been rapid development in the aircraft used on each side. The great object when introducing an improve-

By courtesy of Topical Press Agency.

AN EARLY EDITION OF ONE OF THE FAST BRITISH SCOUTS.

These machines and their successors have been unbeaten for speed since the commencement of the war. The one shown above is an 80-h.p. Sopwith, and, fitted with floats, an identical machine beat the world at the Monaco Seaplane Meeting in 1914.

ment is to do so as rapidly and suddenly as possible, in order to gain the advantage of taking the enemy by surprise. For under present conditions it is hardly possible to employ exclusively for long an improved type of any instrument of war, especially in the case of aircraft. Only one example of a new aeroplane has to fall into the enemy's hands, and any secret details it embodies may be disclosed. Sometimes it is not necessary to wait even for that, as many things can be copied on grasping the principle on which they are worked, or perhaps immediately the *idea* is seen.

In matters relating to aeroplanes there is no doubt that the British and French have been far the most fruitful in ideas and innovations during the War, but the Germans have been extraordinarily quick to grasp an idea and to utilise it in some cases sooner and often more extensively even than its originators. There is no doubt the Germans recognise a good thing when they see it. For example, they copied the Avro biplane which had to descend at Friedrichshafen, and also produced an almost exact replica of the Morane monoplane ; while one German " battle plane " is similar in principle

to the original Caudron double-engined biplane, many of which had been used by the French months before the Germans employed machines of this type.

Active service has proved how necessary standardisation is for aeroplanes, and there is no doubt that the high pitch of standardisation reached before the War by the German authorities in their military aeronautics, and, in consequence, by German aeroplane constructors in their factories, has stood them in good stead throughout the campaign, although it may not have altogether compensated them for the lack of progress which it caused in peace time. Nevertheless, as a result of it they have been enabled to produce continuously a large output of aeroplanes and an adequate supply of spare parts, which is just as important. This last is essential, for an absolutely inexhaustible supply of spare parts of every description, from a bolt to a spare wing, must be stocked at each aircraft base. The more perfect the standardisation, naturally the task of keeping a large number of aeroplanes in repair and flying order is made more simple, and can therefore be more efficiently performed.

An ever-increasing fleet of aeroplanes, both in the firing-line and in reserve for training purposes—a supply equal to, or larger than, the enemy's fleet—is most necessary in present-day warfare. Although Germany started the War with far more aircraft than any other Power, and also with better facilities for manufacturing them, we have reached the position when this does not affect us, in view of our own and France's tremendously increased output.

In any case, air power does not by a long way depend on aeroplanes alone, either in numbers or in quality; and Germany could not wrest from us our ascendancy in the air if she had ten times as many aeroplanes as we have.

CHAPTER III

THE ROYAL FLYING CORPS AND THE ROYAL NAVAL AIR SERVICE

It is important to note that in the earlier despatch mentioned in the last chapter Sir John French specifically speaks of "the individual ascendancy" gained by the Royal Flying Corps; special stress must be laid on the word "individual" to understand properly the reason for our aerial achievements during the War.

A good pilot is born and not made, although a man can become a competent aviator in the real sense of the word only by systematic training and acquired experience. However, skilful pilots in relatively large numbers can only be trained from men with a *natural* talent for flying. Pilot for pilot, our service aviators are far superior to the Germans, which is extremely fortunate for us; for, after all,

it is only a matter of luck and not of virtue that the British national temperament happens to be splendidly suited for flying, just as it is for hunting or cricket; although, as a matter of fact, it is largely a direct result of our bent for most kinds of sport.

At any rate, the British service airmen are, on the whole, the finest in the world, for they have all the brilliant daring and confidence of the French, but more restraint; while the German pilots are too clumsy, and lack the dash which so often carries ours out of difficult corners. In the future, when flying is as simple and mechanical as driving a motor-car, we shall not derive nearly as much advantage from our national talent as we do at present; but that, of course, does not affect the immediate position, which is, that however many aeroplanes Germany may build, she is utterly powerless to obtain a sufficient number of good pilots to fly them.

In the superiority of the pilots of the Royal Flying Corps chiefly lies the secret of all our success in reconnaissance work, directing artillery fire, bringing down enemy aircraft over our lines, eluding them over their own lines — "getting away with the news"—and in repeatedly raiding

important military places. The same applies to the *personnel* of the Royal Naval Air Service. Some readers may not be conversant with the distinction between the R.F.C. and the R.N.A.S., as the two flying corps are generally called, so a few of their fundamental characteristics will be enumerated.

The R.F.C. exists, primarily, for service with the Army in the Field, and to it falls the tasks mentioned above: air reconnaissance, co-operation with artillery, and bomb-dropping. The R.N.A.S. is a service of the Navy (its officers all append "R.N." after their names, although they receive the special ranks of Flight Sub-Lieutenant, Flight-Lieutenant, Flight-Commander, Squadron-Commander, Wing-Commander and Wing-Captain), and its chief functions comprise co-operation with the Navy with sea-planes and land-machines, the aerial defence of the British Isles,[1] and air raids. In addition to this, a certain part of the British front in Belgium has been allocated to the R.N.A.S. for various operations.

In many respects the R.N.A.S. is to the Navy

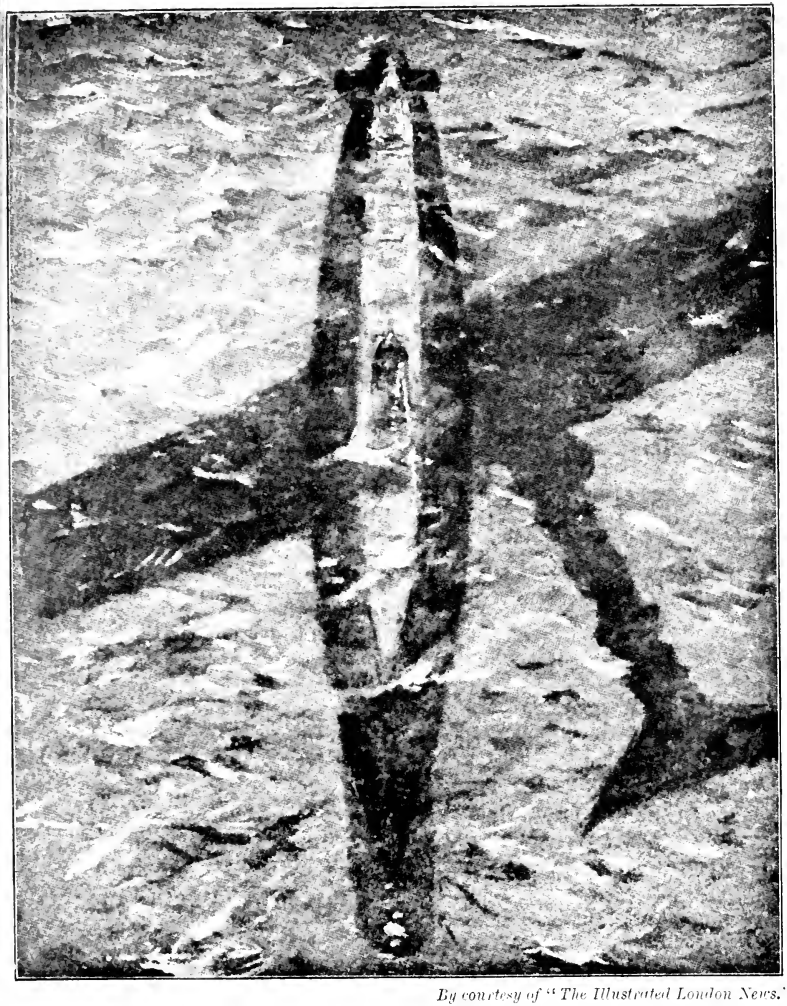
[1] Since this was written, it has been announced that the aerial defence of London is to be transferred to the War Office, *i.e.* the R.F.C.

what the R.F.C. is to the Army. Thus, in the naval attacks which were made on the Dardanelles, the R.N.A.S. directed the gunfire of the ships with deadly effect, both in the single-handed attempt made by the Fleet, and in the combined operations with land forces which took place later. For work of this kind, or indeed for any that has to be performed by seaplanes a considerable distance away from an air station, seaplane-carrying ships are used, and these are, of course, fitted with special apparatus for hoisting the seaplanes on board and for letting them down gently on to the water again. These ships are very comprehensively stocked with stores and spare parts of every description.

The defence work carried out by the R.N.A.S. is of various kinds. Constant aeroplane patrol duty takes place all round the coast, and the R.N.A.S. also patrols part of the Continent. A large amount of seaplane work takes place, an important phase of which is searching for submarines. Nothing could demonstrate more forcibly the exclusive advantages which aeroplanes possess for certain kinds of work than this, for a submerged submarine can often be seen clearly from the air when it is invisible to a ship

even in close proximity. Just as our land-machines signal to the gun-batteries below them, so the seaplanes direct the attention of the destroyers, with which they co-operate, to the submarines. On one occasion, it will be remembered, Squadron-Commander Bigsworth even destroyed a submarine from his aeroplane without assistance. A significant fact in connection with this is that now practically all German submarines have lately been fitted with anti-aircraft guns, which fold down out of sight when not in use.

It is obvious that in all these operations with aircraft, both on land and sea, a great deal more is required of a service pilot than to be able to keep his machine aloft for a given period; this is particularly so in the case of single-seater aeroplanes, in which he has often to perform the duties of an observer in addition to those of pilot. If it is true that the best airman is almost useless for active service on a bad aeroplane, it is even truer that a good machine is useless with a bad pilot, for not only will he be unable to realise to the full the advantages of its good qualities, but he will almost certainly smash it up into the bargain; so that surprisingly little could be



By courtesy of "The Illustrated London News."

A SUBMARINE SEEN FROM AN AEROPLANE.

The submarine is submerged, and only the periscope would be visible from the surface of the water. Aeroplanes possess enormous value for naval as well as military use, and British seaplanes have proved of the greatest value in revealing the presence of German submarines.

accomplished with even ten thousand aeroplanes if an equal number of really good pilots was not available to fly them. As a matter of fact, this has been Germany's chief trouble as regards aviation from the beginning of the War. The German pilots were good enough so long as they only had to exhibit qualities of stolid endurance ; in fact, probably no other but German pilots would have had the perseverance or the patience to have gone to the trouble of making the flights which broke the world's height and duration records in 1914. But when it came to active service, something more than this was required of them, and this something was lacking. An aviator may be as brave as a lion and still not have the skill necessary to out-manœuvre and defeat his opponent in an aerial duel.

Take, for instance, the question of bomb-dropping. There is at present no apparatus with which an aviator can really accurately aim bombs, so he must possess great personal ability to drop them correctly ; such a talent it is impossible to inculcate if it does not already exist in a pilot. A satisfactory sighting apparatus will be invented sooner or later, but there are many difficulties to overcome, such as that of calculating the forward

impulse of the bomb after it is dropped, which is influenced not only by its own weight, the speed of the wind and that of the aeroplane, but also by the altitude at which it is released. At present, therefore, we have to rely on the skill of our service aviators for success in bomb-dropping, and here again we realise the meaning of our "individual ascendancy."

Freak flying has come into considerable prominence during the War. For some time before war broke out, "looping the loop," tail-sliding, and upside-down flying had been viewed with cold disfavour from certain quarters, where such feats were regarded as mere circus tricks almost beneath the notice of a serious pilot, especially if he happened to belong to the R.F.C. or the R.N.A.S. It was asserted that the possibility of such feats having once been publicly demonstrated by Pégoud (who, by the way, really was not the first to perform them deliberately, Chanteloup having got into serious trouble a fortnight previously for doing the same things, which were considered by his superiors in the Army as taking foolhardy risks with a Government machine), it was quite unnecessary for pilots to practise such evolutions. Happily, however, not very much

notice was taken by the pilots themselves of this point of view, and, in fact, few aviators considered themselves expert until they could turn their machine at will to any position and from that attitude regain their normal equilibrium. It was not enough to see some one else do these things; it was not enough even to try them but once; they had to be done often, until the pilot could feel comparatively at ease, mentally if not physically, in any conceivable position.

It is quite impossible to judge the value of the complete confidence which this familiarity with the unusual inspired not only in those who practised it, but in those who witnessed it. Innumerable times during the campaign this knowledge of fantastic flying has been clearly the means of saving the lives of many airmen. The late Flight Sub-Lieut. Warneford, after dropping bombs on the Zeppelin, was hurled upside down by the terrific force of the explosion. Although he was not himself versed in freak flying, he had certainly learned enough from the experience of others to enable him to keep his head—difficult enough as it must have been—and effect a safe landing.

Another case in point was that of a young

R.F.C. officer who was turned upside down in a storm-cloud in bad weather. He only realised he was upside down when his revolver slipped out of his pocket—but fortunately was able to right himself.

While on the subject of remarkable occurrences, one or two deeds of bravery performed in the air and which stand out in the records of the War may be recalled. One of the finest of these acts was done by Second-Lieut. W. B. R. Moorhouse, V.C., who died as gallant a death as an officer and a gentleman could wish. He set out from the British lines alone, and flew towards the important railway station of Courtrai, where he dropped bombs which effected considerable damage. In order to do this, he descended to the low altitude of 300 feet, and was severely wounded by rifle fire. Instead of landing in the enemy's lines and saving his life, he determined at least to save his machine, and flew the thirty miles back to our lines, although he was in the greatest pain, having been again wounded, this time mortally, by an anti-aircraft gun. He made a good landing, delivered his report, and died the next day in hospital.

Another deed which required the greatest

pluck was that performed by Captain A. E. Borton and Captain Marshall, both attached to the R.F.C. While on reconnaissance work, Captain Borton was severely wounded in the head by bullets fired from a hostile aeroplane. The observer, Captain Marshall, leant over and helped him to bandage his wounds—no easy or safe matter when travelling over eighty miles an hour—and the flight was continued. The German aeroplane renewed the attack, and the British pilot became almost unconscious, but nevertheless the reconnaissance was completed and a consistently accurate report handed in.

The official " Eyewitness " put on record quite one of the bravest acts of the War. This was when an R.F.C. officer, Second-Lieut. W. Acland, and his observer were attacked by a huge German aeroplane with two engines. The British aeroplane, however, got the better of its opponent, which was forced to nose-dive 2000 feet; but Mr. Acland's petrol tank was pierced by anti-aircraft shrapnel, and the petrol was ignited by the exhaust pipe. The whole machine rapidly became a burning mass, but the pilot did not collapse under the horrible mental suspense of knowing that the aeroplane might fall to pieces

any moment, nor did he give way to the intense physical pain of being gradually enveloped in the flames, but kept at his post with the greatest courage, made a successful landing, and thus saved the life of his passenger.

But if the officers of the R.F.C. and the R.N.A.S. have the greatest possible chance to distinguish themselves on active service, there is hardly another branch of the Army or Navy where the N.C.O.'s and men have to work so hard with such a small chance of gaining honours or distinction. The N.C.O.'s and men who constitute the rank and file of the Flying Corps are air-mechanics, the great majority of whom are skilled artisans of great experience, many of them having been previously employed in aircraft firms. Upon the skill, devotion, and hard work of these men really depends the *efficiency* of the flying services. It may be argued that they are under military discipline and have to work hard, whether they like it or not; that is perhaps to a certain extent true, but no one who is not entirely ignorant of the conditions of work in all branches of engineering can be unaware of the enormous difference—sometimes amounting to well over 100 per cent—between the output of a man who

is determined to do the least possible amount consistent with safety (if he is under military orders) and that of a man who means to work as hard as he can.

Therefore, let no one belittle the magnificent efforts of the air-mechanics of the R.F.C. and the R.N.A.S. Few people outside those directly connected with aviation realise what active service means for aeroplanes. In the very important task of keeping a large number of machines in care and repair in the Field, not only the ordinary vigilance which is requisite in peace time is necessary, but, in addition, a considerable amount of ingenuity is required to cope with the special unpremeditated difficulties which occur almost every day. Repairs and replacements of every sort have to take place incessantly at the bases; engines must be cleaned after a few hours' flying; fabric torn by bullets has to be repaired; broken struts replaced; tyres changed; in short, there are a thousand and one everyday duties which have to be performed by the air-mechanics of the corps, and upon their conscientious and swift fulfilment depend, not only the efficiency of the corps, but the lives of the pilots. It must not be imagined, however, that

these laborious tasks are not often performed under the most dangerous conditions possible. An incident which was exceptional for its nature rather than the bravery required—and this is in no way deprecating the courage of the men concerned, but emphasising the dangerous nature of their daily work—occurred when one of the propellers of a British airship broke during an important journey. Two of the crew at once volunteered to change it in mid-air, and coolly effected the renewal, straddling on the rod holding in position the propeller, which was the only thing between them and the Channel, over which the airship was then travelling.

