Opportunities in Aviation

by Captain Arthur Sweetser
U. S. Air Service
and Gordon Lamont
Late Lieutenant in the Royal Air Force, Canada

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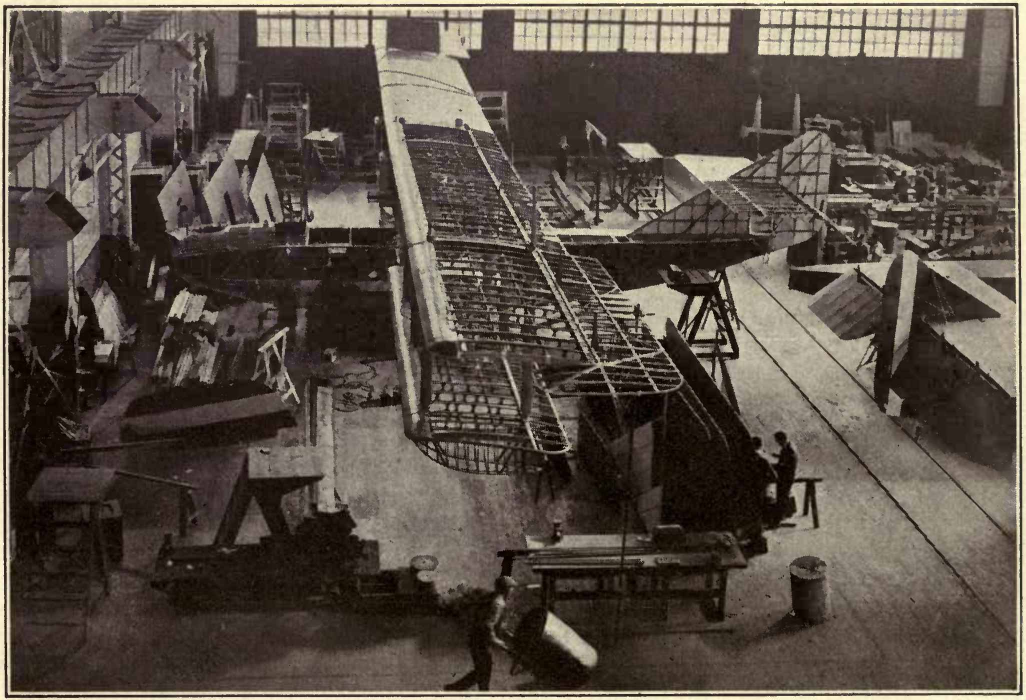

At work on one of the F–5–L type of seaplane at the Naval Aircraft Factory, League Island, near Philadelphia. The F–5–L is one of the largest type of naval seaplane, and flew from Hampton Roads, Va., to Rockaway Naval Air Station, L. I.

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By Captain ARTHUR SWEETSER
U. S. Air Service
Author of "The American Air Service" and
GORDON LAMONT, Late Lieutenant
in the Royal Air Force, Canada

Frontispiece

HARPER & BROTHERS
Publishers New York and London

Acknowledgement is made to the *New York Evening Post* for some of the material which first appeared in its columns.

Opportunities in Aviation

Printed in the United States of America
Published, January, 1920

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To that great new gift which is so soon to come to us, this little book is enthusiastically dedicated by the authors.

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INTRODUCTION

Any ordinary, active man, provided he has reasonably good eyesight and nerve, can fly, and fly well. If he has nerve enough to drive an automobile through the streets of a large city, and perhaps argue with a policeman on the question of speed limits, he can take himself off the ground in an airplane, and also land—a thing vastly more difficult and dangerous. We hear a great deal about special tests for the flier—vacuum-chambers, spinning-chairs, co-ordination tests—there need be none of these. The average man in the street, the clerk, the laborer, the mechanic, the salesman, with proper training and interest can be made good, if not highly proficient pilots. If there may be one deduction drawn from the experience of instructors in the Royal Air Force, it is that it is the training, not the individual, that makes the pilot.

Education is not the prime requisite. Good common sense and judgment are much more valuable. Above all, a sense of touch, such as a man can acquire playing the piano, swinging a pick, riding a bicycle, driving an automobile, or playing tennis, is important. A man should not be too sensitive to loss of balance, nor should he be lacking in a sense of balance. There are people who cannot sail a sail-boat or ride a bicycle—these people have no place in the air. But ninety-nine out of one hundred men, the ordinary normal men, can learn to fly. This has been the experience of the Royal Air Force in Canada.

There will be as much difference between the civilian pilot, the man who owns an airplane of the future and drives it himself, and the army flier, as there is now between the man who drives his car on Sunday afternoons over country roads and the racing driver who is striving for new records on specially built tracks. If aeronautics is to be made popular, every one must be able to take part in it. It must cease to be a highly specialized business. It must be put on a basis where the ordinary person can snap the flying wires of a machine, listen to their twang, and know them to be true, just as any one now thumps his rear tire to see whether it is properly inflated.

The book, in a large sense a labor of love, is the collaboration of an American officer of the United States Air Service and another American, a flying-officer in the Royal Air Force. If the Royal Air Force way of doing things seems to crowd itself to the fore in the discussion of the training of pilots, the authors crave indulgence.

In a subject which lends itself dangerously to imagination, the authors have endeavored to base what they have written, not on prophecy, but on actual accomplishments to date. The latter are indeed so solid that there is no necessity for guesswork. Aviation has proved itself beyond peradventure to those who have followed it, but up to the present the general public has not sufficiently analyzed its demonstrated possibilities.

The era of the air is undoubtedly at hand; it now remains to take the steps necessary to reap full advantages from it.

ARTHUR SWEETSER,
GORDON LAMONT.

OPPORTUNITIES IN AVIATION

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I

WAR'S CONQUEST OF THE AIR

THE WORLD WAR opened to man the freedom of the skies. Amid all its anguish and suffering has come forth the conquest of the air. Scientists, manufacturers, dreamers, and the most hard-headed of men have united under the goad of its necessity to sweep away in a series of supreme efforts all the fears and doubts which had chained men to earth.

True, years before, in fact, nearly a decade before, the Wright brothers had risen from the ground and flown about through the air in a machine which defied conventional rules and beliefs. The world had looked on in wonder, and then dropped back into an apathetic acceptance of the fact. Despite the actual demonstration and the field of imagination which was opened up, these early flights proved to be a world's wonder only for a moment.

For years aviation dragged on. Daredevils and adventurers took it up to make money by hair-raising exploits at various meets and exhibits. Many died, and the general public, after satiating its lust for the sensational, turned its thought elsewhere. Flight was regarded as somewhat the plaything of those who cared not for life, and as a result the serious, sober thought of the community did not enter into its solution.

Business men held aloof. Apart from circus performances there seemed no money to be made in aviation and consequently practically none was invested in it. What little manufacturing was done was by zealots and inventors. Workmanship was entirely by hand, slow, amateurish, and unreliable.

Strangely enough, scientists were equally apathetic. It might have been expected that their imaginations would be fired by the unexplored realms of the air and by the incomparably new field of experiment opened to them; but they were not. The great question, that of flight itself, had been answered, and but few were interested in working out the less spectacular applications of its principles. Aviation remained very much of a poor sister in the scientific world, held back by all the discredit attaching to the early stunt-flying and by failure to break through the ancient belief in its impracticability for any purposes other than the sensational.

So the science limped along, unsupported by either public interest or capital. Now and again some startling feat attracted the world's attention, as when the English Channel was first crossed by air and England was made to realize that her insularity was gone. For a moment this feat held public interest, but again without a true realization of its significance. There seemed nothing which would drive man to develop the gift which had been put within his reach.

Up to that fatal moment in August, 1914, when the World War broke out, aviation had made but little progress. All nations had what passed as air services, but they were very small and ill-equipped and were regarded with doubt and suspicion by the military leaders of the various countries. Compared with what has since taken place, the experiments previous to the war were only the most rudimentary beginnings.

Then came the war. Man's imagination was aroused to a feverish desire for the development of any device for causing destruction. Conventions, usages, and prejudices were laid aside and every possibility of inflicting damage on the enemy was examined on its merits. Sentiment or any regard for personal danger involved was thrown to the winds. Science was mobilized in all lines in the struggle to keep one step ahead of the enemy.