This is but one instance out of many of the deliberate valour which the men of the R.F.C. and the R.N.A.S. have constantly shown. The acts may vary, but seldom the courage exhibited in performing them. Often it is necessary for an aeroplane to be repaired under heavy fire from the enemy. Here there is none of the intoxicating abandon of a bayonet charge to lighten the consciousness of extreme danger, so that the heroism shown by the air-mechanics must be of the most intense description.

In the course of a lecture which he delivered

six months before the War, Colonel F. H. Sykes, then Commandant of the R.F.C. said :

" Success in war [1] will depend as much on the efficiency and keenness of the ground *personnel* as upon those whose duties are more essentially in the air, and we should not overlook the fact that, although our officers and men are of the keenest, those employed on ground work must be continually subjected to the disheartening effects of seeing the results of their hours of toil brought to nothing by the mischance of a second. To the good air-mechanic the machine for which he is responsible is his pride. I know men who regard their machines almost as living things. They are intensely proud of its achievements."

With what keen insight and sympathy has this distinguished officer expressed the feelings which inspire the mechanics of the air services.

And what a tribute he pays them !

[1] Col. Sykes was, of course, specifically referring to the R.F.C.

CHAPTER IV

SCOUTING FROM THE AIR

ANY one who has not flown at a considerable height might think that, once well over the enemy's lines, it is then quite an easy matter for a pilot or observer to obtain and record all the information required regarding the disposition of the enemy's troops, supply bases, lines of communication, etc. But this is not nearly so simple as it may at first appear.

For it must be remembered that, while it is generally possible to undertake reconnaissance at a height of about 6000 feet, where a pilot is to a degree safe from being hit by anti-aircraft guns, it is often necessary, owing to misty weather or other circumstances (such as when a *very* detailed report has to be made), to perform the work at a considerably lower altitude, and this is when the anti-aircraft guns give the

airman a very unpleasant and dangerous time. It can be said that the German anti-aircraft guns are really a greater menace to our airmen than are their aeroplanes, for their shooting with those weapons is certainly good, probably because they have so much opportunity for practice, with our pilots continually flaunting them over their own lines.

The danger from anti-aircraft guns lies not only in being directly hit by them; the balance of an aeroplane can sometimes be completely upset by the air-zone in its line of flight being violently disturbed by the bursting shrapnel from an "Archibald." This is, of course, very unfortunate from the aviator's point of view, for it counterbalances the advantage which he would otherwise derive from the fact that it is very difficult indeed actually to hit the speck which an aeroplane—flying at any speed between seventy and a hundred miles an hour—presents at an altitude of a mile or so.

Very little has been done in the way of armouring aeroplanes, except underneath the pilot's seat, and, in some cases, the nacelle. It is, in fact, astonishing how often a well-built but unprotected aeroplane will stand being hit

by rifle-fire without its flying capabilities being affected. Indeed, a British aviator, after one flight, counted no less than three hundred bullet holes in the wings of his machine, and in spite of these it flew as well as ever. Strange as it may seem, even the wooden spars between the wings of a biplane are often hit without disastrous effect, the result being only partial splintering. Nevertheless, there is a great deal in favour of steel being used for struts and spars and, in addition, wherever else possible in the construction of the machine. For steel will only bend in most cases, and hardly ever smash save under very exceptional conditions. A number of military aeroplanes have, as a matter of fact, steel construction almost throughout. With aeroplanes as they are to-day, in spite of the many soft places where a bullet can go through without doing much damage, there are, of course, many vital spots, such as the propeller or the engine—not to mention the pilot—where one well-directed bullet will stop the mechanical flight of the machine instantly.

Aeroplanes are not armoured extensively to-day owing to the great extra weight that would have to be added, and which would seriously

impair the efficiency of any machine. But it is certain that some satisfactory means will have to be devised of protecting the pilot and his machine to a greater extent than at present. The best principle appears to be that of having only two *classes* of substance in the aeroplane : one kind that will let the projectiles pass through without serious damage resulting, and the other substance —steel plate—that will absolutely repel the gunfire. It is not the slightest good fitting armour that will only partly stop projectiles fired from the ground ; it is necessary to fix the given height at which the armour is to be effective—*e.g.* 5000 feet—and then have it thick enough to turn off anything that may be fired at it.

There is one factor, however, which it is almost impossible to allow for in advance ; *i.e.* the atmosphere. For instance, in the present war reconnaissance at the Western Front is carried out mostly at 6000 feet, and at this altitude in France as much can be seen as at 3000 feet in England, because the air is so much clearer. When armouring aeroplanes in peace time, it is not possible to anticipate in what country they will have to operate. The climate

may make it necessary for them to be immune at 2000 feet, or again, at 8000 feet; and as the difference in weight between the armour required for the former altitude and that for the latter is very large, the question is one of importance.

There is yet another danger from which the scouting aeroplane must be more perfectly protected, and that is from rifle fire of his own lines. Things are certainly better than they were, but at the beginning of the campaign a pilot was as much fired at by his friends below as by his enemies. This was the case on both sides; and, considering the widespread ignorance regarding details of the various types of aeroplanes that was prevalent when war broke out, it was only to be expected. Although an expert can tell almost any type of machine in the air at a glance, it is exceptional for a novice to be able to recognise a certain make of aeroplane even from drawings, diagrams, or photographs which he may have seen. There is no doubt that in the future, or quite possibly before the end of the present War, *every* unit of an army will be able to differentiate between their own and hostile aeroplanes as easily as every unit of a navy can tell its own ships from those of

the enemy. The distinction will have to be recognised, however, by the shape and design of the machine, and not by the flags or other marks which are now painted underneath the wings, for these become almost invisible at a distance.

But if those on the ground do not find it very easy to identify a flying machine, the observation which has to be carried out from the aeroplane itself is far more difficult to perform accurately.

A great deal depends upon the observer himself, for his work is quite as individual as that of the pilot; and, unlike the pilot, military knowledge and experience are essential to him. The earth looks amazingly different from an altitude of a few thousand feet to its appearance at the level of the ground. Objects lose all their upright shape, and to a large extent their colour; a block of large buildings, for example, appears as a small patch of variegated grey, a field like a little space of grey-green. There is so much merging of colour that it is essential the observing officer should have almost perfect eyesight. Roads and railway lines are simple to locate when the weather is clear; but when it is even slightly misty or foggy it is sometimes

hardly possible to discern details on the ground.

The responsibility attached to observation duty is enormous. Imagine the difficulty of judging the numbers of troops in either massed or open formation. Probably all that can be seen from the aeroplane is a little dark mass, or many small scattered groups. Are there fifty thousand men down there or seventy thousand or a hundred thousand? Upon the correct judgment of an observer may depend the lives of thousands of soldiers, and ultimately, perhaps, even the issue of a whole campaign.

The air scout must also constantly be on the look-out to detect important objects deliberately concealed from him, such as masked batteries or gun emplacements hidden almost underground. Colonel Sykes, in March 1914, referring to the arduous duties of an observer in war time, said: "Know that much, very much depends on you, your vision, decision, accuracy and certainty. You see something. Your flyer throttles down to the lowest safe flying speed. Unless your faculties are well trained you have passed it, and not decided what it is. Long training and much practice for observers is essential."

By courtesy of "The Illustrated London News."

OVER THE ENEMY'S LINES.

This is one of the finest photographs of the War. It shows an Allied aeroplane—a Morane monoplane—well over the German lines at the Western Front. The photograph was taken from another machine flying at a height of about 6000 feet.

In fact, just as a good pilot is one with a natural talent for flying, so a good observer is one with an "eye" for country and location; and, just as the manipulation of the aeroplane is to a certain extent instinctive to the former, so is the immediate mental grasp of the essential details of a panorama more or less natural to the latter. But although it may come naturally to him, he has not only to assist and supplement his faculties with field-glasses, maps, and sketches, but to record his information accurately with reports, photographs, and further sketches of his own. Added to this, he has at times to look after wireless apparatus, message bags, signals to artillery, and also to keep an eye on the petrol supply, and thus it can be imagined what a very busy man he is.

Photography from an aeroplane is always difficult and sometimes dangerous, and an observer must not invariably rely on his camera, but observe as though he did not possess one. In some cases the photographer has to lean out of the machine in a most perilous manner in order to get the view to be taken correctly focussed, and not distorted and slanting, for in many machines direct downward vision is not possible.

A fairly common method is that of fixing the camera underneath the aeroplane.

A new Italian camera,[1] invented specially for air reconnaissance work, was described in a recent issue of *The Aeroplane*. The camera is fixed underneath the machine, and holds about three hundred negatives, which are automatically released at given periods. A series of views is therefore taken at regular intervals, and thus an absolutely consecutive and complete record of the ground traversed is obtained. The time between each photograph is easily regulated by the pilot, synchronised with the height of the aeroplane, for, of course, fewer exposures are needed the higher the altitude. It is estimated that, at 3000 feet, three hundred views would completely photograph a strip of land 160 miles long by 1 mile broad. It can be seen what great possibilities the invention offers.

It has been mentioned before that wireless is used on aeroplanes. Special obstacles lie in the path of wireless being fitted to craft travelling at such a high speed as an aeroplane; but very

[1] The camera referred to is the Piazza-Douchet Photographic machine, described in the *Aeroplane* of May 26, 1915. A somewhat similar Italian camera, called the Fabri, was exhibited at the Aero Show at Olympia in 1914, and described in *Aeronautics* of April 1914.

great progress has been made in this direction, the exact nature of which cannot, naturally, be disclosed here.

In a different sense from wireless, of course, the aeroplane is itself a wonderful message-carrier, swift, sure, safe. For these reasons it has frequently been used for certain kinds of despatch-carrying work during the War, such as transporting documents from town to town. In entrusting an important despatch to one of our airmen to deliver, the commanding officer is to a large extent relieved from anxiety of the hidden dangers which lurk behind every hedge for the ordinary courier.

The pilot ascends and the next moment is out of sight; and there are very few things that will stop him from arriving at his destination. Should he encounter a hostile aircraft, he would endeavour to evade it rather than fight, for he must not run even a small risk of failing to carry out his task. This would also be the policy of an air scout returning home after having obtained valuable information.

But in all these operations there is one enemy from whom it is impossible to escape—the weather. A storm or a hurricane may

arise when a pilot is coming back, tired out from a hard day's work; for these caprices of the weather nearly always seem to occur at unfortunate moments for the pilot. In war he cannot, as in peace time, land in the nearest suitable field, for that field may be in the enemy's hands. So often the only course open to him is to struggle back to his own lines. Every airman has to fight the weather innumerable times in his career, but the difficulties of doing so are accentuated in war time. The service pilot must ascend each day to perform reconnaissance work and direct the artillery fire in practically any sort of weather, and so flying often takes place under conditions which would be considered impossible in time of peace.

And, therefore, many things have been learnt during the War about flying in bad weather, facts which otherwise would not have been found out for years.

CHAPTER V

AIR RAIDING

THE air raids of the present War demonstrate forcibly, if in an elementary manner, the vital difference which exists between aircraft as a weapon and every other kind of weapon; what they also show is that the immense power possessed by this new arm will, when it has reached its full development, far exceed that of any which exists to-day.

Wherein lies the fundamental distinction between this and all other implements of destruction in war? Not so much in the extent or severity of the damage which it can inflict, as in the ubiquity of its range. Hitherto it has been possible to determine, to a certain degree, the limits of a theatre of war, at any rate for the time being; that is to say, we have known, for example, that the operations at the Eastern

Front or in the Balkans would be confined within a relatively limited area, and that if the area expanded it would do so at a comparatively gradual rate. But in the case of aircraft this is not so. Every place within hundreds—and, in the future, it will be thousands—of miles of a given spot is immediately within the direct range of aircraft. There will be, in other words, no such thing as a Front.

In the present campaign, however, air raids are carried out on what will later be regarded as almost an experimental scale. Only four or five years ago the idea of sixty-two aeroplanes setting out and dropping bombs on a place nearly a hundred miles away would have been generally regarded as the unattainable ideal of an enthusiast. But to-day such a raid is merely *fait accompli.*

At present, success in air-raiding depends almost entirely on the flying and bomb-dropping capabilities of those engaged, which are purely due to inherent talent. This explains to a certain extent the essential difference between the raids which have been carried out by British aircraft and those performed by the Germans.

Raids are made by the R.F.C. almost daily;

but these, although often of equal or greater value, have not been on such a big scale as some carried out by the R.N.A.S.

Almost the first British raid of note was carried out by the late Flight-Commander C. H. Collett, who flew to Düsseldorf, in October 1914, on a Sopwith biplane, and dropped bombs on the Zeppelin shed there. Commander Collett flew the journey at a height of 6000 feet, and descended to 400 feet within a quarter of a mile of the shed. However, he did not succeed in completely destroying it, so about a fortnight later, it will be recalled, Squadron-Commander Marix made a further attempt. This time both the shed and the Zeppelin inside it were completely wrecked—the Germans admitted it—flames over 500 feet high springing out immediately after Squadron-Commander Marix had dropped his bombs. On the same day as this success occurred Squadron-Commander Spenser Grey performed a remarkably fine flight of nearly four hours' duration from Dunkirk to Cologne and back, where he discharged his bombs on the military railway station, effecting considerable damage.

A notable raid was carried out the following

month on the Zeppelin Works at Friedrichshafen by Squadron-Commander Babington and Flight-Commanders Briggs and Sippe. A flight had to be made of 250 miles in all, across mountainous country (over which very bad climatic conditions for flying nearly always prevail), and the airmen were subjected to a heavy fire from below when they descended for the attack. Bombs were successfully dropped on the Zeppelin factory and much damage was done. Unfortunately, the petrol tank of Commander Briggs' machine was pierced, forcing him to come down in the enemy's territory, where he became a prisoner. The results obtained from this raid were very valuable indeed, for the work at the Friedrichshafen factory was greatly hindered.

But the next important British air raid, which occurred, dramatically enough, on the following Christmas Day, for sheer brilliance and daring eclipsed anything which had previously taken place. In the very early morning seven R.N.A.S. officers on seaplanes, escorted by light cruisers, submarines, and destroyers, set out to raid the German naval base of Cuxhaven. The attack commenced at daylight, starting from

a point near Heligoland. This must have been the most spectacular and novel contest of the whole War. On the one hand were our cruisers *Arethusa* and *Undaunted*, our seaplanes, submarines, and destroyers, against us the enemy's Zeppelins, aeroplanes, and submarines. Quickly our ships' guns put to flight the two German airships, while even the hostile aeroplanes did not hit one of our seacraft. After dropping bombs with great effect on the harbour itself and enemy warships lying outside it, our seaplanes got ready to return. The British cruisers, which had been waiting off the enemy's coast for three hours, picked up, as arranged, three out of the seven pilots; three more were picked up by British submarines, and the remaining officer, Squadron-Commander Hewlett, temporarily lost, was finally rescued off the Dutch coast.

After these successful attempts, operations began to be organised on a much larger scale, and in February 1915 no less than thirty-four British aeroplanes and seaplanes raided the district round Bruges, Zeebrugge, Blankenberghe and Ostend, practically demolishing the railway station at the last-named town, smashing

the German gun positions at Middelkerke and damaging the power station at Zeebrugge. In this attack two machines were damaged.

Three days afterwards forty R.N.A.S. aviators again raided the same district, in order to complete the damage which had been effected previously. This time the operations were conducted on a still more ambitious scale, and the results were equally successful.

A great many other important raids have taken place, but the few mentioned will suffice to show that the sole purpose which animated them all was the accomplishment of some object of direct military importance. This has also been the case in most of the raids performed by French aircraft, which has been extremely active and successful in air-raiding throughout the War. The British Admiralty *communiqué* of the raid of forty R.N.A.S. pilots even contained the following:

> Instructions are always issued to confine the attacks to points of military importance, and every effort is made by the flying officers to avoid dropping bombs on any residential portion of the towns.

So far as the German raids on England go, quite a different state of affairs has existed.

All the raids, up to the time of writing, have been performed by Zeppelins, and they have all taken place during the night, while ours have been accomplished in broad daylight; however, it is owing to the very fact that the Germans have had to use Zeppelins instead of aeroplanes that their raids have taken place at night.

But the difference lies primarily in the spirit which has inspired the raids. It is impossible for the German airships to locate at night-time any specific object on the ground below them, in view of the darkened lights all over the country; so that if they effected any damage of military value, such as the destruction of an important public building or a munition factory, or the bombing of a training camp, it would be purely by luck. And even the chance of serious damage resulting from the blind methods they adopt is certainly very slight, for, although it is possible for an airship—or an aeroplane for that matter—to fly by compass with a certain degree of accuracy, that degree is a very inexact one, unless the pilot is aided by landmarks, as he would be in daytime. One difficulty, for instance, is that it is impossible to tell, or even guess, in the dark, the extent of side-drift which

a wind may be causing the airship. It is, therefore, clear that while the Zeppelins may be able to fly assisted by their compass and the lines of the coasts and the river Thames with sufficient accuracy to tell, roughly, what county they are over, and *in very calm weather* over what town, that is the limit of their ability to locate the country;[1] at any rate, it is quite certain that it is impossible for them to identify any object or building beneath them, for everything appears as a black mass, and an even twinkle of lights.

Allowing for the slight amount of damage which aircraft dropping bombs at random might possibly inflict, even then the Zeppelins have been

[1] This statement, which has been borne out by Mr. Balfour in a letter, is entirely unaffected by anything which Lieut.-Commander Mathy (who led the second Zeppelin raid over London) said in an interview published in the *New York World*, and reprinted by the London Press. The interview was given several days after the raid took place, by which time Berlin would know from various sources where the bombs had dropped. Commander Mathy was able, therefore, to name important military objects near which his bombs had dropped, and state that those military objects were aimed at. This method could be plausibly employed, no matter *where* the bombs were dropped, because, after all, every spot in the British Isles is at present near *something* of military value. In fact, all that the interview with Commander Mathy showed was the German Government's sudden and futile desire to attempt to disprove that the Zeppelins drop bombs at random without military object, and heedless of civilian lives, in exactly the same way that it tried to mitigate the crimes of the German submarines by equally unconvincing methods.

unsuccessful in doing even that small percentage of military damage. The record of their raids has been a series of murders of non-combatants[1] of all sorts, from old women to hens!

Why, then, do they continue to come? There are two reasons for their persistence, one of which deals with the psychology of the German nation. Germany considers Great Britain to be her worst enemy, the source of all her troubles, and the foe from which most is to be feared. Nothing could aggravate and kindle such a feeling more than the realisation that, no matter how deeply involved we might be in the War, even to our last penny and our last man, the actual inhabitants and the territory of the United Kingdom, even of the whole British Empire itself, is, thanks to our Navy, almost certainly safe from invasion and the horrors and barbarities which the Germans would probably rather inflict on us than on any nation.

There was one method of escape from the attitude of utter impotency in which they stood in regard to us: by way of the air. And this road they took. As they have shown con-

[1] Since this was written fourteen soldiers have been killed in a Zeppelin raid. Does this alter the actual object of the raids—or change their record?

sistently throughout the campaign, the Germans draw no distinction between civilians and soldiers, combatants and non-combatants, for, according to their code, the subject of an enemy is an enemy under every circumstance. Was it likely, therefore, that the behaviour of the German Government in matters of the air should differ from their policy on land and sea, especially when there was, in the case of air raids on England, the additional incentive of being able to give vent to that consuming hatred which the German public feels toward the British people ?

These air raids from Germany, although utterly futile, have probably done us good by rousing the country and by stimulating recruiting, and are very significant for at least two reasons. For they demonstrate how a country like Great Britain, which is otherwise reasonably secure in war time, could in the future be attacked and beaten, unless it possessed a really strong air fleet. And the German raids, inhuman as we think they are, do certainly indicate that the ethics of warfare will undoubtedly alter with the development of the " fifth arm " on the huge scale which it will assume.

This book does not pretend to deal with any

questions as to the morality of methods of war, but still it is necessary to point out the great changes which aircraft must inevitably introduce in this respect.

For it must be borne in mind that, when an aviator is not able to descend low in order to drop bombs on military objects in a town, buildings of a quite harmless character will be struck accidentally; also, that often inoffensive edifices may be easily mistaken from above for military works, the destruction of which has been ordered, and thus they may be deliberately if inadvertently destroyed. It can be seen, therefore, that aviators must not always be charged with inhumanity on the superficial evidence of apparently brutal acts which they may accidentally perform; deeper investigation is necessary.

Another important consideration also arises out of the question as to what may or may not be regarded as legitimate prey for air raiders. Precedent must not be relied upon in this matter; one set of customs cannot be made to fit circumstances quite other than those from which they have been evolved. Thus, to-day it might be considered as inhuman to destroy from

the air factories situated in towns perhaps hundreds of miles from a theatre of war manufacturing textiles for soldiers' clothing, and employing hundreds of women, who might be killed in a raid. Dropping bombs on such a place is only condemned at present because the idea is *new* to us, because we are not used to it. If, in the past, nations had been *able* to put out of action every single person and every single instrument engaged in supplying the enemy troops with food, clothing, ammunition, rifles, guns, ships, coal, field-glasses, and the thousand and one material things on the largest supply of which victory may be said to depend, they certainly would have put them out of action. So we must not be led into the easy illusion of thinking that this was not done for the sake of humanity. After all, an enormous percentage of the population, even of industrial Britain, is employed on Government work of some description; and, as it is urged on the nation day by day, the result of the War depends as much on those at home as on those at the Front. So it would seem inevitable that all these war workers should, with the advent of aircraft, come under similar conditions of danger to the soldier himself.

But, even allowing for these considerations, there is certainly no defence to be extracted from them for the German policy in regard to air raids, and stress has been laid on them for that very reason. Presuming that, with the use of aircraft in war, a greatly increased proportion of the territory and inhabitants of a belligerent country may perhaps come to be regarded as being within the legitimate sphere of hostilities, even that cannot justify the absolutely random bombardment of a whole country by aircraft. If the German raiding operations had been conducted by day-time, *with exactly the same results*, fairly convincing excuses might possibly have been made for them. But the method of creeping over in the dark is an overwhelming proof of the Germans' intention to attempt a paltry vengeance without thought of military significance. Is it possible that it was seriously hoped to intimidate the British nation by this means ?

Nevertheless, no matter how severely the German air raids may be condemned, nor how void they be of military importance, the fact remains that it is very difficult for us to repel

the raiders at night, though we could effectively do so during the day-time.

The difficulty of locating aircraft in the dark is extreme. The Zeppelins are generally discerned travelling at an altitude of about 3000 to 6000 feet, when the aeroplanes which then attempt to pursue them are probably still on the ground, perhaps several miles away ; merely to climb to an equal height, even supposing the airship would remain still—which it very emphatically will not—would take the aeroplane about ten minutes to a quarter of an hour. By the time that the aeroplane pilot is at about the same height as the airship was when it was first seen, both he and it are naturally in quite different relative positions to those from which they started and probably much farther apart, in distance if not in height.

How is the aeroplane pilot to locate the airship ? Sound does not help him, for the noise of his own engine prevents him from hearing anything else. Sight is of very little use to him, for he can only see the object of his search if he can get reasonably close to it. The one thing for him to do is to search carefully in the most likely directions. And he has to examine a

certain area at not only one possible level, as on the earth or on the sea (except in the case of submarines, with which a similar difficulty of location ordinarily occurs), but he must search an absolutely indefinite area at several different altitudes; for it is quite possible that at 5000 feet, he might pass underneath the Zeppelin flying at 6000 feet, and know nothing at all about having been anywhere near it, especially if it is drifting down wind with stopped engines.

In addition, there is great difficulty attached to night-flying itself, quite apart from airship-chasing. As the pilot cannot see the angle which his machine bears in relation to the earth, and thus ascertain whether he is maintaining his lateral stability when, for instance, he is banking for a turn, he must exert every nerve to "sense" it—a very exhausting process. Also, very great skill and experience are required to land safely at night, even on a good aerodrome; should the pilot be forced to make an involuntary landing on bad ground, often it is hardly possible for him not to smash at least the landing chassis of his aeroplane, or perhaps the entire machine.

It can therefore be seen that although hostile airships cannot distinguish in the dark, objects

or places on the ground to a sufficient extent for them to be really dangerous, they are, on the other hand, fairly immune from being brought down by aeroplanes. Nevertheless, there is certainly the chance of our aviators being lucky enough to find a Zeppelin easily, and this chance is appreciably greater than is the raiders' chance of their bombs striking anything of military importance. A really well-synchronised combination of anti-aircraft guns and searchlights is probably the most certain method of repelling Zeppelin attacks at night-time (in the day-time aeroplanes are, of course, infinitely better), as we can see from the immunity which Paris now enjoys, and which is solely due to the rings of searchlights and guns that encircle her. It is not practical to employ both guns and aeroplanes, owing to the obvious danger of hitting friendly aircraft. Paris has shown how successful an adequate system of lights and guns can be, used in conjunction with properly controlled town-lighting, and it is common knowledge that Sir Percy Scott adopted a somewhat similar form of aerial defence for London.

Before passing from the subject of German

air raids on England, there is one consideration which should be recalled in connection with the destruction of a Zeppelin by the late Flight-Sub-Lieut. Warneford, V.C. It will be remembered that this act was performed in Belgium, and it certainly revealed the feasibility of another way of dealing with Zeppelins bound for England. If, owing to technical difficulties, it is enormously difficult for aeroplanes to repel the marauders effectively while they are actually over England, it does not follow that British aviators cannot encounter them on the Continent either on their way over or on the return journey—whichever is most favourable as regards light and weather—and attack them then.

In reviewing *in toto* the raids which aeroplanes have accomplished during the War—and British and French machines have been by far the most active and successful in this direction—one obvious conclusion is reached: that, to achieve substantial military results, flights of aeroplanes must concentrate on prearranged objects, and that each raiding pilot must possess considerable personal talent and nerve. It is only occasionally, or when the object to be destroyed is comparatively small, that the bombs

carried by one or two airmen would be sufficient, except in the case of an airship in its shed, where something of a highly inflammable nature can be ignited. But, on the other hand, the smaller the object the harder it would be to hit, so a greater number of pilots and machines might be needed.

In the beginning of this chapter reference was made to the fundamental difference between aircraft and all other weapons. The aeroplane has, as a weapon, more than once been compared to a gun with an enormously increased range. This parallel is somewhat erroneous, for aeroplanes, unlike guns, transport a human being—two eyes and a brain—as well as a mere mass of metal. In fact, in this simple attribute lies the whole essence of the indispensability of aircraft in modern war. In the future we shall better realise the potency of this man-carrying capability of the aeroplane. When aeroplanes are really plentiful, a force of thousands of men can be landed in an unprotected part of an enemy's country. Probably part of this contingent of aeroplanes would serve for repelling an attack; part for carrying fuel, food, ammunition; and part for transporting men. True, such opera-

tions would always require very fine organisation, and huge landing-grounds would have to be found, but they will possibly be employed sooner or later.

For whether we watch the actual strides which aviation has made in its progress during the present campaign, or prophesy the future developments that will arise from it, they all point to one thing—the elimination of Distance from our hitherto earth-bound existence; for the quintessence of the mastery of the air is the mastery of the long miles from the mountain to the sea.

CHAPTER VI

AIRSHIP *VERSUS* AEROPLANE

In the last chapter it was said there were two incentives for the German air raids on England, and one of them was mentioned. The other reason is more nearly connected with aviation itself. After spending millions of pounds and many years of work in developing Zeppelins, the German Government, when war came, obviously had to use their fleet of these dirigibles in one way or another, if only for the sake of appearances; and what could be more spectacular than "attacking" England with them, since it was soon realised that they could not be used for any purpose of military value? If this simple theory of utility is considered, it can be seen that the German plan of devoting such a large proportion of their fleet of Zeppelins to futile raids on England amounts almost to an admission of their

failure in directions of true military importance. It was, of course, never mentioned to the German public in the Berlin official reports that the airships were almost blind when they were over England, and that therefore they were able to do practically no damage except kill a few civilians; and such is the universal ignorance which prevails regarding aviation, that probably the German public does not realise this simple circumstance even up to the present day. In fact, through German eyes the Zeppelins may have justified their existence magnificently, and their behaviour during the War may appear to them to have been one long triumph.

But has it been? Could it have been? Obviously not, as can be shown by drawing a rough comparison between the outstanding capabilities of aeroplanes and those of airships in general, including Zeppelins.

The airship is far slower than the heavier-than-air flying machine, for the fastest speed of the one is 55 m.p.h. (or one may even allow that the latest Zeppelins perhaps approach nearly 60 m.p.h.) against the 90 or 100 m.p.h. of a fast aeroplane. Also an aeroplane can attain a far greater altitude than an airship.

The airship height record, which was made by the Italian dirigible MI., stands at 12,200 feet, as against the aeroplane record of over 26,000 feet.

The two points where the airship scores over the aeroplane are in weight-carrying and the capacity for staying aloft with ease for a long period. However, in regard to weight-carrying in particular, it is certain that during the next few years, or even sooner, the discrepancy in this respect between airship and aeroplane will lessen rapidly. It was always stated before the War that a Zeppelin could carry a ton or more of explosives, but much less than this appears to have been dropped from each of them on every occasion that a raid has been made on England. It is probably found in actual practice that a smaller bulk of explosives must be carried, owing to the great load of fuel which is consumed on a long journey; and a large allowance of lift must be made against the considerable extra weight, amounting to several tons, which even a slight shower of rain adds to the weight of the ship.

So far as duration goes, apart from the record-breaking flights of twenty-four hours or so made

by German aeroplanes, the fact remains that flights of even four or five hours are a great strain on an aeroplane pilot. It is but a slight strain on the crew of an airship to keep aloft for a considerably longer period.

In comparing the utility of the two types of aircraft for service in warfare, such a detail as cost is of small account, so lavishly is money spent on armaments to-day. So it is but a slight advantage for the aeroplane that its cost is only about one-fiftieth that of a Zeppelin. Important disadvantages are, however, the slow rate at which these huge dirigibles can be produced ;[1] the enormous flat open space they require to effect a safe landing, and which often cannot be found near a theatre of war ; the great difficulty of getting them in their sheds without injury ; the laborious task of transporting and setting up the portable hangars, which, owing to their great size, are very heavy and cumbersome ; and,

[1] During the first twelve months of war, for instance, at least eight, and probably ten, Zeppelins (out of the sixteen with which Germany started the War) were destroyed in various ways, and, if sufficient new ones to replace these were constructed in that period, even that would probably mean the greatest possible speeding-up at the Potsdam and Friedrichshafen works. It must be remembered that the Zeppelin shops are constantly occupied with repairs to existing ships, particularly in war time, and this naturally impedes the fresh output. A Zeppelin requires a thorough overhauling after every two or three long journeys.

finally, the practical certainty of destruction resulting should one of the airships encounter bad weather, and what would be dangerous weather for an airship would scarcely trouble an experienced aeroplane pilot. A large percentage of the total number of Zeppelins which have been wrecked were lost owing to bad weather; at one stroke, for example, two of the latest naval type were smashed on the Danish coast during a snowstorm early in the War. In addition, an important point is the size of the crew. A Zeppelin is manned by nearly thirty (although Italian airships require only about three men) but an aeroplane only carries one or two; and, as these thirty men require quite as much training as the crew of a submarine, it can be seen what a severe additional loss in *personnel* the destruction of one of these craft entails.

But, after all, the foregoing are only individual advantages or disadvantages on particular points. Let there be a fight between a modern aeroplane and airship, and probably in at least ninety cases out of a hundred there will be the same result: the destruction of the dirigible. And, in the present War, in spite of the seventeen or more separate air-compartments and the rigid girders

which they possess, the Zeppelins remain as vulnerable as ever; and, in fact, it is this very vulnerability against aeroplanes which keeps them far away from the firing line [1]; and this necessitates that they shall creep over to England during the night instead of facing the daylight, and, in short, reduces them to a relatively unimportant quantity in the campaign.

During the War up to the time of writing the late Flight-Sub-Lieutenant Warneford was the only pilot fortunate enough to meet a Zeppelin in flight under anything like fair conditions. It was light enough for him to see his opponent, and he was already at about an equal altitude to the airship when he sighted it, a very lucky circumstance for him.

Warneford's fine act, so far from being a surprise, was, indeed, an emphatic confirmation of the opinion for long held in the aviation world in England and France; namely, that almost any clever pilot on a fast aeroplane can bring down an airship.