Almost immediately aviation challenged the attention of the responsible leaders. The handful of French planes which in those early fateful days of August penetrated up into Belgium brought back the information of the German mobilization there, and this led to the rearrangement of French forces in preparation for the battle of the Marne. As a result aviation at once leaped into high repute for scouting purposes and the foundations were laid for its great development.

But as aviation had proved itself in the warfare of movement leading down to the Marne and sweeping back later to the Aisne, so it proved itself in the French warfare which was so unexpectedly to follow. When the two opposing lines were so close together that they locked almost in a death grip, each side kept such strict watch that ground observation was greatly hampered. Apparently there was only one way to find out what was going on behind the enemy's lines. That was by looking from above. The first aviator, therefore, who sailed into the air and spied the enemy introduced one of the most important developments in the strategy of modern warfare.

Thereupon began one of those silent battles of the rear, of which we see and hear so little, but which indeed decides sometimes far in advance of the actual test of battle just which side is going to win. Scientists, inventors, manufacturers, and practical fliers began coming together in increasing numbers to exact from this latest method of warfare its last degree of usefulness. In the studies and factories on both sides of the lines men dedicated themselves to the solution of the problem of flight.

Stage by stage the difficulties were overcome. First it was the Germans who with their terrible Fokker planes harnessed the machine-gun to the airplane and made of it a weapon of offense. Then it was the Allies who added the radio and made of it an efficient method of observation and spotting of artillery fire. Increased engine-power began to be developed, and bombs were carried in ever-increasing numbers and size.

The moment an enemy plane fell on either side of the line the victors gathered about their prey with a keenness which could come only of the hope that they might find in it some suggestion that would make their own flying more efficient. Each learned from the other, so that the different schools on either side of the line had all the advantage of watching the development of their rivals. Very shortly after an improvement appeared on one side it reappeared in the planes of the other side.

It is doubtful if ever a more desperate scientific battle was fought than that which featured the development of the air services of the various belligerents during the war. Control of the air was so vital that neither could afford to overlook any possibility; and, as a result, the scientific evolution was truly astounding. No man was reserved on this subject of airplane improvement. All contributed their best skill and ability to the common reservoir of knowledge.

Very soon man's conquest of the air became so complete that different types of planes were developed for different kinds of work. The plane of the early days which wandered off by itself wherever it saw fit, gathered what information it could, and returned to drop a note to the commander below, developed into a highly efficient two-seated plane equipped with machine-guns for protection against attack, wireless for sending back messages, and cameras for photographing the enemy's positions below. The plane which had earlier dropped an occasional bomb in a hit-or-miss fashion over the side now developed either into a powerful two-seater with a great weight-carrying capacity and a continually more efficient scientific method of aiming its missiles or into a huge machine for long-distance night-bombing work capable of carrying from two to a dozen men and from two to four tons of bombs. During this time the strictly fighting plane, usually a single-seater, increased in speed, "ceiling," and agility till it could dart, twist, and dive about, three to five miles above the trenches, protecting friendly bombing and observation planes below from enemy attack or swooping down to send enemy planes in flames to the ground.

Vital though all this work was for the war, it had an incomparably greater value for the perpetual struggle which all mankind is waging against nature. While the various nations were seeking to destroy one another through the air, they were in reality destroying the chains which bound them to the ground and winning their freedom in a new element. The advance which the Allies or the Germans made over each other in scientific aerial development was a joint advance over the restrictions of gravitation.

This, indeed, apart from the spread of democracy and internationalism, may well stand out in history as the war's richest heritage. Problems which had been considered insoluble were solved. The casting aside of all conventions, all restrictive habits of thought, all selfishnesses, and the focusing of the highest scientific ability in a struggle which might mean the life or death of the nation, had brought as a by-product a development beyond our wildest fancies.

Aerial operations in any future war, however, will have at once a problem which has only recently and in very much smaller degree confronted the navy, namely, the assurance of attack not only on the front, in the rear, and on both flanks, but from above and below as well. Recently the navy has had to face that problem—submarines operating below and airplanes above; but the problem of attack upon a ship is not so serious as upon an airplane.

Already, in order to meet this danger of attack from every possible direction, a most complete strategy and system of formations have been worked out. In this way the various types of planes operate in different air strata according to their missions, the upper planes echelon somewhat behind those below on the order of a flight of steps facing the enemy. This system provides a quick method of reception of an attack and the assurance of quick support, no matter where the attack may come. Obviously there would be nothing in all of warfare on either land or sea comparable to a collision between two such aerial fleets. The speed of the lighter planes, quick, life-taking duels in several different strata at once, would provide a clash of action, speed, and skill far more beautiful and yet in many ways far more terrible than anything ever recorded in the history of war.

Fleets of the skies—who shall attempt at this day of the infancy of the science to limit their scope? Aerial battle-planes of colossal size and power are as certain to come in time, and in not a very long time, as the dreadnought of to-day was certain to follow the first armored ship of only a half-century ago. Never yet has man opened up a new avenue of war that he has not pursued it relentlessly to its final conclusion. It is certain that he will not fail to push aerial development with all the energy with which he has devoted himself to the science of destruction.

The avenue of the seas has been up to now the world's greatest civilizer. Very shortly, without doubt, it will be replaced by the avenue of the skies. If we are to strive for freedom of the seas, what shall we say about freedom of this new element? The laws of aerial travel and aerial warfare open an unlimited field of speculation.

II

THE TRANSITION TO PEACE

DEVELOPMENTS during the war, despite their startling sensational character, had, however, been so overshadowed by human suffering and desperation that but few minds were awake to the changes that were to influence man's future. Amid the disasters, battles, and unprecedented movements in the politics of nations, the achievements of flight could command but a passing notice. People looked and wondered, but were distracted from following their thoughts through to the logical conclusion by the roar of a seventy-mile gun, the collapse of a nation, or the shock of battle on a one-hundred-mile front.

Let us, however, weave together a few things that were done in those days of sensation, which may have a particular effect on the future of the science. Most conspicuous, perhaps, was the obliteration of distance and of all the customary limitations of travel.

German airplanes in squadrons penetrated into snug little England when the German fleet stood locked in its harbor. The Italian poet D'Annunzio dropped leaflets over Vienna when his armies were held at bay at the Alps. French, British, and finally American planes brought the war home to cities of the Rhine which never even saw the Allied troops till Germany had surrendered.

None of the conventional barriers stood in the way of these long trips. A new route of travel had been opened up along which men flew at will. The boundary-lines of states below, which look so formidable on the map, were passed over with the greatest ease, as well as such natural obstacles as the Alps and the English Channel.

Tremendous saving in time was constantly being effected. Men were able to dart back and forth from the front to the rear and from England to France with a speed never dreamed of by other means of travel. To be sure, the front-line demands for planes were too severe to allow a very wide use in this way, but nevertheless the possibilities were there and were constantly availed of.[1]

Indeed, the British early established a

[1] Some of the British statesmen flew to and from the Peace Conference in Paris.

communication squadron for this specific purpose. In the last three months of the war 279 cross-country passenger flights were made to such places as Paris, Nancy, Dunkirk, and Manchester, all of them without a single accident! Moreover, a Channel ferry service was created which in seventy-one days of flying weather made 227 crossings, covered over 8,000 miles, and carried 1,843 passengers.

With trains seldom going above 60 miles an hour, the slowest airplane went 80 and the average daylight plane on the front probably equaled 110. The fast fighters went up to 120, 130, and even 140 miles an hour, over twice as fast as any method of travel previously known. Just as the curtain closed on the war, there had been developed in the United States a plane credited with 162⅔ miles an hour, and no one for a moment believed that the limit had been reached.

Altitude likewise had been obliterated. The customary height for two-seated observation and bombing planes was between one and two miles, and of single-seated scouts between two and four miles. These altitudes were not the freakish heights occasionally obtained by adventurous fliers; on the contrary they were the customary levels at which the different kinds of duties were carried out. Many men, of course, went far higher. Since then an American, Roland Rohlfs, flying a Curtiss "Wasp" set the unofficial altitude record at 34,610 feet —higher than the world's highest mountain.

Life at these altitudes was not possible, of course, under ordinary conditions. The temperature fell far below zero and the air became so thin that neither man nor engine could function unaided. As a result the fliers were kept from freezing by electrically heated clothing and from unconsciousness from lack of air by artificially supplied oxygen. Similarly the oil, water, and gasolene of the engine were kept working by special methods.

The armistice threw the different nations into a dilemma as to their aviation plans. Obviously the huge war planes which were still in the building in all the belligerent countries were no longer necessary. Almost immediately, therefore, the placing of new contracts was halted by the various governments, enlistments stopped, and plans set in motion for the new requirements.

Within a very short time the United States canceled several hundred million dollars' worth of contracts on which little actual expenditure had been made by the manufacturers. Shipments of men and planes overseas were of course brought to an end and at the same time arrangements were made for bringing back from France the great aerial equipment mobilized there. Indeed, the air service units were among the first to be returned, especially the labor and construction troops in England.

Nevertheless, military aviation of the future was definitely safeguarded. A bill was presented to Congress for an aerial force of 4,000 officers and 22,000 men, a fitting contrast to the force of 65 officers and 1,120 men with which the country had entered the war. Certain flying fields and schools which had shown the greatest value in the past and promised most for the future were definitely designated for permanent use, and especial effort was made to keep in the service the best of the technical experts and designers who had helped to solve America's problems of the air.

Abroad demobilization was less rapid, as it was in all other lines. The British, who had given particular thought to after-war aviation, immediately turned to converting all their valuable war material and experience into a national force which should assure England of the supremacy of the air as well as strength in her supremacy of the seas. France, the custodian of Germany's great aerial force, found more than enough work for all her men in taking care of the hundreds of surrendered machines. Both nations at the same time took long steps toward building up the civil machinery necessary for private, non-military flying.

For several months, of course, there was a hiatus. Thought had been so concentrated on military aviation that the conversion to peace work proved slow. Only the most general plans had been made in any of the countries, and those by ardent supporters of aviation, who were forced to make the most earnest efforts to obtain consideration of the subject in the midst of all the vital problems of peace and reconstruction. Greatest of all the difficulties was that, as private flying had been prohibited during the war, there were, with the coming of peace, no rules and regulations ready for it. Also many great projects for international flights had to be postponed because of complete lack of international rules in this respect.

Nevertheless, most spectacular and convincing flights followed one another in rapid succession. The most outstanding of these flights was, of course, the first crossing of the Atlantic by seaplane—a triumph of organized effort by the navy. At the same time all over the world flights took place with astounding frequency which illustrated, as little else could, the certain future of aviation. Seas, mountains, deserts, places otherwise almost impassable were traversed with ease and speed.

Army fliers flew from the Atlantic to the Pacific within a few months of the signing of the armistice. It required but fifty hours of flying-time, just a fraction over two days. At that time no attempt was made to obtain speed, as the purpose of the trip had been to locate landing-fields and make aerial maps for future transcontinental flights.

The four planes that made this trip might be considered as the pioneers of vast flocks of airplanes which within a short time will be winging their way from coast to coast. If, with machines built specifically for war purposes and with no special landing-fields or routes laid out, aviators could successfully travel from one coast to the other in fifty hours of flying-time, how much more rapidly will future trips be made when special touring-planes have been developed, routes and landing-fields are laid out, repair-shops are built, and the trip becomes a matter of routine rather than aerial experiments.

The effect that this new method of travel will have on American life and development is staggering to the imagination. San Francisco and New York will be almost neighbors, while Chicago and New Orleans will be but a pleasant day's trip apart. The business man, the statesman, and even the courier can be transported from one end of the country to the other, independent of steel rails and other devices, in record time.

Such experiments have already proved successful in Europe. The British Foreign Office in London, anxious to keep in close touch with the Peace Conference at Paris, turned to the airplane to assure quick transportation of men and documents. The slow train trip with the irksome transfer to and from the Channel steamer and the more irksome voyage across the Channel itself, were avoided by a special service through the air. Thus two great capitals were brought within a few hours' time of each other, which greatly facilitated the vital negotiations under way.

Civilians were finally granted the right to make the trip under military supervision.

Fourteen passengers were transported from Paris to London in two hours and forty minutes as against six hours and forty minutes, the fastest time ever made by any other means of travel. Each of them had twenty pounds of luggage, and luncheon of cold ham and champagne was served on board over the Channel, followed by a game of cards. It was easily demonstrated by the return trip that men could leave either capital after breakfast, have several hours in the other, and return home for dinner.

Then a French flier with six passengers made the flight from Paris to Brussels. The time consumed between the two capitals was but two hours as against over five by the ordinary train travel. As an instance of some of the problems which this particular flight brought about, it was observed that a Belgian policeman approached the plane as it was about to leave and inquired for passports and papers. Everybody made excuses for not having them. The policeman refused to allow the airplane to leave. Finally the pilot, losing his patience and temper, started the motor and flew off before the angered official knew what had happened.

Two other French aviators about the same time crossed the Mediterranean from France to Algiers and back in the same day. Though unequipped with seaplane devices, they started out with full confidence that their motors would carry them over the water. With only their navigating instruments and an occasional vessel to guide them, they reached their destination after a perfect trip and created a great sensation among the natives who came down to see the airplanes alight.

Far more spectacular, however, was the flight made from London to Delhi. A Handley-Page machine, which had flown from London to Cairo during the war and taken part in the final military operations against the Turks, left Cairo, on November 30th, shortly after the armistice. Five and three-quarter hours later the airplane with five passengers reached Damascus, a trip practically impossible except through the air because of the ravages of the war. At 7.40 the next morning they set out again, flew northeast along the Jebel esh Shekh Range to Palmyra, then east to the Euphrates, down that river to Ramadi, and thence across to Bagdad, a flight of 510 miles made in six hours and fifty minutes without a single stop, part of it over country untrod even by the most primitive travelers. Thence they went on *via* Bushire, Bander Abbas, Tcharbar, and Karachi to Delhi, where they received a tremendous ovation as the first fliers to arrive from the home country. From Delhi they continued on without mishap to Calcutta. This distance from Cairo to Karachi, 2,548 miles, was made in thirty-six hours' flying-time; from Karachi to Delhi the distance is 704 miles, and from Delhi to Calcutta 300, a total of 4,052 miles from the main city of Egypt to the greatest commercial port of India. No route had been surveyed, no landing-places obtained, no facilities provided. Territory inaccessible to ordinary travel, land where the white man is almost a stranger, was crossed. Yet it was all done as part of the day's work, in no sense as a record-breaking or spectacular trip.

The certainty of flight from London to India was demonstrated. A bi-weekly service for both passengers and mails was at once planned. Almost immediately preparations for the route were worked out, twenty-five airdromes and landing-fields were designated, of which the main ones would be at Cairo and Basra on the Tigris, with subsidiary fields at Marseilles, Pisa, or Rome, Taranto, Sollum, Bushire, Damascus, Bagdad, Bander Abbas, Karachi, Hyderabad, and Jodhpur. It is estimated that the flight of 6,000 miles, at stages of about 350 each, would take seven or eight days as against the present train and steamer time of five or six weeks. At the same time another route far shorter than that which would be necessary by following the sea route lies over Germany, Russia, and the ideal flying-land along the Caspian Sea, Krasnovodsk, Askabad, Herat, Kandahar, and Multan.

As with Asia Minor and Asia so with Africa, the British at once made plans for aerial routes. Only a few weeks after the armistice announcement was made of plans for an "All Red Air Route" from Cairo across the desert and the jungle to the Cape. This could all be done over British territory, with the part over Lakes Victoria Nyanza and Tanganyika covered by hydroplanes. The moment men were released from the war, surveying of this route was begun and tentative plans made for landing-fields every 200 miles over the 5,700-mile trip.

The air is ours to do whatever we can with it. There must be developed a large interest in this country in the business of flying. We must make the air our third, fastest, and most reliable means of communication between points in a way to compete with transportation on land and sea. The airplane, instead of being the unusual thing, must become a customary sight over our cities and villages. The first step in the development is the training of airplane pilots and mechanics.

III

TRAINING AN AIRPLANE PILOT

ANY ordinary, active man can fly. That is to say, any man with nerve enough to take a cold bath or drive an automobile down Fifth Avenue can maintain himself in the air with an airplane, and turn into a good pilot with practice. In other words, the regular man who rides in the Subway, who puts on a straw hat on May 15th or 20th, as the case may be, has not only the right to be in the air, but owes it to himself to learn to fly.

Any one with a reasonable amount of intelligence can be made a good pilot. He need not hold a college degree, or even a high-school diploma, tucked away in some forgotten place. If he has the sense of touch of the normal man, the sense of balance of a normal man, can skate, or ride a bicycle, he should be in the air, flying. There is a difference between the war or army pilot and the peace-time flier yet to be developed.