The effective method of attacking Zeppelins

[1] It is true that on rare occasions the Germans brought one or two Zeppelins into the field of action on the Eastern Front; but they were only able to do this because Russia did not possess sufficient aeroplanes to cover their huge Front.

is with very fast-flying and quick-climbing aeroplanes such as the British type nicknamed "tabloids," armed with bombs and with a large-calibre carbine firing special bullets. The first object of the attacking airman is to get above the airship in order that he may be sheltered from the fire of its guns by the envelope itself; he can then drop bombs, which is always easier and more certain than firing a rifle. In any case, he would certainly get in a much better shot gliding down in a rush alongside the gasbag than by attempting to fire at it from the level of its gondola, or from below it, in both of which positions he would be exposed to the airship's guns. Experiments were carried out some time ago in mounting a gun on a platform on top of a Zeppelin, but it was found that the comparatively large amount of gas which is always leaking upwards from an airship would ignite with the flash of the gun, so the idea was reluctantly abandoned. If it had proved possible, it would have made the task of the attacking aeroplane decidedly more hazardous.

It is obvious that great speed and climbing power are essential in the aeroplane which, even under favourable conditions, may deliver a

successful attack on an up-to-date airship. As previously mentioned, the latest type Zeppelin can travel at least fifty-five miles an hour in calm weather, and the aeroplane which would destroy such a craft must be able, if necessary, not only easily to beat its speed, but at the same time fly all round it, underneath it, or above it.

A curious phenomenon occurred in the case of the Zeppelin which Flight-Commander Bigsworth pursued at 3 A.M. on the 17th May 1915. Commander Bigsworth dropped his bombs on the dirigible, but it did not blow up. This was probably because not sufficient air was mixed with the gas of the airship for the bomb to ignite it, for the rent in the envelope might easily almost close up again without allowing much air through. This, one would imagine, is an extremely unusual occurrence, and is hardly likely to happen often. A sensible idea might be to release two bombs almost together, the first being a high-explosive to tear the fabric open, and the other an incendiary bomb to ignite the gas.

It has been suggested that aeroplanes should escort airships on raids, etc., and defend them against attacks by hostile aeroplanes. The idea

might be practical if the speed of an airship could approach that of aeroplanes [1] which would be fast enough to repel attacks. However, as things are, it is not quite clear how the escorting machines would pass the time waiting for their charge. One writer has humorously suggested that the aeroplane pilots should loop the loop and practise tricks in the intervals! Anyway, it is certain that no sort of order or formation could be maintained, and it is strongly probable that the idea would prove a failure.

Although it has been shown that a Zeppelin—or, for that matter, any airship—is no match for an aeroplane, it does not follow that these lighter-than-air craft have no uses at all in warfare. For instance, Zeppelins have done a great deal of patrol work round the German harbours in the North Sea, and for this they are admirably suited. Again, they might be useful for transporting important *personnel* or light material rapidly to places where there were no railway

[1] It may be pointed out that aeroplanes which would be effective for repelling hostile aeroplanes attacking the airship would have to possess a speed of at least 90 or 100 miles an hour, while the speed of the fastest Zeppelin does not exceed 60 m.p.h. The normal speed of such fast aeroplanes cannot be safely reduced to 60 m.p.h. for any considerable period, although fast machines can generally be slowed down for short distances to a much lower rate even than 60 m.p.h.

lines, or where existing lines had been destroyed. There are, in fact, quite a number of ways in which their services would be valuable, but such purposes would all be of minor importance, and subservient to the real uses which make aircraft so invaluable in war.

In justice to airships, their early state of development must be remarked upon. As there have been thousands of aeroplanes constructed as against about a hundred airships, the former are naturally in a far more advanced stage of evolution. It is, therefore, premature to lay down a final judgment as to their value for military purposes, for in the next great war dirigibles may be capable of doing all manner of things which appear utterly impossible for craft of their class to-day.

We can, therefore, only specify their limitations in the present campaign. That these limitations are very narrow, and, indeed, infinitely out of all proportion to the utility of the airship, is apparent. More than once since war broke out the Zeppelin has been likened to a battleship of the air, and the aeroplane to a submarine or destroyer. But this parallel is all in error, for the only similarity is that an ironclad,

if unprotected by destroyers, is, like a Zeppelin, more or less at the mercy of its small antagonist. On the other hand, the battleship has enormous and unequalled power for most operations of naval warfare, and is supreme against all other seacraft, while the submarine possesses no other function but the one. A Zeppelin not only cannot compete with the aeroplane as regards travelling power, but, moreover, it cannot perform most of the military functions for which heavier-than-air craft are employed.

The Zeppelins appear somehow to have assumed, among the general public, terrifying proportions; their actual dimensions are, perhaps, alarmingly big—indeed, they certainly are. But as engines of war they are lamentably defective machines; and it is only necessary to examine closely their capabilities to discover how nearly destitute they are of merit for military use.

CHAPTER VII

TYPES OF AIRCRAFT IN USE

In the preceding chapter, when writing of airships, reference was generally made specifically to Zeppelins. This was done for two reasons; first, because it is against airships of the Zeppelin type that we have chiefly to contend in the present War; secondly, because they are the finest and most efficient dirigibles yet produced, and it is only fair to name the best examples of a class of aircraft as representative of what the whole is capable.

There are, however, various other kinds of airships in use both in Germany and in other countries. In Germany there are four chief types. First, of course, there is the Zeppelin, the distinctive feature of which is the rigid framework, composed extensively of aluminium, over which the envelope is stretched. Secondly,

there is the Schütte-Lanz, nearly equal in size to the Zeppelin, also a rigid type of vessel, but with the frame constructed chiefly of three-ply wood instead of metal. This ship has a pointed tail, unlike the blunt end of a Zeppelin, which makes it rather the faster of the two. It appears that some of the latest Zeppelins are having their tails built in a pointed shape to increase their speed. Thirdly, there are the semi-rigid airships built by the German Government, which are supple all round except at the keel, along which iron girders are fixed the whole length, and from which the cars are suspended. The fourth type is the Parseval, a rather smaller vessel, which is entirely supple, with no rigid construction in the envelope at all. Nearly all airships belong to one of these four types.

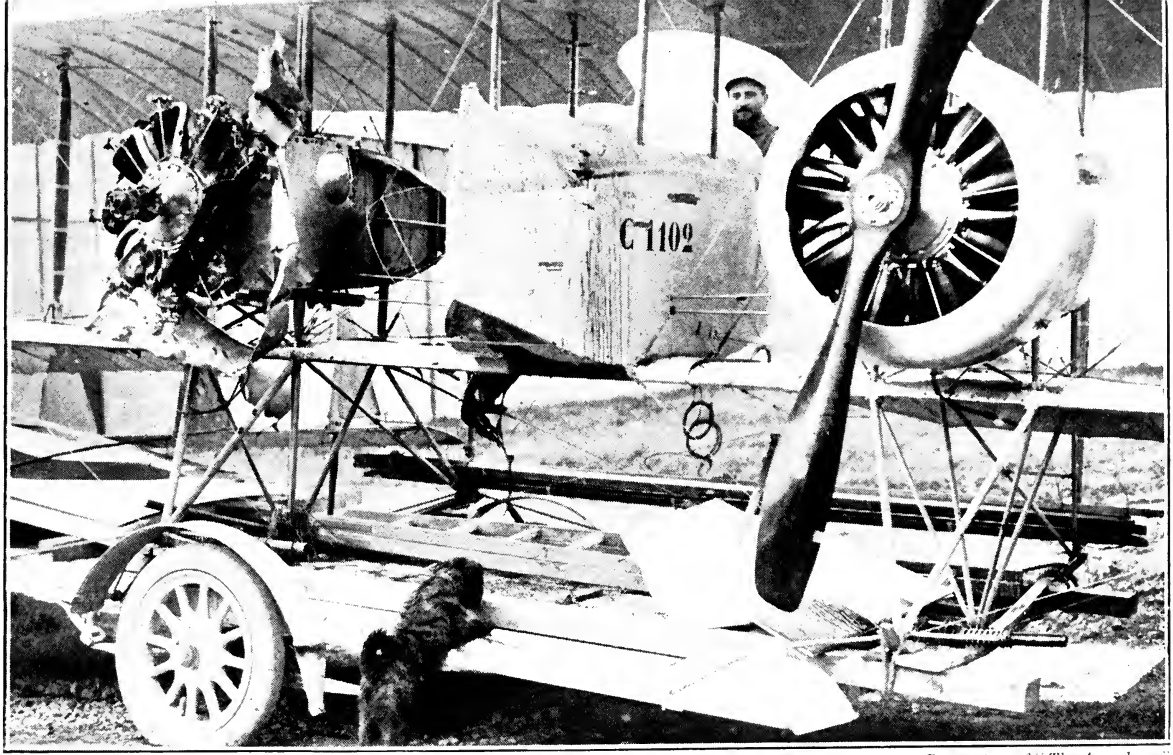
Germany is certainly far ahead of any other nation as regards airships, both in knowledge and in actual possession. France has a fairly large fleet of dirigibles, chiefly of the Astra, Clément-Bayard, Zodiac, and Lébaudy types; Italy has about a dozen small but useful ships; and then (when war broke out) came Great Britain with a few of the miniature ships of the

"Beta" type, a Parseval, and an Astra-Torres —one of the fastest ships ever built. These originally belonged to the Army, but were later taken over by the Navy. In the particular spheres of utility to which all airships are limited, they have done some good work during the War, but compared to Zeppelins they resemble toys.

There is one function in military aeronautics where lighter-than-air craft have proved in some ways superior to aeroplanes in their imperfect present-day state. This has been in directing artillery fire. Three or four hours is quite a short duration for one bombardment, and it is a great strain on an aeroplane pilot to keep aloft even for that period, especially when he has to hover as slowly as possible round one position, while he is subjected to a severe gunfire from the enemy. The Germans some time ago brought out the Parseval-Sigsfeld kite-balloon, which is a small sausage-shaped balloon, anchored generally to a motor-driven winch on the ground. Along the bottom of the ballonnet is what looks in the air like an additional bulge, which holds it excellently against the wind. These balloons carry from one to three observers, according to their size, and their superiority to the ordinary

man-lifting kite is, of course, that they do not require a wind to lift them from the ground. It was seen that these contrivances were excellent for directing artillery fire, as they could stay up for hours on end with ease, and, accordingly, the Allies have sensibly made use of the idea. But although these kite-balloons may be suitable in some instances, there are many occasions for which they are totally unsuited, such as when one observer has to fly about and direct the gunfire of several batteries. They are, of course, very vulnerable, so can hardly be used except near their own lines, and even then they must be well protected by anti-aircraft guns; they cannot, obviously, be used for observing long-range fire. Aeroplanes, therefore, continue to be used for directing gunfire far more extensively than these kite-balloons.

This particular comparison, like many others, shows the desirability of fitting aeroplanes with more than one engine, and with dual control, and so enabling them to keep aloft for longer periods with ease. It is an unnecessary drawback that aeroplanes should only have a single engine, for it is a drawback which can be overcome. Also many pilots, when their engines have been



By courtesy of "The Aeroplane."

A FRENCH DOUBLE-ENGINED CAUDRON BIPLANE JUST AFTER A COMBAT IN THE AIR.

This photograph demonstrates in a remarkable manner the value of multi-engine aeroplanes, for, after one of its motors was completely smashed, the machine flew very well and made a safe landing.

stopped by a mechanical defect or by a bullet, would have been saved from death and their machines from falling into the hands of the enemy if they had had even a partial reserve of engine power to fall back upon; and numberless machines would have been saved by observers when the pilot had been shot, if dual control had been fitted.

For the merit of the multiple-engined aeroplane in warfare is essentially, not so much that it shall be provided with greater aggregate power, as that it shall be far more reliable, by being able to fly reasonably well with but a proportion of its motors running, should the remainder have been put out of gear.

There have been many attempts made in this direction; in England, years ago, by Short Bros., and more recently by other constructors in America and Russia. But the first successful application of the principle during the War—apart from Sikorsky—was the biplane fitted with two 80 h.p. engines, each revolving a separate propeller, made by the Caudron firm in France. This was followed by the German battle-aeroplane, which was an improvement of the same idea. This battle-aeroplane—he is called "Fritz"—is extremely fast and very

reliable, and at the time of appearance was the best machine of the type that had been produced.

Both the German machine and the Caudron are aeroplanes which, though fitted with multiple engines, are only *incidentally* larger than usual; in fact, in the latter the size is increased as little as possible to accommodate the additional power plant. This should be specially noted by those who are under the impression that several engines serve primarily as an end to the production of altogether larger aeroplanes.

However, this increase of size actually is the principal object in the Sikorsky biplanes, which are designed chiefly to carry a large crew and considerable weight.

The Sikorsky is a huge biplane fitted with four 120 h.p. engines, which are placed at almost equal distances along the front edge of the wings. Each engine drives its own propeller, and the aeroplane will fly quite well with only two of them running. In the position where the nacelle and engine are placed in an ordinary machine, a totally enclosed cabin for the crew is built. The Sikorsky can take sixteen passengers quite easily, and has on occasions

ascended with well over twenty persons on board.

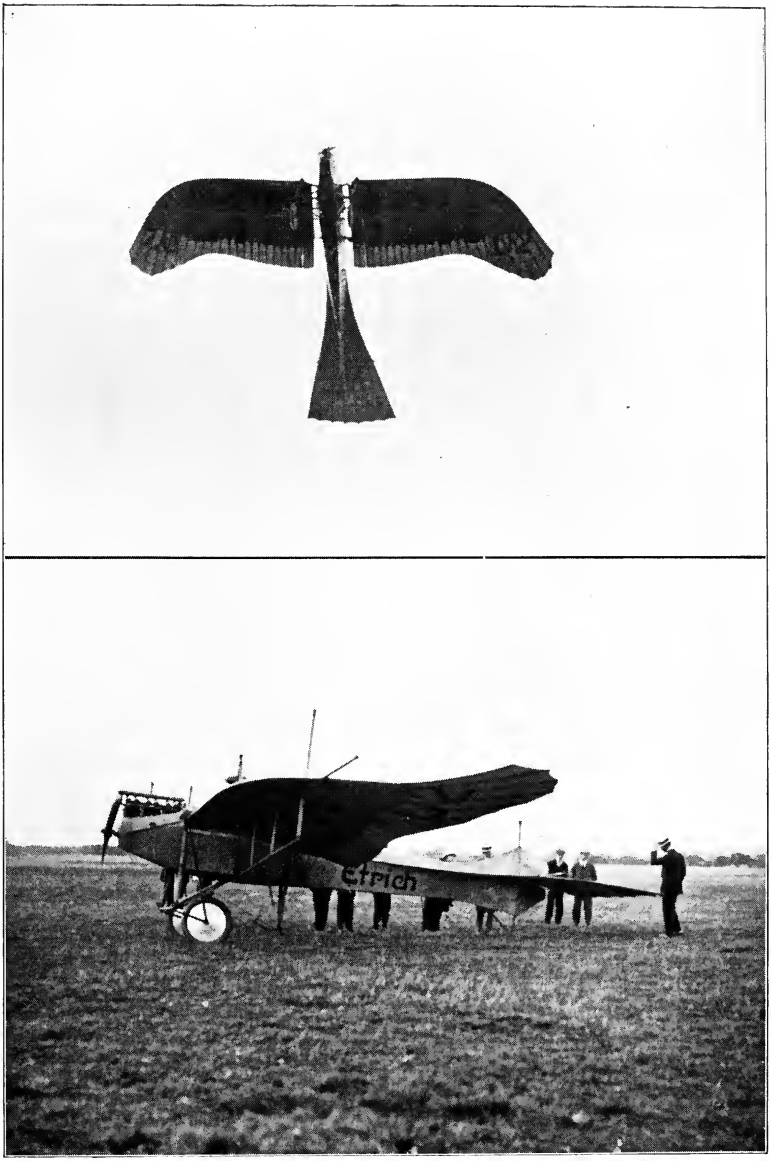
Considered purely as a flying machine, aeroplanes of this type—*i.e.* those in which weight-carrying is the first consideration—are quite efficient; but as serviceable war aeroplanes their relatively slow speed and climbing power detract from their value considerably. It would seem that the most advantageous solution for the present War is a compromise between size, or rather weight-carrying capacity, — the two are synonymous in an aeroplane—and the best possible speed and climbing power consonant with effectiveness. In other words, multi-engined aeroplanes for the War should be large and powerful enough to be able to carry a good many more bombs than ordinary machines, and yet still sacrifice enough of weight-carrying capacity for sufficiently fast speed and climb to make them really useful.

It can be seen that with the development of the multi-engined machine, not only will the aeroplane more nearly approach the airship as regards weight-carrying, but it will also compete with it in regard to duration. For the multi-engine principle will greatly increase the re-

liability of aeroplanes and go far to relieve the pilot of the mental anxiety which he often feels in war time when his engine is troublesome; while even a small consequent increase in the size of aeroplanes will make it possible to carry several pilots, who could take it in turns to control the machine. So the great strain which staying aloft for several hours at present imposes on pilots would be considerably lessened.