War flying calls for highly trained men, a man who has proved himself fit for combat under all conditions, a man who can shoot straight, think quickly, and turn immediately. He must possess a little more than the average nerve, perhaps, or he must be trained to the point where shooting and maneuvering are the natural reactions to certain circumstances. He must be able to stand altitudes of 20,000 feet; he must be quick with his machine-gun, have a knowledge of artillery, and know, in fact, a little about everything on the front he is trying to cover. This requires training and aptitude.

The day is coming for the man who wants to make a short pleasure flight, or go from town to town, touring by air. He need know nothing of machine-guns or warfare. He may never want to do anything more hazardous in the way of maneuver than a gentle turn. His maximum altitude would be perhaps 8,000 feet. He would in all probability be flying a machine whose "ceiling" was 10,000 feet, and he might never care to tour at a height higher than 2,000 feet. There is no reason why he should go high. One can have all the thrills in the world at 2,000 feet, follow the ground more easily, without wasting time or gasolene in attempts to fly high enough so that the earth looks like another planet below.

Let us illustrate a bit from the Royal Air Force of Canada, which is as good as any other example. The experience of the flying service of one country has been essentially that of another country, and we Americans may yet learn of the air from the English. In England the air is just another medium of travel, as much a medium as the ground and water—but that is, of course, another story.

In 1917 the Royal Flying Corps, later incorporated into the Royal Air Force, came to Canada to take up the instruction of Canadian boys for flying in France. Americans enlisted with the pick of the Canadian youth, and droves were sent overseas. Very soon the cream had been skimmed off and there came a time when material was scarce. Meanwhile the war raged, and there was no option but to take drafted men from all sections, Montreal in particular. Many could not speak intelligible English, and few had enjoyed any educational advantages. The men who came as cadets to be trained as pilots in 1918 graded much lower in personal and physical qualifications than the type of the previous year. And yet these same drafted men, who had withstood for three and a half years the call of their country, had more control over their machines at the end of their course than the men of the year before.

At the end of four, five, or six hours' solo these men could do all the high maneuvers, commonly thought dangerous, such as the barrel roll, the loop, the stall turn, the Immelmann turn. An astounding showing compared to the boys of 1917, who were forbidden to stunt and who rarely disobeyed the orders. In our American service we had specially selected men. They were college men, tested, qualified, and picked. But our men—and it's no reflection on them—seldom did their higher maneuvers with less than fifty hours of solo flying.

There is just one answer—it is a matter entirely of training.

It might be said that the Canadian casualties on the Texas flying-fields near Fort Worth during the winter of 1917–18, when the Royal Air Force occupied two airdromes, were the cause of comment all over the country. There were fifty fatalities in twenty weeks of flying, and machine after machine came down in a fatal spinning-nose dive, or tail spin, as the Americans speak of the spin.

Shortly after the Royal Air Force returned to its airdromes in Canada in the middle of April the Gosport system of flying training, which had been used successfully in England, was begun on the Curtiss J. N. 4B-type training-plane. The result was an immediate and material decrease in fatal accidents. In July, 1918, there was one fatality for every 1,760 hours of flying, and by October fatalities had been reduced to one in every 5,300 hours of flying. That is a remarkable achievement, as official data from other centers of training show one death in a flying accident for every 1,170 hours.

Briefly, the Gosport system is a graduated method of flying instruction. The cadet is led by easy steps through the earlier part of the training, and only after he has passed aerial tests in the simpler methods of control is he allowed to continue with the rest of his course and "go solo." The scheme provides that before he goes solo he must have spun, and shown that he can take his instructor out of a spin. Only then is he considered fit to go on his own.

"Dangerous" and "Safe" as terms to describe flying technique gave way to wrong and right. There was built up under sound instruction one of the best schools of flying in North America, the School of Special Flying, at Armour Heights, Ontario. There is no reason why there should not be established in this country a number of such schools, under men who have had army experience, to train great numbers of civilian fliers within the next few years. There is going to be a strong demand for the best flying instruction that can be given. It should be noted that only the most perfect system of flying instruction should be used, for the best is safest, and the safest, no matter how expensive, is comparatively cheap.

There is no reason why there should be an extended period of ground instruction for the non-military pilot of the future. He should be taught the elementary principles of the theory of flight, should know something about the engine with which he is going to fly, and understand some things about the rigging of his airplane. The details could come to him in constant association with the airplane before, during, and after each flight. No time need be spent on such subjects as artillery observation, machine-gunnery, wireless, bombing, photography, patrol work, and other subjects of a purely military nature, on which so much stress has been laid in training army pilots.

"What is an airplane?" Before going ahead with the method of Gosport instruction every pupil is given a lecture on the ground in which he is asked that question. One definition which was passed out to us in Canada was, "An airplane is a machine . . ." At this point the flight sergeant in charge of rigging would look dreamily into the distance. "An airplane is a machine . . ." he would begin again with an air of utter despondency. That was certainly no news to cadets. They had an idea that it might be a machine, and wanted to know more about it.

"An airplane is a machine with lift-generating surfaces attached to a frame which carries an engine, fuel, aviator, and devices by which he steers, balances, and controls his craft," the mournful flight sergeant was finally able to convince them.

Lift-generating surfaces—these are the bases of all flying. Every one knows, for instance, that a paper dart, instead of falling directly to the floor, sails in a gliding angle for some distance before crashing. Lift is generated under those plane surfaces moving through the air—and the lift keeps that paper dart gliding. Little eddies of air are compressed under its tiny wings. Imagine an engine in the dart, propelling it at some speed. Instead of having to nose down to get enough speed to generate lift under its wings, the dart would be able to fly on the level, or even climb a bit.

Just so with an airplane. A gliding airplane about to land with power shut off is that paper dart on a large scale. The airplane flying is the dart with power. To make the airplane safe to fly, to give control to the pilot so that he may steer it where he wants to, there is a rudder, moved by a rudder-bar under the foot of the pilot. It is impossible to turn a swiftly moving airplane in the air by the rudder alone. It must be banked to prevent skidding, even as a race-track is banked high on the turns. On its side an airplane will cushion its own bank of proper degree by the use of ailerons. These ailerons are sections of the wing-tips which may be moved either up or down. They are counterbalanced so that movement of the left down gives you the right aileron up. With left aileron down, the lift of the left wing is increased, and it tips up; at the same time the lift of the right wing is decreased, and it sags down. In that way the airplane is tipped up for a bank. These ailerons, wing sections, really, are controlled by a device known as the joy-stick in the cockpit.

We have seen how an airplane is made to tip and turn. Before a machine is under control we must be able to climb, or come down to the ground for a landing. Vertical control of an airplane is attained by the use of elevators, flaps on the tail plane acting as horizontal rudders. A pull-back on the joy-stick lifts the flaps, raises the nose of the machine, and causes it to gain height. Push the joy-stick forward, the elevators are turned down, and the machine goes into a dive for the ground. In making many maneuvers all three controls, rudder, ailerons, and elevators, are used at once and the pilot feels his way with the machine, guiding it with the stick and the rudder-bar.

After the explanation of the use of these controls, and their demonstration on the machine as it awaits its turn in the air, the pupil is taken up for his first ride—strictly a joy ride, and not always joyous for those who take every chance to be seasick. After he has a glimpse of what the ground looks like from the air, and has recovered from his first breathless sweep off the ground, the pupil is given a lesson in the demonstration of controls. The instructor explains through a speaking-tube attached to his helmet the very simple principles. Forward with the stick to nose down, back to lift it up, left stick tilts the machine over on its left wing, and right stick banks it to the right. Right stick and right rudder, in proper proportions, turn the machine to the right, left stick and left rudder to take the machine out of the turn and fly it straight again.

Then the wonderful moment when the instructor calls through the tube, "All right, now you take the stick." You clutch it as though it were the one straw in a great ocean. "Not so hard," comes the voice. "Now put your feet gently on the rudder-bar. Not so rough; easier, man, easier on that stick!" For a glorious moment she is yours, you hold her nose up, and you are flying an airplane tearing over the checkerboard country far below.

Then, like the voice of doom: "Now, do a gentle turn to the left. Don't forget to give her rudder and stick at the same time. That's right. Begin the motion with your feet and hands at the same time." The world swings furiously, and down below that left wing-tip a little farm sways gently.