The task of flying in war time will also be made far easier with the perfection of automatically stable aeroplanes—*i.e.* machines which will maintain their balance without the assistance of the pilot. At present there is quite a graduated scale of machines possessing a greater or lesser amount of inherent stability, from the very fast scouts, in which the pilot dare not remove his hands from the control lever for a second, to the machines specially designed for inherent stability, such as the Dunne[1] biplane, on which the aviator can walk along the wings in mid-air without having to worry in the least about the machine not flying safely. In addi-

[1] It should be stated that the Dunne biplane is a machine of completely different type from any other aeroplane. The wings form a V, and there is no fuselage. However, although the Dunne is the most stable machine existing, there are many other aeroplanes of ordinary type which are also very stable.



By courtesy of "Flight."

TWO VIEWS OF AN ETRICH MONOPLANE.

This is a typical example of the aeroplanes with swept-back wings which German constructors used to build before the war. They were extremely stable, but had to be abandoned owing to their relatively slow speed.

tion to this particular aeroplane, there are many others which will fly perfectly well without the pilot touching the controls for long periods.

Automatic stability received more encouragement in Germany than anywhere else, and for years the predominating feature of nearly all German machines was their swept-back wings, which made them more stable than other aeroplanes. Wings of this shape were abandoned in order to obtain greater speed and climbing power, for indeed it has been found that really stable aeroplanes are generally slow, and therefore cannot be employed extensively in war. The present campaign has shown that completely automatic stability would be such an enormous asset in war that constructors will certainly experiment further in this direction in order to endeavour to produce, if possible, very fast machines that are inherently stable. At present it would seem that biplanes generally lack speed in proportion to their stability. But from that it must not be imagined that slow machines are necessarily stable, for this is certainly not the case.

In regard to aeroplanes increasing their lifting capacity, vast new possibilities can be

seen, some of which may reach fulfilment before the end of the War. Some one has pointed out that it is not necessarily an advantage at all for machines to be able to carry more bombs than they can at present, as that would mean "trusting too many eggs to one basket." If this argument is set out on the hypothesis that where forty small aeroplanes now perform a raid, half a dozen larger machines carrying the same quantity of explosives would do the work less effectively, this view is probably correct; because, in the first place, the larger machines would present a better target for the enemy; secondly, if, say, two machines out of forty were brought down, it would not matter very much, while the loss of two of the six large ones would make a considerable difference to the raid. But if this *is* the basis of the argument, the chief advantage of having large aeroplanes—which is that a far greater *total* quantity of bombs can be dropped—immediately vanishes.

As regards the immediate evolution of really large aeroplanes for use in the present War, a great deal depends on the engines which we can make for them. In this direction Germany certainly has the lead, for she has had for long

past a very large output of engines which are well constructed and very reliable; whereas at the beginning of the War there were only one or two firms in this country constructing aero-engines of any sort whatsoever. However, our ally, France, has been of the utmost assistance to us in the matter of motors, not only in sending us large supplies of actual output, but also in assisting British engineering firms to commence the manufacture of French engines of proved merit.

The engine of an aeroplane is indeed its very life, and with a weak or faltering motor the best designed machine is wasted. In the early days of aviation it was the petrol motor that made flying even possible; and to-day the aeroplane is still as dependent on the engine for the continued development of aviation, as it was in the darkest ages of flying.

There are, roughly, two distinct types of aero-engines in use to-day. There is the rotary type, in which the whole engine revolves, generally at the same rate as the propeller, and of which the best examples are the Gnome and Le Rhône. The great asset of engines of this type is their extraordinary lightness for

power, and it must be remembered that light weight is an enormous advantage in an aeroplane, where every pound saved is of the utmost importance. On the other hand, their great drawback is the delicate character and sensitiveness of their working. They require a great deal of attention, and not only must they constantly be dismantled and cleaned out after every few hours' running, but they also want skilful, experienced handling and "tuning up" to obtain the best results. This is naturally a serious drawback in warfare.

The other[1] class of engine is the stationary type, similar in principle to the ordinary motor-car engine. A good stationary aero-engine wants very little adjusting and will run for a long period without attention; but, although it is more reliable than most rotaries, it is heavier.

There is, therefore, on the one hand the powerful, light, but delicate rotary engines, which have been most successfully produced in

[1] Besides these two chief types of engines, there are one or two aeromotors constructed on the radial principle. In these, the cylinders are placed in a circle, in the centre of which is the crank-shaft. The cylinders are fixed and do not revolve. Very good results are obtained from these engines, which have proved highly satisfactory.

France; and, on the other hand, the wonderfully reliable, but comparatively heavy, stationary engines, made by such firms as Mércèdes and Benz in Germany, in Italy by F.I.A.T., and in England by Beardmore, The Green Engine Company, and the Sunbeam Company. Two or three years ago the aeroplane seemed behind the engine in point of development, but to-day it has possibly surpassed it. What is now awaited is the production of a very powerful engine combining lightness with efficiency and reliability.

It is most essential for the progress of aviation that a really big petrol engine should be evolved. Up to the present, approximately 300 horse-power is about the utmost for a successful aero-engine, but this is not nearly powerful enough, for in the near future petrol engines will be required developing, not hundreds, but thousands of horse-power.

That such engines can be evolved there is little doubt. When Blériot crossed the Channel in 1909 the aero-engine he used was a 25 horse-power Anzani; and in the few years since then we have increased the power of our aero-engines tenfold, so that events show a

definite and distinct trend towards the demand being met for really high-powered aeroplane engines.

As regards the progress of aircraft in general, there is one type in particular which it must inevitably fall to the lot of Great Britain to develop and perfect. That type is the seaplane. It is natural, as an island nation possessing a great Navy, a vast mercantile fleet, and having interests and responsibilities chiefly on the seas, that this country should find special interest in seaplanes. Even to-day we have made greater progress, and are better equipped with them, than any other Power.

There are many special difficulties peculiar to the seaplane. Even if, in specified cases, a machine may fly and alight as well with floats attached as with a land chassis, that does not mean that seaplanes are simply aeroplanes fitted with floats. Far from it.

There are, of course, various kinds of seaplanes, ranging from the delicate contrivance which, if carefully handled, may occasionally descend safely on very calm water, to the really big affair that will stand up to a fairly choppy sea. The most difficult problem about

a seaplane is, indeed, to make it seaworthy. In the future, when very big seaplanes are evolved, they will have to be able to withstand much rougher seas than can the machines which exist to-day. In fact, they will have to be able to remain safely anchored in almost as bad weather as most ships can stand to-day.

The prospect of crossing the Atlantic by aeroplane will almost certainly be revived after the War, and there is a clear probability of a successful crossing by air being made within a short time after peace is declared.

One of two methods will have to be decided upon by any one who resumes the attempt. The first plan is to design a machine without providing against an involuntary descent, which in such an aeroplane would undoubtedly prove fatal. The machine on which the late Mr. Hamel intended to attempt the cross-Atlantic flight was of this type, and the great advantage gained is in lightness. The second plan is to endeavour to construct a seaplane capable of making an enforced and, if necessary, prolonged descent in safety. At present no existing seaplane could stand up to ordinary Atlantic breakers for five minutes; and the problem of

making a seaplane capable of doing so will prove a very difficult one.

People who do not realise the extraordinary driving force of the sea should witness a seaplane, which on land appears very strong, being turned over and smashed like matchwood by the breakers of a comparatively light sea. The simple remedy of indefinitely increasing the constructional strength of the seaplane is not wholly practical, for the obvious reason that if a seaplane is made too heavy it will not ascend from the water easily, or fly properly; and, after all, the seaplane's element is the air and not the water, even if it does have to rest on the latter frequently for quite long periods. Besides, resisting the waves is not only a matter of material strength, because once a seaplane overturns it will sink, and the strongest seaplane might overturn more easily than a lighter one better designed to sit on rough water. The really successful seaplane must be seaworthy as a result of its *design* rather than of its actual material strength, just as the best specimens lift off the water easily because of the good design of their floats, instead of by sheer engine power alone.

As a matter of fact, this "getting off" with seaplanes for long presented a difficult technical problem to seaplane constructors. The suction of the water to ordinary flat-bottomed floats is enormous, and until recently this suction was only overcome by engine power simply wrenching the machine off the water. Now, however, specially designed floats have practically eliminated this obstacle, and seaplanes can "get off" smoothly and without strain or effort. But before any measure of success was attained, floats of the most extraordinary shapes and designs were produced, for years.

Many people express surprise when they learn that it is far more difficult to fly a seaplane than a land-machine. The general impression seems to be that water is a sort of feather bed which breaks the fall of a bad landing. The actual facts, however, are quite different. Not only has the seaplane pilot to land on a substance which is quite as unyielding for that particular purpose as the ground, but, unlike the solid earth, the portion of that substance which he has selected for landing on may completely upset his calculations by rising up several feet, or descending an equal distance,

or doing both within two seconds, just at the crucial moment when he is flattening out after his volplane. Many stretches of water are quite transparent from above, trees or plants growing on the bottom being clearly visible, and in such cases it is extremely difficult, when flying, to judge exactly the level of the surface of the water, especially when there is a slight mist or fog. As a safe landing depends essentially on the pilot being able to judge just when to straighten the flying angle of his machine, this is a serious matter.

It is probable that in the future considerable attention will be paid to the amphibious type of aeroplane—*i.e.* that which can descend on, and ascend from, land or water, for there appear to be great possibilities in this class of craft, especially in a country like England, where the sea must be traversed for every journey to a foreign land. There have been several fairly successful attempts made to produce these amphibians, but somehow they have been neglected.

As regards the two great types of machines,—monoplane and biplane—very much the same conditions apply to seaplanes as to land-machines,

and it is certain that for general naval and military purposes the machine with two planes —or possibly more—will retain its predominance over the monoplane.

In so far as the principal classes of machines go, such as pusher (with propeller behind the planes) and tractor (with propeller in front of planes), the War has not greatly altered the opinions previously conceived about them. No improvement has yet superseded the advantage of the tractor biplane having its engine placed in front of the pilot,[1] for the weight of the engine often saves him from being killed or even badly injured if the machine falls to the ground. On the other hand, the pusher type aeroplane still remains far superior to the tractor in giving the pilot or observer an excellent view of the ground, and a good range all round the machine with a gun. It is easy to realise the importance

[1] In all aeroplanes, with the exception of one or two experimental machines, the position of the engine (in relation to the planes and pilot) corresponds to the position of the propeller. Thus the engine is placed behind the wings in all modern pusher biplanes, and in front in all tractors. A notable exception was made in the Mann and Grimmer biplane, fitted with two propellers behind the planes, with the engine placed in the extreme front of the aeroplane. This arrangement is theoretically almost ideal, but in practice the weight of the shaft gearing and the comparatively slow speed of the machine for war purposes detract from any advantage otherwise gained. Nevertheless, with further development the principle may prove to be of value, and its present drawbacks overcome.

of this comparatively unrestricted view in war. In some tractor machines, which are admirable in every other way, it is necessary for the pilot to cant them many degrees if, when observing or bomb-dropping, he wishes to see the ground immediately beneath him.

Finally, tractor biplanes are faster than the other type. And, as speed is the sovereign quality of the upper air, a great deal must, if necessary, give way to it. A few years ago sixty miles an hour was the world's ideal, the rate of famous express trains ; the fiction writer's *pièce de resistance* ! Now the aeroplane which can only attain that figure is far too slow for the firing line, for nearly twice that speed is the order of the day.

PART II

THE MAN AND THE MACHINE

CHAPTER VIII

HOW AN AVIATOR IS TRAINED

It is quite true that a brilliant flier is born and not made, but it is even truer that a man can only become a competent aviator in the full sense of the word by the process of acquiring a long and almost invariably hard-earned experience.

Many people are led into the belief that when a pilot can "stand on his head" in the air, or balance his machine delicately on one wing-tip without disaster resulting, he has nothing more to learn about flying; but this is emphatically not the case. In fact, should that be the full extent of his knowledge, his training has only begun. It has already been pointed out that aerial gymnastics, such as looping the loop, have rendered great service to pilots during the War. But it is by no means their abilities in matters of such comparatively unessential worth which

make the aviators of the R.F.C. and the R.N.A.S. the finest in the world.

Many other qualities are essential in an officer who can fly well enough to belong to either of these corps. A junior flying officer, to be retained in either service, must at least have sound judgment and a delicate sense of touch—"good hands" is the usual phrase—and if he is to "make good" on active service he must possess many other qualities besides these. He must have absolute confidence in himself and yet be able to realise the full extent of every risk he takes with his machine. He must have plenty of pluck and nerve, but no "nerves," a sense of direction, and, above all, that very necessary ingredient, a fair amount of common sense.

These attributes are essential in the average R.F.C. or R.N.A.S. officer. The very finest pilots in the world sometimes have a sixth sense: an inherent ability to battle with the weather—the sort of instinct that senses each gust of wind before it strikes the machine.

But the foregoing qualities only provide for the actual flying capabilities of an officer. They do not indicate, for example, whether he has any real knowledge of aeroplanes, or if he has the

slightest practical experience of aero-engines. And it can be easily seen what an immense advantage it is for a pilot to have a working knowledge of his aeroplane and its power-plant. With such knowledge, an airman on active service can frequently ascertain, for instance, whether a projectile hitting his machine has done but slight injury, or whether the damage inflicted is severe enough to warrant him returning immediately to the base. It will also frequently enable him to know what is wrong with his engine if it is not giving sufficient power ; and perhaps he will be able to make, without descending, an adjustment, should it be a trifling one for which only accurate knowledge is necessary. But practical experience may render him a greater service than any of these should he be forced to descend for a moment in the enemy's country for some simple repair. For it might make all the difference to him between capture and escape.

In war time it must of course frequently be left to the pilot himself to decide whether he considers a certain machine safe to fly or not. The aeroplane may be punctured all over with bullet-holes and yet be reasonably safe ; or it

may be untouched and yet have become unsafe from some cause not apparent to a comparatively ignorant or unpractised eye.

The necessity can be seen, therefore, of a service pilot acquiring all possible available knowledge relating to aeroplanes during his period of training. That this necessity is recognised by the R.F.C. is shown by the fact that even after an officer in that corps has taken his Royal Aero Club Certificate for actual flying, he has to gain his "wings"—which emblem he then wears sewn on his tunic. To gain them he has to pass an examination bearing essentially on a practical, common-sense knowledge of the ways of aeroplanes.

How much of all this can the prospective aviator learn at a civilian school, and how much can only be learnt afterwards by prolonged experience?

As already remarked, a man must have a natural talent for flying if he is to become a good pilot; and this talent can no more be inculcated in the most painstaking enthusiast than it can be denied even in the laziest pupil. The Germans have discovered this to their cost, for throughout the War they have been

extremely short of good pilots, and even their best are rarely as good as our best.

Apart from this inborn faculty, a pupil will only learn a great deal outside the prescribed course of tuition if he sincerely desires to learn it, and he will have to work hard and very seriously to do so, for it is no easy task.

It may be of interest to examine the various stages through which a pupil passes at the Grahame-White School of Flying, which operates at the London Aerodrome, Hendon, and at which many airmen have been trained for the services.

The first lesson is that of mastering the controls while the machine is on the ground; the necessary movements to be made are almost instinctive. Thus, to turn to the left, the left foot is moved forward, working a cross bar connected with the rudder; or, to ascend, the central hand-control is pulled back, this being an adaptation of the natural movement of leaning backwards. Every movement must be steady and gentle, never rough nor spasmodic. The pupil is next taken for passenger flights with an instructor, after which he makes short, low, straight flights first with the instructor and afterwards by himself; then he does left-

hand[1] circuits with the instructor, and, later, unassisted. He can now practise right-hand turns, figures of eight, volplanes, etc. When he can perform all these with ease he is ready to go through the test flights to obtain the Royal Aero Club Certificate, the official rules for which are as follows :

A and B. Two distance flights, consisting of at least 5 kilometres (3 miles 185 yards) each in a closed circuit, without touching the ground or water ; the distance to be measured as described below.

C. One altitude flight, during which a height of at least 100 metres (328 feet) above the point of departure must be attained ; the descent to be made from that height with the motor cut off. The landing must be made in view of the observers, without restarting the motor.

The candidate must be alone in the aircraft during the three tests.

The course on which the aviator accomplishes tests A and B must be marked only by two posts or buoys situated not more than 500 metres (547 yards) apart.

The turns round the posts or buoys must be made alternately to the right and to the left, so that the flight will consist of an uninterrupted series of figures of eight.

The distance flown shall be reckoned as if in a straight line between the two posts or buoys.

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[1] The gyroscopic action of the propeller turning to the left makes left-hand turns easier than right-hand turns, so they are therefore attempted first.