"Now you are in a gentle turn—feel that breeze on your cheek? We are side-slipping;

give her a touch more of left rudder. Not so much. Now your nose is dropping; pull back on the stick. Back! Not *forward! Back!* Now your nose is too *high;* take us out, and don't forget that *opposite* stick and rudder.

"Now fly straight for a few minutes. Your right wing is low—bring it up. Your nose is too high. Now it is too low. Keep it so that the radiator cap is above the horizon. That's right."

So goes the business of instruction through the lessons on straight flying, gentle turns, misuse of controls, side-slipping, and approach, take-off, and landing. The trips should average thirty-five or forty minutes, long enough to teach the lesson, but not long enough to weary the pupil. Here at take-off and landing the pupil finds himself up against the most difficult part of his training. He has the problem of stopping a large machine weighing a ton or more, traveling at a landing speed of forty to fifty miles an hour, with the center of gravity just balanced over the under-carriage. An error in judgment will pile the machine up on its nose with a crashed propeller, and perhaps two broken wings and damaged under-carriage. Not a dangerous accident for the pilot, but very humiliating.

Army practice has shown that a pupil should have about sixty practice landings dual, that is to say, coached and helped by his instructor. By this time he has a total flying time of six to twelve hours. At this point, before he goes solo, the Gosport system provides that he shall be taken to a reasonably safe height for the practice of high maneuvers. At a height of say two thousand five hundred feet the instructor shows him how a stalled machine falls into a spin. The question of teaching higher maneuvers to civilian pilots is open to argument.

As soon as the instructor shuts off the engine the machine rapidly loses flying speed. It reaches a point where there is not enough air passing over the wing surfaces to support the plane in the air. Her nose begins to drop, and he pulls the stick back. The stick is full back, she stalls, topples over on her side, and plunges nose first. The instructor kicks on full rudder, and the world whirls below like a top, and the air whistles, swish, swish, swish, in the wires at every turn. Stick forward, opposite rudder, and she comes out so fast that your head swims. That is the spin.

"Now you try it," says the instructor. For there is nothing to a spin unless a machine does not come out of it—a rare thing if the plane is properly handled. The pupil is now ready to go solo, and for the first couple of hours' solo flying he does nothing but make circuits around the field, landing and taking off. Then his instructor takes him dual for forced-landing practice, business of getting down into a field within gliding range by gliding turns. Then the pupil tries it solo, throttling down for the practice, a most valuable experience which increases the confidence of the pilot. He learns to use his own judgment and to gauge height and ground distance as it appears from the air.

After three or four hours of solo time the pupil is scheduled for another demonstration of higher maneuvers, spinning and the stall turn. For the stall turn the pilot noses the machine down to get an air speed of seventy-five miles an hour. A little bank, stick back, she rears into the air with her nose to the sky and propeller roaring. Full rudder and throttle off. In silence she drops over on her side into the empty air; blue sky and green fields flash by in a whirl. She hangs on her back while the passengers strain against the safety belts, and then her nose plunges. The air shrieks in the wires as the ground comes up at terrific speed.

It is time for the pupil to go up for his solo spin under the plan adopted for army purposes. Up, up, up the pupil flies, three thousand feet, and the ground below looks soft and green. Would it be soft to hit in a spin from that height? It would not. Have people ever spun that far? he wonders. They have. Have machines ever failed to come out of a spin and killed the pilot? The answer is too obvious. With faith in nothing in particular, and with his mind made up that one can die but once in a spin, he stalls and spins her—and comes out. He is so surprised and exhilarated that he tries it again before he loses his nerve. Yet again. The pupil is a pilot, the air has no terrors, and he has learned the oldest truth of flying, that there is nothing to a spin unless you don't come out.

The natural result of training a pupil along those lines is that he graduates rapidly into a good stunting pilot. He realizes that he cannot tempt the devil at three hundred feet and hope to live, but he takes a good altitude, throws his machine upside down, and knows that, given enough air, he must come out. He does come out unless he loses complete control of his mind and body. With fifteen hours of solo flying the pupil has really become a pilot. He is beginning to show that he can control his machine. From then on it is a question of the polishing of the nice points, making his forced landings perfect, not side-slipping a foot on his vertical banks, and coming out of spin so that he always faces the airdrome—all of which distinguish the good pilot from the poor pilot.

IV

SAFETY IN FLYING

THE fatalities on the training-fields of every country during the period of training in war, and before and after the war, testify only too surely that flying cannot be absolutely safe. It is no reflection on the future of flying to realize that it has not been safe, and that it can never, perhaps, be made fool-proof. One or two things must be remembered before we become despondent over the future safety of flying.

When the United States entered the war the entire personnel of the Signal Corps numbered one hundred and sixty officers and men. At the time the armistice was signed more than thirty thousand pilots had been trained. They were trained in great numbers under high pressure. We did not have the machines to train them in or the instructors to fly with them. We had not the experience in wholesale training of flying-men, and yet we turned out vast numbers. It was a question of getting the men through their flying and getting them overseas as quickly as possible. We had no adequate methods of inspection of machines, and no laid-out course in flying-training. We had to learn by our own experience, in spite of the fact that England at all times gave unstinted aid.

The wonder is really that we did not have more flying accidents. There were few men in the country who really understood what conditions tended toward a flying accident. There were few who had ever gone into a spin and lived to tell about it. At that time a spinning-nose dive was a manifestation of hard luck—like a German shell. If you once got into it, it was only the matter of waiting for the crash and hoping that the hospital might be able to pull you through.

Toward the end, of course, this situation had been largely overcome, the Gosport system of flying had been tried out, and there was a vast increase in the knowledge of flying among the instructors and pupils. The spin had been conquered, training was on a sound basis, and accidents were being rapidly cut down.

One of the most obvious ways to cut down crashes was by making sure that the pilot was in good condition physically. Flight surgeons assigned to every camp were detailed to make a study of the very delicate relationship between a sick and stale pilot and the crash. It was discovered, for instance, that a man who went up not in the best condition multiplied by many times the ordinary hazards in the air. It became the duty of these surgeons to conduct recreation and exercises so that pilots would always be in good trim.

Flying for an early solo pupil is the greatest mental strain that a man can experience. Every moment the fact that he is up in the air, supported only by wood, wires, and fabric, may be on his mind. He is making desperate efforts to remember everything his instructor has told him since he started his dual. He tries to keep that nose on the horizon, the wings balanced, and the machine flying true. He is in fear of stalling and consequent loss of control. He goes into his turns, hardly knowing whether he is going to come out of them, and noses down for a landing, mentally giving prayer, perhaps, that he will come out all right. He can't possibly remember everything he has been told, but he tries to salvage as much knowledge as possible to make a decent landing.

These experiences tend to bring about two conditions, aerophobia (fear of the air) and brain fatigue, both resulting in complete loss of head on the part of the pilot and inability to react to impulses. Nothing is more likely to produce immediate and fatal aerophobia than the sickening sight from the air of a crash, yellow wings flattened out against the green ground a thousand feet below. A comrade, a tentmate? The pupil looks at his machine, sees the wires throbbing, and watches with wonder the phenomenon of rushing through the air—he may let his imagination dwell too long.

During his first hour's solo a swift stream of hundreds of impulses is borne along the nerve centers to the brain of a pupil. It is like the pounding of heavy seas against a light sea-wall. His brain reels under the repeated shocks and the pupil falls into a detached stupor. He waits while his engine throbs ahead, and lets the machine fly itself. He seems to take no active participation in the operation, and unless he recovers control of his brain and his machine it is a crash. Physicians then have the problem of learning from a dazed and perhaps badly injured man how it happened. He can recall nothing, and seldom knows when he lost control.

These are the things that happened when

this country was hastening fliers overseas. As a matter of national necessity it was essential that as many men as possible be put through their dual and solo flying and sent across to the other side. It was better for the country at large to turn out five hundred pilots a month, say, with 5 per cent. of casualties, than one hundred a month with one-half of 1 per cent. or less of accidents. These figures do not represent the actual conditions, but they picture the problem.

Now the civilian who would take up flying has just as much time as he wants to spend in learning to fly. He is paying for his instruction, and he should continue it for perhaps fifteen to twenty hours of dual instruction. He should fly the machine with an instructor in it, and really get accustomed to the feel of the air. He should become sensitive enough so that he can differentiate between the tight, firm touch to a machine flying under complete control and the slack movement of stick and rudder of a plane very nearly out of control. He should recognize these danger signs and know how to correct his flying position.