The alighting after the two distance flights in tests A and B shall be made :—

(*a*) By stopping the motor at or before the moment of touching the ground or water ;

(*b*) By bringing the aircraft to rest not more than 50 metres (164 feet) from a point indicated previously by the candidate.

All alightings must be made in a normal manner, and the observers must report any irregularities.

When he has obtained this certificate his course of tuition is normally at an end at all civilian schools.

It depends on the pupil himself how much he has learnt. It is obviously against the interests of any good school that the instructors should endeavour to hurry the pupils through their courses with the idea of obtaining their certificates for them and getting them off their hands as quickly as possible. But, however thoroughly the instructors may wish to teach, their efforts are wasted if the pupil's only desire is to secure his "ticket" and announce himself a full-fledged aviator—which he is not—without his having the slightest inclination to realise intelligently what he is doing, and why.

But an immense amount can be, and has been learnt in a few months by those who

are determined to become thoroughly competent.

It is impossible to define exactly what knowledge there is to be picked up in an aerodrome, outside the actual specified tuition, because it is too varied and too vague. One has seen enterprising pupils, who have afterwards generally become highly successful pilots, watching and helping the assembling and dissembling of engines; assisting in some minor capacity in the repair of school machines; prowling round workshops, repair shops, hangars; carefully watching the flying of expert pilots; questioning instructors; last and not least, talking to mechanics—for there is generally more to be learnt from one good mechanic than from a dozen scientists, each with a theory of his own.

When the pupil has gained his certificate at a civilian school, he would then be transferred to a Government school to practise on more up-to-date aeroplanes, for those on which the novice first learns are naturally of a somewhat primitive nature: slow, safe, easy to control, very strong, and with a good view of the ground. It is assumed, of course, that the pupil has been accepted by the Royal Flying Corps or the Royal

Naval Air Service "on probation"; that is to say, he has been given a commission in one of those services subject to his making satisfactory progress in flying, and proving himself suitable to hold the King's Commission. If he turns out a good pilot, he will be confirmed in his rank; if he should not, then he cannot remain in the flying services. This latter proviso was framed particularly for those fortunate enough to be taught to fly from the commencement by the Army or the Navy, instead of at their own risk and expense. For, in the case of the man who has already taken his certificate at a civilian school, it can then be seen whether he has any talent for flying or not. A very high standard of mental and physical fitness and ability is required in the R.N.A.S. and the R.F.C., and there is no disgrace or blame whatever attached to an officer who is not retained in them for not having sufficient ability in flying.

It can be seen that the test for the Royal Aero Club Certificate only comprises three short, relatively easy flights, and that, therefore, a pupil need not have much experience to be able to perform them. The certificate, in fact, means very little, but forms a convenient halting-

place; for, when he has taken his *brevet*, it is apparent whether it is worth a man's while to consider seriously the question of entering or continuing in the R.F.C. or the R.N.A.S. (or, in peace time, whether he should continue his career as an aviator), and, on the other hand, the R.F.C. and the R.N.A.S. can take the measure of a man's ability, and are often, therefore, saved the possibility of wasting machines and instruction on a temperamentally unsuitable candidate. It should be stated that in England only a small proportion of pupils who take their "tickets" lack sufficient talent to enable them to enter one or other of the air services.

If the pupil proves suitable, he would then be put through a graduated course on modern-type machines, until he is at last competent to handle the fastest military scouts.

A service aviator must be able to stand a great deal of strain, both mental and physical. There are British military airmen who have, during the campaign, for six months on end averaged four or five hours' flying a day, in every kind of bad weather. When it is realised that this means, on a fast machine, a distance of about three hundred and fifty miles a day, under trying and dangerous

conditions which constantly demand instantaneous and decisive action, coolness, vigour, and courage, some idea can be gleaned of the magnificent stamina of our flying officers. They have, it is true, a great advantage over the ordinary soldier in that their bases are well behind the firing lines, so that they are comfortably quartered, and often provided even with beds.

Flying can be witnessed with just the same delicate shades of appreciation that appertain to the more acknowledged arts, and an experienced spectator can judge to a high degree the knowledge and talent which are displayed or even possessed by a pilot from his manner of handling an aeroplane. It does not matter if he has never seen him fly before, or if he has no knowledge of his identity. In fact, to such an extent can this faculty be developed that an expert spectator is able, without previous knowledge, to recognise a pilot by the manner in which he manipulates a machine in the air.

Bearing in mind this fact, and the clearness with which the exceptional talent of a gifted airman differentiates his flying from that of the mediocre performer, is it to be wondered that the true airman—the natural exponent of the art

of flying—has often something of the artistic temperament in his nature? But, if he joins either of the flying services, this strain of unrest must be held under control. For, besides being an aviator, he is always an officer, and, as such, he must exercise qualities of discipline—in the real sense of the word—both over himself and over others.

This is not always such a simple matter as it may appear. Although he has often to exhibit far more initiative than his compeers in any other branch of the Army or Navy, the flying officer may never, especially in warfare, forget that he is not, as it were, a free agent. He must remember that he is flying a *military* aeroplane, of which there must necessarily be a shortage for all the many purposes of war during the whole of the present campaign, and that, as a highly-trained servant of the State, his life is a valuable asset which must not be jeopardised lightly or for any relatively worthless object. When he is carrying an observer he has to be ever conscious that he is responsible, too, for the life of another highly-trained servant—quite apart from regarding his passenger as a human freight entrusted to his care. Thus,

the flying officer must control his personal desires, if they are not synonymous with the interests of his country. For instance, to attack a greatly superior enemy aeroplane, which he could avoid, when returning home with valuable information, might be a downright, if unintentional, disservice to his country; for the result might be the loss of important news to the commanding officer.

Always in warfare must his individual wishes be subservient to military discipline, the real meaning of which is the placing of military objects —and therefore ultimately the ends of state— before personal inclinations, no matter how heroic in design they may be.

Prompted by the great increase of aviators which the War has brought, it has been suggested that flying will lose the elusive distinction and romance with which it is now encircled, at any rate for the great masses, and become as common and simple an acquirement as driving a motor car. This may be true, though in a different sense from that which was intended. As every one interested in the welfare of Aviation hopes and foretells, flying will certainly become an ordinary everyday accomplishment; but that does not

mean that it will lose its prestige. It will simply mean that the really first-class pilots will stand out above the multitude of mediocre " aeroplane-chauffeurs " who will arise, far more distinctly than they do at the present time, when most airmen, at any rate the British ones, being highly selected, have a decided bent for flying.

The few truly superb aviators will ever remain what they are at present : kings of the air. And as such they will retain the homage they enjoy to-day, which is at least as much due to them as it is to those who excel in other spheres of life which do not demand such qualities of courage and endurance as are required by Aviation, the youngest of the sciences.

By courtesy of "The Aeroplane."

A GERMAN KITE-BALLOON ABOUT TO ASCEND.

The kite-balloon maintains the same position when in the air, and the "bulge" at its lower end forms an excellent stabiliser. The occupants are suspended in a basket which hangs by a cable.

CHAPTER IX

THE MAKING OF AEROPLANES

An aeroplane is at once a fairly simple and yet at the same time an elusively problematical article to construct. That is, of course, a rough generalisation, and aeroplanes vary tremendously according to whether they are easy or difficult to build. But, applying a platitude, it may be said that an aeroplane is a reasonably easy thing to make if you know how to do it.

Nothing of an equal size has to be more carefully constructed than an aeroplane, and there is an amazing difference in the flying capabilities, to say nothing of the durability, between machines well constructed by one firm and others of identical design badly or indifferently built by another. There is, in addition, the great question of safety. It is no

exaggeration to say that a pilot's life depends on the good workmanship and faultless material of every single part of his machine. It is for this reason that a higher standard of worker is required in the aeroplane industry than in many other branches of engineering. It is not enough for an aeroplane worker to be only a skilful artisan: he must be a conscientious one too. It is so much easier for a man to forget the ultimate strain which the particular part he is making will have to stand when it takes its place in the finished flying machine, than it is for him to consider whether he himself would care to trust his own life to that part, in the way in which an airman will have to. Without, therefore, casting the slightest reflection on the excellent body of men who are employed in the aeroplane industry, and who certainly do not belong to the thoughtless class, it is reassuring to remember the stringent examination to which every part of an aeroplane for the War Office or the Admiralty is subjected. In addition to each constructor's own inspectors, an inspector from the Aeronautical Inspection Department (for R.F.C.) or from the Inspection Air Department (for R.N.A.S.)

must pass each separate part of an aeroplane before it leaves the constructor's factory, and also the completed machine when it is erected. This constructional examination is, of course, quite apart from the flying test through which a machine must be put before it is accepted by either of the flying services.

The aeroplane industry is composed, to a large extent, of several recognised skilled trades, a large proportion of the skilled artisans in an aeroplane factory consisting of woodworkers, turners, fitters, acetylene-welders, milling hands, coppersmiths, splicers, press tool makers, etc. In most cases, however, a good deal of adaptation is required from the methods of working employed in other trades to those necessary in the manufacture of aeroplanes. For instance, the most expert cabinet-maker is useless on aeroplane woodwork until he has been taught the difference between the handling, selection, and working of wood for aeroplanes and that for cabinet-making.

Aeroplane manufacture is divided, roughly, into three great departments: woodworking, metal fittings, and erecting. In the two first named the workers employed are chiefly those

belonging to some of the standard trades mentioned before; but for the erecting shop previous aeroplane experience is far more necessary. Since war broke out constructors have, of course, increased their staffs very largely, and it has been a much easier matter for the experienced hands in the woodworking and fitting shops to initiate skilled newcomers into the special requirements of aeroplane manufacture in those departments than it has been for the experienced hands in the assembling shops to do likewise. And more than a word of appreciation is really due to those loyal expert artisans with long experience of aeroplane construction who have successfully assisted the newcomers with their work. Perhaps the effort which they have made in this direction, and the forbearance and patience which it has naturally demanded, can only be appreciated by those who have watched its progress.

It is difficult to explain why erecting should require experience outside the bare knowledge of knowing where each part should go. But the fact remains that it is in the erecting shop that the "life" is put into an aeroplane, and it seems to depend upon some intangible instinct

in the erectors themselves—perhaps an acquired instinct which can only be gained by experience—as to whether an aeroplane will fly its best or its worst after it leaves the factory. That this quality of "life" exists in an aeroplane no one acquainted with aviation would for a moment deny. Nothing could demonstrate it more forcibly than the example of an aeroplane that has been dissembled after use and left so for some time. When it is assembled again it is invariably found that its flying capabilities have deteriorated to a large extent. In other words, the "life" has gone out of it.

In addition to erecting, there are several other special departments in an aeroplane factory which do not exist in any other branch of engineering. For example, there is the dope shop. This is where the wings and all other fabric-covered parts are coated with a special preparation for tightening and strengthening the fabric, and making it waterproof, oilproof, and airproof. Then, again, there is the propeller department. As a matter of fact, propeller-making is such a difficult and important matter in itself, that only a very few aeroplane constructors make their own propellers, while

there are many firms devoted exclusively to this branch of the aircraft industry.

Propeller-making is a science quite of itself, and it is hard, without having seen the process, to realise the difficulty of designing, and the care required in manufacturing, good propellers; for they must be immensely strong to stand the great strain to which they are subjected in the air, and they must also be perfectly balanced. If a propeller bursts in the air through centrifugal force, it is a very dangerous experience for the pilot, particularly in war time, and so infinite pains have to be taken in the making to prevent this.

Designing propellers is a most complicated affair, especially when something occurs which completely upsets previous calculations. An example of this was the case of an aeroplane which, although fitted with a four-bladed screw, flew quite as well with two of the blades broken off. That the relation of the propeller to the aeroplane is a very carefully calculated one may be judged from the fact that almost every make or type of machine has a different propeller, the size and shape of which is regulated by the aeroplane's engine power and engine speed, by

the make of its engine, by whether it is a tractor or a pusher machine, and by many other considerations.

The delicacy and fine-limit working which are required in the making of propellers are really characteristic of the whole aircraft industry. Take, for instance, the camber[1] of an aeroplane: the slightest divergence from the originally designed dimensions in this part will make a great difference to the flying of a machine.

Fine material as well as fine workmanship is required for aeroplane building. Only the finest wood and the finest metal are good enough for a flying machine, and material that in another trade would pass muster has to be scrapped unhesitatingly in an aeroplane factory.

At the present time there are many things appertaining to an aeroplane which are not manufactured by the aeroplane constructor proper. The first in importance among these is the engine. Only in one or two very exceptional cases does any aeroplane manufacturer make his own engines. One would think that in time this separation of manufacture would disappear, and the way will probably be led

[1] *I.e.* the curvature of the wing.

by the big engineering firms who have opened aircraft departments, and to whom the question of large expenditure in laying down plant is not very important. Just as it is quite natural that motor-car firms should make the engines for their cars, so it is inevitable that the same should apply to aircraft firms. That motor-car bodies continue to be supplied chiefly by coach-builders is no parallel case, for, while the body of an automobile is merely a piece of furniture, the engine of an aeroplane is a mechanical accessory of prime importance which comes under the direct heading of the engineering branch. When aviation is advanced sufficiently for aircraft to have really elaborate bodies or nacelles, it is quite possible that these may also be made by the coach-building firms who are making motor-car bodies to-day. Taking into consideration how closely allied are the aeroplane and its engine, and how indissolubly bound up is the progress of the one in the development of the other, it will be realised as inevitable that aeroplane-builders will ultimately make their own motors. There will be many firms experimenting in special directions who will want aeroplane engines made suitable to

their requirements. The ordinary engine firms may be too busy, or not enterprising enough, or not sufficiently confident of the ultimate result from a business point of view, to undertake these experiments; so that reason alone will be incentive enough to start constructors making their own engines.

Besides engines, and, of course, the covering fabric, such accessories for aircraft as tyres, various instruments, gauges, etc., are also not made by aeroplane constructors to-day, but specialities such as these will probably always be confined to outside makers.

About the most complete firm in respect of internal production is probably the Curtiss Company of America, which is one of the very exceptional companies referred to which makes the motors for its own aeroplanes. When war broke out and brought large orders from the Allied Governments, this firm executed a remarkable speeding-up of its output. Within two months of the declaration of war it increased the production of its factory to six machines a week, within a year to six machines a day, and shortly after to twelve machines a day, which is a unique feat in the history of aeroplane building.

This performance is extremely instructive in itself, for it shows that a really large output of aeroplanes is perfectly feasible. Nevertheless, in aeroplane work quality must emphatically always come before quantity, no matter how urgent the demand. That quality can be consonant with quantity up to a certain point is true, but after that particular point quality will suffer, and this must not be the case in aircraft work under any circumstances. In the case of motor cars a different state of affairs exists, so a comparison must not be drawn. The best British cars are admittedly the finest engineering jobs in the world, but, so far as output goes, the largest American firms can produce as many automobiles in a day as the British companies can in a month or even twelve months. But the relatively poor standard of workmanship and material embodied on the popular American cars, although good enough, or at any rate safe enough, in a motor-car—on which no great strain is placed except on one or two isolated places, which can be specially strengthened—would be absolutely fatal for aeroplanes.

This does not in any way depreciate the quality of the Curtiss biplanes because they are

produced rapidly. As a matter of fact, the output of no aeroplane firm in the world is large enough to-day for the quality of the work to suffer on that account. It is only pointed out that over-production will have to be sedulously guarded against in aeroplane works, particularly in the United States, where more is known about factory organisation and output than anywhere in Europe, and whence the really large output of aeroplanes — which will in consequence be produced cheaper than elsewhere — may eventually come, unless we are careful. In fact, the boot is often on the other foot, and European manufacturers have frequently to be thoroughly shaken up in order to obtain a really efficient output from their factories, so that the danger of poor work from too great speeding-up is not likely to come from this side of the water.

American organisation and American efficiency in factory output should prove of the very greatest value to British aeroplane constructors, if they will only make up their minds to learn from them—but they will, nevertheless, have to use their own discretion where to draw the line. Thus, in the future, American constructors

will probably introduce, or endeavour to introduce, the chain system in aeroplane workshops. The chain system, as most people are aware, is so called because of the continually moving chain or passage on which the articles—automobiles in particular—are placed, and on which they pass through the assembling shops; the assembling is done almost instantaneously while the articles are on the move, and it is an essential adjunct to the system that each man performs only one simple skilled function, which, of course, necessitates a far greater number of workers than does the ordinary method.

At the present stage of development in aeroplane construction no one can decide whether it will be possible to use this chain system and still maintain a high technical standard of work; but eventually it will probably rest with Europe to judge at any rate the results. This is because aviation has been practically at a standstill for years in America, except in the case of the one or two firms who have lately commenced to supply aeroplanes in quantities to the Allied Governments. The chief cause of this is that the United States Government has taken hardly any interest at

all in aircraft. Anyhow, the fact remains that at present, and, so far as can be seen, for some time to come, apart from the few civilian buyers and supporters of aviation in the States, American constructors of importance are, and will continue to be, wholly dependent for their existence on great European Governments, who certainly are extremely particular about the quality of the work they accept. In this way the standard of workmanship will be maintained.

France has for long shown that beautifully constructed aeroplanes can be turned out in fairly large quantities, and, indeed, an aeroplane is actually simpler to make than a first-class motor car. In time to come, therefore, a first-class aeroplane of ordinary present-day size might be made in the same time as it takes to construct a fairly good automobile in Europe to-day.

There are at the present time, however, many difficulties — most of which may be described as temporary—attached to aeroplane production on a large scale in these islands, and probably in every other belligerent country as well. Primarily there is the ever-moving element of Change. The exigencies and experience of the

firing line continually demand that service aeroplanes shall be modified, improved, altered or revised, and it can be easily imagined that engineering firms, particularly those just commencing to build aeroplanes, find it a great impediment to their output to have even small details on their machines frequently altered. Then, again, it is very difficult for these firms who have recently entered the industry to obtain really experienced workers; and experience is an enormous asset in building aeroplanes, even of the Government's own design, for which complete drawings are supplied. It is, indeed, difficult to imagine a manufacturing industry in which individuality — one might almost say personality—finds more play than in the production of aeroplanes.

All sorts of firms have commenced making aeroplanes since the beginning of the War, and those who thought it was going to be an easy job have had a rude awakening. All the newcomers, who consist chiefly of motor-car constructors, coachbuilders, and even furniture makers, were asked to make aeroplanes to Government designs, and were supplied with complete drawings of every single part, which

no doubt helped to create the illusion of simplicity. Curiously enough, these particular aeroplanes are far more complicated and difficult to construct than almost any of equal or greater merit designed by private aeroplane constructors and now being made by their respective designers for the Army or the Navy.

It is, of course, unwise and unusual for a firm only recently engaged on aeroplane work to attempt designing original machines of its own, unless it happens to secure the services of a really able and experienced aeronautical engineer, at present a most difficult matter. Designing must be left to the older-established aeroplane firms proper, at any rate for the time being, while the others gain their experience.

For these pre-war aircraft firms, with their valuable experience, mere repetition is not a very difficult matter, especially if they can be given bigger orders for one type of aeroplane than most of them have received hitherto. If a factory sets out to make a few hundred machines all of one type, the output will naturally be vastly larger than if it has to make twenty of one kind of aeroplane, fifty of another kind,

and so on, even if the total sum of the several small orders equals or even exceeds that of one big contract. The best course possible would be for constructors to supply machines of their own design, should they be effective for war purposes. For, having a first-hand knowledge of the development and behaviour of the machine, and its aerodynamical and practical basic principles, the constructors may, if necessary, be able to overcome, by some simple but perhaps not obvious alteration, difficulties which may hinder the quick production of the machine in large quantities. And it is only natural for a firm to take more pride and enthusiasm in its own production than in one of a strange origin. It is, on the other hand, most important to reduce as far as possible the number of types of machines in use, in order not to multiply the variety of spare parts at each aircraft base.

About ten months after the outbreak of the War there was, it will be recalled, a widespread demand, originated by Mr. H. G. Wells, for ten thousand aeroplanes. That number hardly exists in the whole world, and one might assume, the majority of Mr. Wells' supporters had not much

more idea of the significance or the potentialities of ten thousand aeroplanes than they had of double or half that amount. With the exception of Mr. Wells himself and a well-known writer on aviation, Mr. C. G. Grey, the editor of the *Aeroplane*, all these enthusiasts imagined the ten thousand aeroplanes as being an effective striking force, without making any allowance for the large number of machines required for training an adequate supply of pilots to fly them, nor the quantity necessary for reserves and spares. No: we were to build ten thousand aeroplanes before the Germans could build even an equal number, although they started the War with incomparably better facilities for turning out aeroplanes in large quantities than we did. After that we were to invade Germany by air and end the War. Very simple, no doubt —on paper. But we must remember that, even although we possess a distinct ascendancy over the Germans as regards most of our pilots and some of our machines, that margin of superiority has always been extremely hard to maintain; so an aerial invasion of Germany in force would not prove exactly a walk-over for us, assuming that there was a force of aircraft

against us equal to our own. Probably by the time we had beaten the German air fleet, if we were able to do so, the damaged remnant which would remain of our own air fleet would not prove the most effective weapon for bringing Germany to her knees.

It is hardly possible, therefore, to accept this demand as a serious means of carrying out a definite military programme; but we can applaud it sincerely as a movement in the direction of obtaining more and more aeroplanes, and still more after that. The exact specified number asked for really does not matter if we regard it in that light. As a matter of fact, ten thousand aeroplanes is not altogether an impossible number for Great Britain, France, and America to build within a reasonable time.

At any rate, our output is increasing enormously, and, even if that particular figure still seems quite far away, we are certainly progressing in the right direction towards it at a rapidly increasing speed.

The British aircraft industry has done marvels considering the comparatively unorganised state it was in when war broke out, and our aeroplane constructors will continue to exert every possible

effort in order to equip our Army and Navy with an adequate supply of seaplanes and aeroplanes.

And it will be seen that their efforts will not have been in vain.

PART III

THE FUTURE OF AIRCRAFT

CHAPTER X

WHAT THE WAR HAS DONE FOR AVIATION

In the past, war has not often meant progress for the sciences, except for those few entirely devoted to purposes of destruction. As for the great general sciences which help to educate, improve, and civilise the world, they, like the arts, remain at a standstill or sink into temporary oblivion, because nations are too occupied with other things in time of war to give attention to them. But in the case of aviation, the youngest of the sciences, which is, or will be, just as important for the peaceful purposes of humanity as for its warlike tendencies, an exception is made by the present campaign.

The full benefit of the enormous development which aviation is receiving during the gigantic struggle which is taking place to-day will only commence to be enjoyed by the world in general

after peace is declared. Probably more was learnt about aircraft during the first year of war alone than would have been discovered in perhaps ten years of peace; and although hardly a particle of this newly-acquired knowledge has been made use of yet, its existence will enable aeroplanes and airships to reach a much higher stage of evolution far more rapidly than would otherwise have been possible.

These are three principal reasons why much of the practical experience which has been gained since the beginning of the War has not yet been put into practice—and in aviation practical experience is infinitely more valuable than theoretical research. First, because constructors, generally speaking, have not had sufficient time in which to perfect their improvements, for they have been working at top pressure turning out standard machines, and so could not spare much time attempting aeroplanes which might turn out dead failures. Secondly, because much of the knowledge gained during the War about aircraft will probably be only indirectly valuable for military aeronautics, and so does not receive immediate attention. For instance, although a great deal of fresh light has been shed on such

considerations as stability, comfort, refinements for the pilot, etc., these things, important though they are, are not of sufficiently urgent military value to justify much trouble being taken over them at present, owing, in the case of the first item, to the fact that great stability in an aeroplane has not, in the past, been compatible with effective speed and climb. Thirdly, a great deal of this knowledge does not exist on paper, properly formulated or tabulated, but only more or less vaguely in the heads of service aviators, commanding officers, and aeroplane engineers and designers. It will, therefore, take some time to leak out, if one may so term the process. At any rate, the encouraging point is that it exists, and it can be safely assumed that none of it will be lost or forgotten.

It is not difficult to realise why we are gaining such an exceptionally instructive experience of aircraft. Under the necessity of warfare, aeroplanes have to be subjected to risks which would not be taken in peace time. Not, of course, such comparatively familiar, if useful, feats as looping the loop or tail-sliding, even if performed involuntarily. Rather, for example, discovering how long an aeroplane will stand being flown

regularly 300 or 400 miles a day, in every sort of bad weather, including hailstorms and gales; exactly where it can stand the strain of being hit by bullets and shrapnel without smashing; how much landing chassis will be left after a few descents in small back gardens or ploughed fields; or how a machine, which is normally fairly stable, behaves when the air zone in its line of flight is whirled round from the disturbances created by "Archie." These are a few of the innumerable things of the utmost value which the experience of war is teaching constructors, designers, and pilots.

But that is not by any means all that the present campaign has done for Aviation, especially in this country. It has, as a natural consequence of the sudden great demand for aeroplanes, enormously strengthened and enlarged the aircraft industry. It has enabled the businesses of British aeroplane constructors to emerge from the almost philanthropic conditions under which, with a few exceptions, they were conducted, and be placed on a sound financial footing. And, moreover, the convincing proofs of aircraft's indispensability for military purposes which the War has demonstrated will

ensure that the trade will remain on that sound footing.

But aviation has also been firmly established in the minds of the world's inhabitants,—another and perhaps more important connection than the industrial sphere. Both belligerent and neutral nations have been enormously impressed by the performance of aircraft in the campaigns, and rightly so. No longer is flying regarded with misgiving and doubt. In the first chapter a quotation was given from a speech by Mr. Lloyd George, merely to take a typical example of the importance which is now attached to aeroplanes by the heads of the Government. Our military and naval authorities have always had far more enthusiasm and confidence in aviation than most of the civilian ministers, but as it is the latter who in times of peace must be convinced in order to get money voted for the air services, their support and interest are absolutely essential to aviation, from either a national or an international point of view. Therefore, Mr. Lloyd George's speech was significant for that reason. Not less fervid, however, in new-found admiration and faith in aircraft is the whole nation, and this will prove ex-

tremely important in at least one direction of progress.

Further, with the expansion of the flying services, and the increased demand for test pilots by private firms, the total number of certified British aviators was nearly doubled in the first year of war. That is to say, the number of pilots who took the Royal Aero Club's certificate during the first twelve months of war was almost equal to the total number previously trained in this country during the preceding four and a half years.

In addition, a number of new aerodromes have been opened in various parts of the country, and although these, of course, are under the control of the R.N.A.S. or the R.F.C., after the War it is conceivable that civilian pilots might be allowed to use them. But besides military or naval flying grounds, new civilian aerodromes, well equipped and within easy access of large towns, similar to the Hendon Aerodrome, will certainly make their appearance, not only in the United Kingdom, but in every country.

The War, then, has witnessed the triumph of the aeroplane, and, as a natural corollary, an increase of all its appurtenances, aerodromes

and factories, and, of course, in the total number of certified aviators. We can derive some satisfaction from the thought that most of our recent pre-war efforts, both official and private, in connection with the manning and equipping of the R.F.C. and the R.N.A.S., have proved to have been consistently correct in conception, although not adequate in magnitude in the face of unprecedented demands. Thus, when we watched the German authorities spending an enormous amount of trouble and money on their airships, it was not from apathy that we did not emulate them, but because the War Office realised that dirigibles would be useless for military purposes.

In other words, comparatively few of the endeavours for aeronautics which have been made in peace time, and during the War, have proved absolutely wrong, and this is a great deal to be able to say. Let us hope that our future progress will be equally successful.

CHAPTER XI

MILITARY [1] AND CIVILIAN AERONAUTICS IN THE FUTURE

It is only very short-sighted people who prophesy definitely a complete future programme for aviation, because a far-seeing and fairly imaginative person realises that several unexpected but quite possible things might happen—such as, for instance, the invention of a successful helicopter [2] —which would, to a large extent, completely change many aspects of aeronautics. What one can safely do, however, is to indicate roughly the chief lines on which the progress and development of aircraft will proceed, presuming the conditions which at present surround and influence it con-

[1] In this chapter for the sake of convenience the word "military" is used in a general sense, implying military and naval as opposed to civilian aeronautics.

[2] A helicopter is a flying machine raised dynamically by air-screws operating vertically, the result aimed at being an ability to hover.

tinue to exist. That almost all the pre-War circumstances have already been drastically altered is evident; but existing conditions appear sufficiently settled for a careful spectator to deduce logically a few of the stages of evolution which should affect aeronautics after the War.

It is quite clear that military aeronautics and civilian flying will entirely part company. This is more or less inevitable, because of the essential difference between the object to be attained in each case. In the past, it is true, officialdom and private enterprise have never been bound very strongly together, but the separation will be in a different sense. There are, incidentally, sure signs that the certain lack of sympathy which existed prior to the War between state and civilian, in the field of aviation, is vanishing.

This division is the separation which will take place between the design of military aeroplanes and those constructed for various civilian uses. In the future, military machines of nearly all types will be just as essentially distinct from civilian aeroplanes as naval ships are distinct from mercantile or pleasure vessels.

It may be true that, in spite of their functions being totally different, the same attributes will be necessary in both classes as regards climb and speed; but the equality of speed of a Dreadnought and an ocean liner does not affect their distinction. Although the two kinds of aircraft may meet on common ground on such points as these, it will not affect the great difference which must inevitably arise between aeroplanes designed for military purposes and those made for civil uses.

An endeavour will be made to outline a few of the chief future characteristics of military and civilian aeronautics, dealing with the former first.

There is one outstanding need regarding military aeronautics which is already being developed. This is the necessity for having several different types of aeroplanes for the various functions of aircraft in war. When war broke out there only existed, roughly, fast and slow machines, one-seaters and two-seaters. Those which were fast, or from which the pilot had a good view of the ground, were termed military aeroplanes, but that was about the limit to their distinction. New types designed for

specific purposes certainly made their appearance on both sides some months after the outbreak of war, but even to-day, on the whole, it can be said that one or two classes of our machines have to perform almost every kind of work, from flying for hours over a battery directing artillery fire to out-manœuvring and bringing down German machines or carrying out raids a hundred miles or so away from the base.

In the future a special aeroplane will be evolved for every separate function. There will be very fast-flying and quick-climbing light scouts for reconnaissance work; two-seater heavily-armoured machines for hovering slowly over the enemy's lines directing gunfire; big, well-armed and well-protected biplanes, seating several men, to defend their own lines from raiders, and prevent the enemy's scouts from reconnoitring successfully; and fast aeroplanes, capable of carrying considerable weights, for raiding purposes. Those are just a few of the chief types the coming of which is assured. In addition, there will be special military aeroplanes for attacking airships, for fighting hostile aeroplanes, for transporting men, and for many other specialised functions. Apart from these there

will be the naval craft of different descriptions, such as the big seaplanes capable of keeping the seas of their own accord, when at rest; the smaller ones for hoisting on seaplane-carrying ships; and perhaps amphibians for work at coastal air-stations.

It must be understood that these indications are of the roughest nature, for it would be impossible to detail accurately every kind of aeroplane which will come into military use during the next few years. But those enumerated above will almost certainly be numbered amongst the most important of them. Indeed, some of the various types mentioned already exist to-day in the R.F.C. and the R.N.A.S. and the French air service, but, owing to the relative scarcity of aeroplanes compared to the enormous and disproportionate demands made on their services, it is frequently impossible to reserve each machine for its intended task.

However, we now know just the types of aeroplanes which are needed for each purpose, which is a very material help towards their future production. Perhaps this has been the greatest lesson which the War has taught to those closely connected with Aviation.

Unfortunately, from the aviator's point of view at least, this improvement in military aircraft as an offensive weapon will not proceed without a correlative improvement in the only artificial means of protection which the inhabitants of the earth, as such, can use against the riders of the air when they are attacked: the anti-aircraft gun. Here, once again, in yet another form, we see worked out the old tragedy of make and break, and make and break again. And never, perhaps not even in the annals of naval history, has this merciless conflict of all ages between arm and armour, construction and destruction, this unnatural yet inevitable law, seemed so terribly cruel as in its latest application to the sphere of aircraft.

To-day, anti-aircraft guns seem at times almost harmless to aircraft, and yet again, at other times, deadly to the utmost extreme. It is true that the percentage of misses is enormous, but it must be remembered that experience is being gained about these guns as great as is the case of the aircraft which is their mark. When the guns are fully developed they will be as dangerous to aeroplanes (even armoured ones) as a modern siege gun is to a fort, or

the biggest naval gun to the most heavily armoured ship; for it must be recalled that the forces of offence, or rather destruction, are always just superior to the forces of protection or construction. Is not the offensive nearly always regarded as an advantage over the defensive?

But to-day, anti-aircraft guns often appear quite futile against aircraft; and yet, when some graceful aeroplane does happen to be badly hit and is brought hurtling to earth, a poor battered broken thing, it is impossible not to feel how tragic is the necessity, even compared with the other inevitable tragedies of warfare, to smash the contrivance by means of which, after centuries of endeavour, man has at last struggled into the air.