Dual flying should be continued up to the point where the pupil flies without thinking, when it becomes the natural thing for him to use both stick and rudder to correct a bump, and when he thinks no more of it than riding over a rut in a road. He should be able to tell by ear, when volplaning, whether or not he is maintaining sufficient speed to hold it in the air. He should be acquainted with the principle of spinning, and should have had some experience in taking a machine out of a spin.

The treacherous thing about a spinning-nose dive is that, to come out of it, a pilot must put his stick forward, not hold it back, in spite of the fact that the machine is falling nose first and spinning at the same time. A spin is possible only from a stall, and only when the stick is back and rudder in either direction is given. The position is an easy one to get into from a steep turn. Air resistance against a machine turning becomes greater, it slows down the speed, decreases the lifting power of the planes. The result is that the nose falls slightly. The pilot moves the stick back to lift the nose, and in doing so pulls up his elevators, offering still more resistance to the air, and checking the speed. The effect becomes cumulative; he tries to hold up his machine, and he has stalled. In a last effort to check the spin he kicks on the rudder, and the thing is done.

The rudder and elevators have formed a pocket in the tail plane, which is like the spoon on a trolling-hook. The pocket is off-center and the air rushes into it as the machine topples over and plunges down. It imparts a twisting motion, which in a turn or two develops into a throbbing spin. Picture the pilot, trying to lift the nose of his machine by holding his stick well back and wondering why the nose does not come up. The pathetic thing is that so many hundred men have thought their salvation was to hold the stick back.

The only possible thing to do in this case is to break the pocket. Put the stick forward to neutral, or even farther if need be, and opposite rudder. The machine will come out in three-quarters of a turn with practice, into a straight-nose dive. Then ease the stick back, and this time the nose comes up and the machine flies on its course. Instructors who have taught their pupils this before they let them go solo have saved many, many lives.

It is reasonable to say that there are no fatal accidents except those from a spin, but, like all general statements, that is open to contradiction. A nose-high side-slip may be fatal, but generally the pilot pulls himself out of it. There may have been men killed in landing accidents, but one seldom hears of them. Men have been killed trying to loop off the ground, and Vernon Castle was killed doing an Immelmann turn at fifty feet to avoid another machine. These are the exceptions. The common or garden variety of accident is from a spin. The spin once conquered, the air is conquered.

One hears about stunting, and the accidents which result from taking chances in the air. There may be two opinions about whether for the flying of the future it should be necessary to loop, to roll, to half roll, and stall turn, or even to spin. As to looping and rolling, the question of the type of machine to be flown will determine that largely. There are many machines which cannot be looped. The large naval flying-boats, for instance, describe a circle two thousand feet in diameter for each turnover—it is almost obvious that not much stunting is done on these boats. A small scout or sporting plane can loop and come out higher than it went in.

There is certain value in practising such maneuvers if the machine will permit it. In battle they are, of course, essential. In peace, however, they may be valuable for the very fact that it accustoms a pilot to unexpected changes in the air. He gets used to the idea that he can pull himself out of any position, given air enough, and he will never be afraid. He becomes orientated on his back, does not lose his head, and simply waits with confidence for his machine to come around. This means that if he is suddenly overturned by accident, or for a minute or two loses control, he knows that his condition is temporary and that he must simply "carry on."

Army pilots who have had a good course in stunting would certainly recommend the same for civilian pilots. That does not mean that it would be necessary, or even advisable. There have been accidents due to stunting by both inexperienced and experienced pilots. Generally it is a matter of altitude, for with sufficient height the greenest pilot can come out of anything, if he does not lose his head.

For the man who would be the pilot for a large commercial plane, such as the Glenn Martin bomber, the Super Handley-Page in England, or the Naval Curtiss flying-boats, no stunting is necessary. He may sit in the cockpit of his machine, and ramble off mile after mile with little motion, and with as little effort as the driver of a railroad locomotive. He has a large, steady machine, and there will be no obligation for him to spill his freight along the course by turning over in midair.

Whatever opinions may be held regarding the advisability of teaching stunting to a civilian pilot, there can be no question that a civilian pilot must have a long and thorough course in the very gentle but essential art of making forced landings. The problem is that of controlling a machine with its engine cut off, to have complete control of it within the radius of its gliding distance. Again, the dart gliding to its uncertain landing. In the hands of an unskilled pilot, an airplane gliding without power is a very dangerous thing. He may pile up the machine against some farm-house, fence, haymow, or clump of woods, smashing it badly and injuring himself. Or he may, through inexperience, lose flying speed in the course of his descent and topple over into a spin.

Even the best pilot may make a mess of his machine if his engine goes "dud" over a forest, city, swamp, or other impossible landing-place. It is his business more or less to keep clear of such tracts when flying. But one of the tests of a good pilot is whether or not he can shut off his engine in the air, pick out his particular field below, taking into account that he must land against the wind, then by a series of gliding turns find himself just coming out of the last turn in front of the fence. He may make a gentle little "zoom" over the fence, using every last bit of flying speed for the last kick, and settle down gently on the other side. One test of instructors in Canada, before they were allowed to take up pupils, was to make three perfect forced landings in succession—one of them as the pilot came out of the spin. With his head still reeling he must pick out his landing-place and make it.

The difficulty is, of course, not to undershoot, to fall short. It must be remembered that in case of actual engine failure there is no motive power, and if a man calculates his distance too short, he has nothing left but to make his landing where he may be. He has lost his height and his chance to reach other fields. He may find himself rolling into the fence of the field he was trying for.

Or, equally bad, he may overshoot. The distance was shorter than it looked, he has more height to lose than he thought. He can gain nothing by sticking the nose down, because in his plunge he gains speed which will carry him too far on the ground. He may bowl over the fence, or, if there is a field beyond, make the next field. More often he finds himself in a patch of woods with a broken airplane.

It is possible that on a turn, a gliding turn with the engine shut off, the pilot may lose his flying speed. Unless he is experienced, he does not realize that on a turn the machine presents more surfaces to the air and greatly increases the air resistance. It is likely to stall unless a safe margin of speed is maintained. The dangerous part of this is that very often the machine will lose its speed when only a hundred feet from the ground, approaching the field. There is no chance to pull it out of a spin unless the pilot is alert and realizes that he has lost speed, and noses down before he spins. Often he spins, and a fall with an airplane from a hundred feet is just as nasty as it can be.

For his own safety in the air the civilian who is about to take up instruction in flying should insist at his flying-school that he be taught thoroughly, to his own satisfaction, the control of his machine with the engine shut off for the moment. There is a certain feel, a sing in the wires, he must know. He should continue at the work of forced landings, going on his solo flights to various heights, pick out his field, shut off the motor, and get down into that field—no other. He should keep it up until he can make nine out of every ten absolutely perfect, and the tenth one, though not perfect, still a good landing.

Then it may be said that a pilot is safe. When he knows in his own heart that nothing can happen to him which will throw him off his guard, or which will worry him, he can take the air without fear.

5

V

QUALIFICATIONS OF AN AIRPLANE MECHANIC

WHAT chance has a good automobile man who knows his engine thoroughly to become an airplane mechanic? There can be only one answer to this question which men ask themselves daily—there is every chance in the world. Commercial flying, in the day when the air is to become a medium of transportation, just as ground and water are at present, must draw to itself hundreds of thousands of mechanics. The only thing to which the future of flying may be compared is the automobile industry at present. And the only place from which the mechanics are to be recruited are from the men who are working in garages putting automobiles in order.

An interesting comparison between the future for the automobile mechanic or airplane mechanic compared with the future for the pilot is afforded in the figures of a well-known flying-officer of great vision. He expects that the skilled mechanic, the man who has spent years at his trade, will command more for his services than a pilot. Any one can learn to fly an airplane in one or two months of proper training. A mechanic may work for years to learn his profession.

It was estimated that it took ten mechanics of various kinds on the ground to keep one airplane pilot flying in the air, and the experience of the United States has shown that there must be a large force of trained men to keep up flying. The present leaders of the automobile world and the aeronautical world are men who got their first interest in mechanics in some little shop. Glenn H. Curtiss and Harry G. Hawker, the Australian pilot, both owned little bicycle-repair shops before they saw their opportunity in flying.

Most essential of all, for the man who would become an airplane mechanic, is a thorough knowledge of gasolene-engines. This should include not only a knowledge of such fundamentals as the theory of the internal-combustion engine, carburetion, compression, ignition, and explosion, but also a keen insight into the whims of the human, and terribly inhuman, thing—the gasolene-motor. Nothing can be sweeter when it is sweet, and nothing more devilish when it is cranky, than an airplane engine.

There are certain technical details which distinguish an airplane motor from an automobile motor, but a man who knows automobile engines can master the airplane motor in short order. Generally speaking, the airplane motor differs from the automobile motor in shape. The Liberty type of engine is V-shaped, with both sets of cylinders driving toward a common center, the crankshaft. Most airplane motors have special carbureters, and their oiling systems are extremely finely adjusted to take up any friction at their high speed. They will be found to be lighter in weight, with pistons, piston heads and other parts made of aluminium. They are, as a rule, more carefully made than most automobile motors, with especial attention to the fitting of all working parts.

One advantage which an airplane mechanic has is standardization, which has reached a high point with Liberty, Hispano-Suiza, and Curtiss engines. Once a mechanic has learned his type he has learned practically every engine of that type. For a long time to come the 18,000 Liberty engines which this country had at the time the armistice was signed will be carrying commercial airplanes across broad stretches of the United States. If it had not been for the pressure of the war this engine might have been developed slowly, as the automobile engines were, with changes from year to year. The Liberty engine has reached a high standard of efficiency, and is likely to be the standard airplane engine in this country for several years to come. An airplane mechanic who knows his Liberty engine will be able to look after most of the airplanes with which he will come into contact.

An engine which was not developed to the same high point in this country as the Liberty motor is the rotary engine, of which the Gnome Monosoupape or Clerget are perhaps the best-known types. These were favorites with airmen flying fighting scout-planes. They weighed practically nothing, for an engine. A one-hundred-horse-power motor weighed only two hundred and sixty pounds, and it was a splendid type for fast work. Briefly, the power generated by the explosions in the cylinders, operating against two centers of pressure, gave a rotary motion to the cylinders and crankcase, revolving around a stationary, hollow crankshaft. Cylinders and crankcase were bolted together, and the cylinders looked like the blades of an electric fan. There was always an odd number of cylinders, so that there would be no dead-centers, no point at which two opposing strains would be balanced, causing the engine to stop. The propeller was bolted on a nose cap which revolved with the engine. This type of engine is not likely to be used to any extent for commercial flying, or even flying for sport. It is expensive, very wasteful of gasolene and oil, and difficult to keep in repair.

For men who may have had some experience in the assembly of airplanes at factories, or of rigging them at flying-fields, there is great opportunity. Expert riggers who know their craft are few and hard to get. They are invaluable for maintaining a machine in flying condition. The use of airplanes in this country will require men for rigging, for truing up the wires and struts. Each airplane must be overhauled after a few hours of flight to discover hidden weaknesses and to tighten sagging wires.

Rigging an airplane has some resemblance to rigging a ship for sailing. The first requisite is to see that the machine is properly balanced in flying position. There is a number of minute measurements which come with the blue-print of every machine and which must be followed out to the letter to get the most successful results. An important detail is the pitch of the planes, or the angle of incidence, as it is called. This is the angle which a plane makes with the air in the direction of its motion. Too great a pitch will slow up the machine by offering too great a resistance to the air; too small an angle will not generate enough lift. The tail plane must be attached with special care for its position. Its angle of incidence must exactly balance the plane, and it must be bolted on so that there is no chance of it cracking off under strain.

Radio operators will be in great demand for flying. Brig.-Gen. A. C. Critchley, the youngest general officer in the British service, who was a pilot in the Royal Air Force, said that the future development of the airplane must go hand in hand with the development of wireless communication. He added that the most difficult thing about flying, especially ocean flying, was to keep the course in heavy weather. There are no factors which will help a man on "dead" reckoning; and a shift in wind, unknown to the navigator of a plane, will carry him hundreds of miles from his objective. The wireless telephone was used to some extent during the war for communication between the ground and the air; it will be used to a greater extent in the next few years.

Another development which is being used by the navigators flying the Atlantic is the radio compass. This instrument may be turned toward a land or sea wireless station, of which the call is known, and it will register the bearing from the flying-boat to this station. It may be turned upon another station, and this bearing also charted. The intersection of these two wireless compass bearings gives the position of the ship at sea. The radio compass is dependable day or night, and is said to be quite as reliable as a sextant or other navigating instruments.

Sailmakers to repair airplane fabrics, to sew new covers for planes—these men must find an opportunity in flying. There are literally thousands of wings, as yet unmade, which will carry the air traffic of the future. It matters not whether men or women take up this branch of the work, it must be done, and done with a conscience. Like all other branches of the mechanical maintenance of an airplane, careless work on the part of a sailmaker may mean disaster for the pilot. One of the latest fatalities at a Long Island flying-field was due to careless stitching, or weakness of fabric, which gave way under great pressure due to high speed. The linen cover of an upper plane ripped off at a height of one hundred and fifty feet, and the pilot was killed in the fall of the machine.

Photographers may yet take the place of surveyors, or work hand in hand with them in the making of aerial maps of the country. The map of the future must be an aerial map, a mosaic map such as was used by our army headquarters. Nothing can exceed the eye of the camera for accuracy. Cameras bolted to airplanes, such as were used by our army for reconnaissance, have already been used for mapping cities. The mapping of the entire country in such a manner is only a matter of time.

One thing which an aviation mechanic of any sort must bear in mind is that he *must* do his work with a conscience. True, he is handling mute metal engines, or dumb wires and struts—but in his work he holds the life of the pilot in his hand. It is not too much to say that hundreds of pilots' lives have been saved by the conscientious work of skilled mechanics who realized the danger of the air.

I have seen mechanics rush from a hangar in a frenzy of excitement and agitation. "That machine must not go up; it has been repaired, but not inspected!" They have done their work with a will in the army; they have learned some of the dangers of flying and weak spots which must be watched. The civilian mechanic must be taught many things.

First of all he must know the value of inspection. Every machine which has gone through a workshop must be inspected and checked over by a skilled mechanic before a pilot is allowed to fly it. The ideal thing would be to have legislation licensing the inspectors of aircraft and requiring that repairs on all machines be examined by a licensed inspector. The inspectors would be under civil service and would be selected by competitive examination. It may sound fantastic, but such precautions are as necessary for the preservation of life as legislation on sanitary matters.

In the second place, there should be time limits placed by law covering the period of usefulness of various parts of an airplane. After fifty hours of flying there should be an inspection of certain working parts of the engine, certain wires in the body which may be strained by bad landings, and other wires in the rigging strained by flying in bad weather. New wires are always sagging and stretching a bit. Wings will "wash out," lose their usefulness by excessive flying, and must be replaced. There is a great volume of data on these matters which should be the basis for laws covering mechanical inspection of airplanes, and with which the airplane mechanic must become familiar.

For the man who would like to work into the piloting of aircraft there is a very good opportunity by starting with the mechanical side. Too many pilots know next to nothing about the construction of their machines. When an engine goes bad they know that it won't run—that is all. The pilot who is a good mechanic is a gifted man in his profession.

There are endless opportunities at flying-fields for mechanics who want to learn to fly. During the war it became customary to take mechanics up for flying at least once in two weeks on some fields. It gave the mechanic an interest in his work and an interest in the life of his pilot. Perhaps nothing stimulated accurate work by a mechanic more than the knowledge that at any time he might be called upon to ride in one of the planes he had helped make or repair.

Some were taught flying by their officers, and later qualified as pilots. Others went through as cadets and became pilots after the regular course. The pilot of the future must learn the mechanical side, and the mechanic should be a good pilot. The two must go hand in hand to make flying a success.

VI

THE FIRST CROSSING OF THE ATLANTIC

THE story of the American triumph in being the first to fly from the New World to the Old World is a story of careful, painstaking, organized effort on the part of the American navy. With the flight of Lieut.-Commander Albert C. Read from Rockaway Naval Air Station to Plymouth, England, nearly four thousand five hundred land miles, the navy brought to fulfilment plans which had been maturing for two years. Since 1917 there have been naval flying-officers anxious to cross the ocean by air, and their plans have been cast and recast from time to time. At first there were many reasons why it was impossible to attempt such a thing while the United States was at war. Destroyers, busily hunting German submarines, could not be spared for a feat more spectacular than useful at the time. Pilots and mechanics could not be spared from the business at hand—training hundreds of seaplane pilots for service overseas.