However, the future shows a very different outlook. For just consider what war will be like when aeroplanes are fully developed. The best that one can imagine about it is that it may be too terrible for nations to wage. The horrors of the present campaign, it may be said, are as bad as any that could possibly arise. That is so; but what aircraft will do is to break the bonds of space that more or less confine these horrors within certain limits. Aeroplane pilots will

surely bombard every single town and spot of an enemy country that could possibly—and even this restriction only if they are scrupulous—be termed of military value in any sense of the word, and this, of course, would include almost every district in a civilised country. However, with the realities and dangers of war immediately brought to their own doorsteps, the class which has it in its power generally to commit a nation to war will think very carefully before making a decision.

So if we glance into the future, it can be seen that anti-aircraft guns will be very essential to protect the inhabitants of the earth. Indeed, even these guns will probably be so inadequate that it will be necessary heavily to armour all important official buildings in large cities.

However, there is one fact which brings overwhelming comfort to counterbalance these depressing prophecies of a world ever at war. And that is the great use to which aircraft will be put in civilian life. It is a profound pleasure to reflect that a great deal of the advantage derived from the increased knowledge and experience of aircraft gained in the campaign will chiefly benefit the nation at large after peace is proclaimed.

It is obvious that constructors will be able to make a really fine aeroplane purely for the purpose of flying, and for that alone, better than any specialised naval or military machine —the flying capabilities of which must always be influenced by military functional qualities. One that will combine speed, climb, stability, and comfort more perfectly than any machine which exists to-day. Stability in the case of such a flying machine would be a most important item, for it would spell not only safety, but the minimum amount of fatigue for the pilot.

This class of aeroplane will, without doubt, take the place in aviation which the private motor car does in the motor world to-day. It will be constructed in various grades and powers, corresponding in range from the small two-seater runabout to the Rolls-Royce limousine. There will be quite as great a demand for pleasure aeroplanes as there is for pleasure automobiles to-day, especially as the cost of the former will in time be brought within the means of as big a class as that which can afford a cheap-priced car at the present time. Even to-day an ordinary two-seater 80 or 100 h.p. biplane only costs as much as a first-class car; and a small single-

seater 50 h.p. machine costs but a few hundred pounds. Increased production will bring even these comparatively low prices down considerably.

At the present time, it is true, such a pursuit as touring by air (not, of course, permissible in war time) would be an expensive luxury, chiefly because there is not a sufficient demand to make the facilities for such a form of travelling cheap. But this pleasurable occupation will be extremely popular, especially when there are numerous civilian aerodromes, repair and supply depôts, and when, in particular, there springs up the class of pilot-owners who will fly their own machines and be able to attend to minor repairs themselves. There are many items which will make flying even cheaper than motoring, such as the comparatively trifling wear on tyres, which on a motor-car is a serious charge.

Apart from pleasure purposes, there are many other civilian uses for aeroplanes. For instance, there will be express mail services by air, and ordinary light-transport aeroplanes will be used extensively; while many business men will find flying indispensable as a means of locomotion. There will, of course, be proper passenger services

over prescribed routes, and there is no reason why these journeys should not become quite as cheap and popular as motor-bus facilities are at present. However, the machines for all these uses must, like military aeroplanes, be specially designed for their specific tasks, and not, as in the case of the pleasure machine, be made solely with the intention of producing the most perfect flying machine possible.

Then, again, air-racing will certainly become the recognised and popular sport it deserves, for it is most exhilarating and exciting. It may not have the totally unknown factor of horse-racing, but it is certainly far more interesting to watch than motor-racing, and calls for the exercise of more skill in the competitors. Owing to good handicapping, some of the most thrilling finishes have resulted at the Hendon Aerodrome, and dead heats have actually occurred on several occasions. As well as course-racing, many long-distance races between various countries will probably become popular.

For air-racing there will naturally be aeroplanes built solely for speed, without thought of any other consideration, except in the case of machines entered for special events, such as

altitude contests, quick-starting and alighting tests, etc. But, it is clear, none of the different machines made for these specialised purposes, military or civilian, will compare with the best pleasure aeroplane, the Rolls-Royce of the air. For this flying machine will embody the best *combination* of merits: fast and slow speeds — one might almost say flexibility — climb, stability, comfort, safety, reliability, durability, efficiency, strength, and good workmanship. The embodiment of all these is essential in the machine which shall signify the successful achievement of the only truly perfect form of mechanical travelling ever conceived—flight! And when we remember that already we have standard biplanes flying at over a hundred miles an hour and climbing at a thousand feet a minute,[1] it can be imagined what a marvellous aeroplane it will be possible for us to have with but a little more knowledge and after a little further development.

When we examine the future of civilian aeronautics, we can see that, at any rate in this sphere, airships will prove extremely useful, no matter how unsuited they may be to war.

[1] This rate of climbing can only, of course, be maintained for the first few thousand feet, owing to the atmospheric conditions decreasing the power of the engine the higher the altitude.

Take, for instance, the favourable record of privately-owned Zeppelins before the campaign. There were three of them carrying passengers in fine weather between certain towns, and, although they made many trips and carried some several thousands of passengers, not a single life was lost. During the war almost as much is being learnt of airships as of aeroplanes, so that there will be an improvement in them also. When it comes to peaceful purposes, such as transport or passenger carrying, it can be seen that in some ways lighter-than-air craft may perhaps be able to excel the aeroplane.

An interesting accessory to the civilian use of aircraft on a large scale will be the further development of air laws. Before the War these were of the crudest nature, and there was, indeed, no need for them to be anything else. But, although every one connected with the world of aviation will instinctively resent any restrictions or hemming-in of the highways of the sky, yet the framing of certain rules, enforced for the ultimate safety of airmen, must be recognised as inevitable. There are already regulations as to which side aircraft have to pass each other, if approaching within certain distance; and what

approximate relative altitudes must be maintained—for, obviously, it would be unwise not to fix some regulation in order to prevent accidents through the " backwash " of one aeroplane upsetting the equilibrium of another. But perhaps prescribed routes will be fixed, and other similar regulations, especially in the vicinities of towns. Last and not least, there will possibly come into being an Air Police to regulate the traffic of the great skyway; for there will surely arise the necessity for Authority to place a restraining arm on the enhanced good spirits and *joie de vivre* of the world, once it escapes into the glorious freedom of the upper air.

CHAPTER XII

A NEW ERA

Surveying from a broad standpoint the substantial changes, retrogressions, and advances wrought by the War, the progress made in various other directions does not appear nearly so important or of such fundamental value as the development which has taken place in aeronautics.

The reasons why this may not yet be fully realised are clear. The immediate improvement being purely in regard to military aircraft, the details of which are naturally kept secret, most people are more or less ignorant of its true significance or even mere existence except what they have learned from statements in the papers. They have not, as it were, come into personal contact with any signs of progress, although every one is enormously impressed with

aircraft as an instrument of war, and thoroughly convinced of its indispensability as such. Even those people who may be vaguely aware of the great expansion and improvement in the flying services are so occupied with thoughts of the War that they do not stop to think of the effect which this evolution will have on civilian aeronautics when peace comes.

A moment's reflection will show the true importance of aviation compared to nearly all the other sciences used in the campaign. After all, great armies and navies and their appurtenances, necessary as they are, do not increase the total sum of human happiness by one jot except inasmuch as they sometimes preserve peace; for but few of the appliances which are perfected to serve the purposes of warfare have any use outside those purposes, so that aviation is a rare exception in this respect. Indispensable though they be, of what real value in times of peace are the submarine, the high-explosive shell, or the sixteen-inch howitzer? But consider the perfection of flying. Will not the happiness of the world be infinitely increased when every man can indeed vie with the birds for the mastery of the air? Does not that spell happiness and freedom?

And the day of at least a partial realisation of that dream is but a very short way off. If proof were needed of this, glance at the recent history of flying. Only four or five years have passed since the " dark ages " of aviation, when flying was an utter uncertainty — when it was impossible to predict whether or no a man would even manage to coax his machine off the ground. What an extraordinary contrast we witness to-day!

No matter how much flying they may have witnessed, those who have never flown cannot appreciate just what the experience itself is like. They may be able in a measure to imagine the wonderful panorama spread beneath and all round, the exhilarating rush of air in the face, the consciousness of speed; but it is quite impossible to realise the extraordinary sensation of buoyancy, of support, faintly resembling that on board a ship in very smooth water.

Man is in some ways a transformed creature when he ascends in an aeroplane, for he leaves many of his frailties behind him. Once he is rushing through the air he loses any sense of giddiness, of vertigo, of danger, which may have assailed him on earth. Indeed, a sudden access

A NEW ERA.

of overmuch courage must be the solution to many of the fatalities which aviation, like every other science, has demanded of her servants. The explanation of this intangible strengthening of a human being can be found by examining how superbly natural is the action of flying, even by mechanical means; there is no friction, no continual jarring against a concrete substance, nothing, in fact, to recall the dangers of contact with the hard earth. In turning, the aeroplane is canted to a correct angle, instead of being forced to remain horizontal, in spite of the contrary impulse, as on land vehicles.

Let it suffice to say that a man, when he is flying, feels more than merely the physical sensation alone. Far away from the dust, the commotion, the inevitable restrictions of the overcrowded surface of the earth, and filled with the indescribable impression of spaciousness, grandeur, dignity, even the most material individual must needs feel, perhaps subconsciously, uplifted in mind and in body.

This, then, is a faint indication of the subtle beauty of flight; nor must it be imagined that this frame of mind, this perception of its poignant charm, is only experienced at the first ascent,

and that afterwards all such thoughts are forgotten. For, familiar as one may become with flying, its wonder never dies. Aviation exerts a mysterious fascination on those who serve it, for ever impelling an increased interest and enthusiasm. It is hardly a known thing that a worker in the realm of aeronautics should, at any time, completely sever himself from its service.

The greatly increased rapidity with which flying will become widely accessible, and the strengthened impetus which will be given to its future evolution, are not the only compensating benefits the War will bring in its wake. There is yet another phase of aircraft's influence.

Consider, for a moment, the domain of aircraft. Is there a single place in the whole civilised world where aeroplanes, made somewhat more reliable, will not be able to penetrate with infinitely greater ease than any other conveyance? But, besides the question of mere facility, think of the enormous speed with which they will travel. Apart from railways, which are even to-day not really universal, and motor cars, which, taken all round, have very severe limitations as to roads, most travelling

is comparatively slow: ships laboriously plough through the waves; camels track heavily through the desert; mules clamber slowly over mountains. But an aeroplane, with its ubiquitous range, speeds unfettered and untrammelled like a bird through the heavens. And it can travel as easily at its hundred miles an hour over the Sahara, the Veldt, or the Himalayas, as over an English country-side. In truth, the speed with which flying will bring together the ends of the earth will seem incredible to many of us at first.

What will be the result of this shortening of distance—for it amounts to nothing less? Primarily, without doubt, an infinitely increased stream of communication from one hemisphere to the other, from continent to continent, country to country, town to town. This new means of communication will be applied to every branch of intercourse. Visitors, business men, commercial salesmen, travellers, musicians, artists, actors,—all will use it; postal mails, merchandise, baggage, goods of almost every description will be carried from Europe to America, from Asia to Africa, from nowhere to everywhere, by way of the air—a magic carpet indeed!

The result of this improved inter-communica-

tion between the corners of the earth cannot fail to be an extraordinarily good one. Just how good, time alone will show. But, at least, we know to-day that harmful illusions and prejudices, misunderstandings and quarrels, friction and faction, between nations just as between individuals, arise chiefly from one source: ignorance.

As a striking example, take the case of this country itself. It is not so very long ago that Great Britain held herself in prejudiced isolation, almost disdaining any intercourse with foreign nations. It was solely ignorance that fostered that absurd ideal, now fortunately obsolete, of insularity and detachment; and, unrelated as it may seem, it was largely due to improved train and boat travelling facilities that we gradually awoke to the realisation of the simple fact that, as our friendship would be valuable to other nations, the friendship of other nations could also be valuable to us. It was in this way that our sympathetic understanding with France was promoted.

It will be admitted that a very large proportion of the international trouble and friction which, if not actually serious enough

for an open breach or a great war, at least creates injurious feelings of ill-will and disturbance between nations, is often directly due to ignorance. One nation is unfortunately not infrequently ignorant of the political ideals of its neighbour, ignorant of its national ambitions, national character, national temperament. The government of one country looks at another country from the same point of view from which it regards its own. Which is all in error. Almost every nation—in peace time if not in war time—can be appreciated, and the aspirations of nearly every state sympathised with, when regarded in the right perspective. And the right perspective is certainly not obtained from a back garden.

This is where aircraft will bring about a change. It does not seem unreasonably optimistic to foretell that in the near future, when flying really comes to its own in the world's civilian life, nations will understand each other better, will have more interests in common. For aircraft will certainly tend to make every country entirely free of access to every other country—which is not the case to-day.

We ourselves will drop the few remaining

shreds of our insularity, and, in common with all civilised nations, come to a better and franker understanding with other countries. Aircraft may unfortunately bring nations closer together, for the purpose of waging war, if future wars there must be; but let us realise that although aircraft can bring nations closer for warfare, it will also serve far more effectively as a medium to bind them immeasurably closer in times of peace. Let us realise this emphatically, because upon the universal appreciation of that possibility alone depends the realisation of the peaceful vista which it opens, and, therefore, ultimately the further emancipation of the world.

Let us resolve when this War is over—if it is possible at the moment to envisage seriously a thought of fraternal peace and its endurance—that the perfecting of aircraft will, as far as lies within our power, see a parallel improvement in the understanding and sympathy between the civilised nations which share the earth—always assuming, of course, that we prosecute the War to a successful consummation. There will, let us hope, be a proper agitation for a command of the air; and, assuredly, very necessary will it be for us to see that we always

have the finest and most powerful air fleet. But it would be an injustice to mankind to contend that the air could not be shared amicably and peaceably; and it would be a crime not to strive for that end. There is such an infinite amount of room aloft that there is certainly enough space not only to satisfy the needs of all, but to enable every nation to move in sufficient breathing space.

Finally, to quote Mr. Kipling's lines:

Oh, East is East, and West is West, and never the twain shall meet
Till Earth and Sky stand presently at God's great Judgment Seat;
But there is neither East nor West, Border, nor Breed, nor Birth,
When two strong men stand face to face, tho' they come from the ends of the earth!

The significance of those lines, in relation to the past condition of the world, is infinitely profound. It is indeed true that, so self-centred is each corner of the earth, that to-day it needs some special distinguishing quality, some merit such as strength of will, to be the common attribute of men from strange lands in order to overcome the usual ignorant prejudice and deep-rooted racial mistrust between one nationality

and another. To bind them to a close understanding still more is needed.

Mr. Kipling, to accentuate his argument, takes East and West. But it is not necessary to go to nearly such far extremes to find intangible barriers not much less pronounced than those which separate Orient from Occident. Indeed, even within the bounds of every continent, one might almost say, there are to be found nations so utterly separated that they lack all feeling for each other but that of blind hatred; or, perhaps, complete indifference.

Aviation can, and will, deliver us from much of this stupid perversity. The conquest of the air by man may prove an opportunity for countries to co-operate, rather than compete in the manner in which they have so inevitably done in the past. After all, have we not overwhelming proof of the good feeling which intercommunication arouses when we regard our relations with France, which in a few short years became transformed from the result of a liberal exchange of ideas and feelings? And in order to realise the full significance of this friendship of ours with France, it is necessary to contemplate the essential difference in most ways

between the English and the French temperament.

Perhaps it would be putting a too literal meaning into Mr. Kipling's verse to say that aircraft will enable the earth and sky, if not, in his own words, to "stand at God's great Judgment Seat," at least to stand, in a measure, united for the first time in the history of the world. At any rate, Mr. Kipling might possibly allow that aircraft will in time enable earth and sky to stand close enough together to fulfil the conditions necessary for the breaking down of the barrier between East and West.

With such a poignant incentive for ever hidden somewhere in their minds, with such an inspired vision for ever firing their imaginations, can it be wondered that men, almost since time immemorial, have given their lives, their work, their all, to the cause of Flight? Do not let us forget that men have been trying to fly ever since the time of Leonardo da Vinci, and that it is only by infinite good luck that the problem of mechanical flight just happened to be solved in this century. So let us appreciate and make the most of our good fortune.

Lastly, let us trust in the belief that the

pioneers of our own generation will continue to progress for ever onwards, with renewed confidence and greater impulse, and that their efforts will speedily lead to an absolute conquest of the air. For the sympathy and co-operation of the world they serve mean much to those who strive along hidden paths.

THE END

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