American efforts to cross the Atlantic by air date back to the spring of 1914 when the flying-boat *America* was built to the order of Rodman Wanamaker. She was a large seaplane, a new departure in her time, and represented the combined effort of a number of the best seaplane designers in the world. Lieut. John C. Porte, of the Royal Navy, came over from England to be pilot of the boat, and after her tests in August she was to have made her flight. But Porte was recalled by his government at the outbreak of war and the project given up.

In the latter half of 1918 the naval seaplane NC-1 was delivered to the Rockaway Naval Air Station—the largest seaplane ever built on this side of the water. She was originally planned, with three sister ships, as an aerial submarine-chaser. One hundred and twenty-six feet from wing-tip to wing-tip, she was equipped with three big Liberty motors—a monster seaplane, ideally suited to the purpose for which she was designed.

The signing of the armistice interfered with her use as a submarine scout, and naval plans for crossing the ocean in the air were brought from their pigeonholes. The NC-1 and her sister ships under construction appeared to have been built for just such a flight. When the war ended, the navy as a whole, and the naval air service in particular, concentrated attention on the possibilities of using the NC planes for the flight. One of the first decisions made was to increase the engine power by adding a fourth engine, and to enlarge the gasolene-tanks for a long flight.

Early in March of this year it became apparent that the spring or early summer would see several attempts to cross the ocean by air. On March 19th it was reported from England that the unfortunate Sopwith machine with its lucky team of Harry G. Hawker and Lieut.-Commander Mackenzie Grieve had started from England for Newfoundland. At the same time announcement was made that naval officers had been conferring over their Atlantic flight plans, and that a start would be attempted some time in May.

As a matter of fact, a great deal of work had been done in secret by Commander John H. Towers, Lieut.-Commander Albert C. Read, and Lieut.-Commander Patrick N. L. Bellinger. As early as February 24th a conference was held in Washington and a date of May 15th or 16th for the flight from Newfoundland was set. This date coincided with a full moon over the North Atlantic, and the machines started May 16th from Trepassey.

There were really only three routes open to pilots anxious to make the first crossing of the Atlantic. There was the flight straight from Newfoundland to Ireland, a matter of about one thousand nine hundred miles of straight flying, with the possibility of favoring winds. There was the Newfoundland-Azores route which the Americans took, and the route from Dakar, French Senegal, to Pernambuco, Brazil, which French fliers attempted. In addition there was the possibility of flight from Ireland to Newfoundland, given up by Major Woods, pilot of the Short biplane, after his forced landing in the Irish Sea.

The great question of a flight straight across the Atlantic was that of fuel consumption. Could a machine be devised which would carry enough fuel to fly across one thousand nine hundred miles of water? The Sopwith Aviation Company designed their machine for such a flight, but sent it out to Newfoundland to catch and take advantage of the prevailing west winds across the North Atlantic. The story of the six weeks' wait for favorable weather, and the desperate take-off to beat the American plane, the NC-4, at the Azores, make it appear doubtful whether such winds are to be relied upon.

The American planes took advantage of those winds in their flight to the Azores, that much is certain. But they were well protected with destroyers, were not pushing their planes to the limit, and did not depend upon favoring winds. That the NC-1 and the NC-3 reached the Azores, but did not make safe landings in the harbor after their long flight, is one of the fortunes of flying which must not reflect upon the American effort as a whole.

The French route which Lieutenant Fontan, of the French army, tried twice, and on which he was twice forced to land because of engine trouble, was laid to take advantage of favoring winds. Across the South Atlantic the winds prevail in the spring of the year from east to west, contrary to the winds on the northern course. A twenty-mile wind at the back of a flier jumping the one thousand eight hundred miles across this bit of water would add just twenty miles an hour to the ground speed of the machine.

Capt. John Alcock and Lieut. Arthur Whitten Brown startled the entire world on June 15, 1919, with the success of their straight flight from Newfoundland to Ireland, covering 1,960 land miles in 16 hours and 12 minutes, at an average speed of 120 miles an hour. Not only was this the longest non-stop flight over land or water on record, but the greatest international sporting event. As such, though credit for the first flight of the Atlantic belongs to the American NC-4, it eclipses for daring the flight of the American navy. The Vickers-Vimy plane left St. John's, Newfoundland, on June 14th, at 4.29 P.M., Greenwich mean time, and landed at Clifden, Ireland, on June 15th, at 8.40 A.M., Greenwich mean time. The machine was equipped with two 375-horse-power Rolls-Royce Eagle engines, and had a wing span of 67 feet and measured 42 feet 8 inches over all.

The start of the American fliers was made after a series of tests of the seaplanes which covered a period of almost two months. At the outset it was decided to fly three out of the four NC planes, on the theory that one of the machines would probably prove to be weaker or less easy to handle than the others. The NC-2 proved to be the unfortunate sister in this case, and because of some defects in the arrangement of her engine-bearing struts she was dismantled and left behind.

With the decision to start three planes simultaneously, the navy made it clear that, although it hoped all three seaplanes might complete the trip, allowance was made for one or two machines to give up the flight if they found themselves in trouble.

The NC-1, and NC-3, and the NC-4 all proved to be up to expectations, and, with increased engine power, showed that they could take-off the water with a load of twenty-eight thousand five hundred pounds. After the necessary tests had been made on Jamaica Bay, Commander Towers said on May 4th that the start would be made a little after daybreak, May 6th. There remained only the task of filling their hulls with one thousand eight hundred gallons of gasolene.

Early in the morning of May 5th, while mechanics were pumping gasolene into the tanks of the NC-1, a spark from an electric pump fell into a pool of gasolene and set fire to her whole right side. In a moment the heavily "doped" linen wings, with seasoned spruce spars, were a mass of hot flame. The sailors at work on the machine, with complete disregard of their personal safety, ran for fire-extinguishers, and with the fire burning around the mouth of the open tanks, confined it to the right wings of the machine and to the elevators of the NC-4 standing close by. No one believed that the NC-1 could be made ready in time for the flight twenty-four hours away.

She was ready the next morning, with fresh wings from the discarded NC-2, but the flight was postponed on account of a heavy northeast wind, reported all the way to Halifax. The machines made their start from Rockaway on the morning of May 8th, at ten o'clock, and two of them, the NC-1, with Lieutenant-Commander Bellinger, and the NC-3, with Commander Towers, arrived at Halifax after nine hours' flying. The NC-4 proved to be the "lame duck" on the first leg of the flight, and came down at sea a hundred miles off Chatham, because of overheated bearings. Some alarm was felt during the night by the failure of destroyers to find her. She appeared the next morning off the Chatham breakwater, "taxi-ing" under her own power.

While her sister ships, the NC-1 and the NC-3, were flying to Trepassey the NC-4 waited at Chatham. Even after the repairs were made, it seemed impossible for the NC-4 to catch up with the other two machines, and she was held stormbound for five days. On May 14th she finally got away from Chatham, and, with her new engines, made the fastest time over the short course to Halifax recorded since the beginning of the flight. Her average for the 320 miles was 85 nautical miles an hour, about 20 miles an hour faster time than either of the other two machines had made.

Four days later she left Halifax for Trepassey in a last-minute effort to catch her sister planes. It seemed certain that she could not get there in time and would be forced to follow on the course a day later. Just as she flew into Trepassey Bay, on May 14th, the NC-1 and NC-3 were preparing to take-off. They postponed their start until the next day. In the mean while repairs were rushed and adjustments made, and she was ready to start the next afternoon, when all three planes started a little after six o'clock.

From the beginning of the flight from Trepassey the NC-4, thought to be the "lame duck" of the squadron, ran away from the other two machines. She lost contact with them very quickly and plowed through the night alone, laying her course by the line of destroyers lying beneath her.

She was about half an hour ahead of the NC-1 at daybreak the next day and within an easy run of Horta, Fayal.

The half-hour lead gave the NC-4 a chance to get through a fog which was coming up over the Azores ahead of the other machines. She held a little above it until she thought she was in the right position. Then she came down through the mist. As it happened, she landed in the wrong harbor, but picked herself up and found Horta a few minutes later. She landed in Horta after fifteen hours and eighteen minutes of flying, in which she averaged 78.4 nautical miles an hour for the flight.

The machine was nearly five hours ahead of the schedule laid down by the Navy Department.

Both the other planes were forced to land at sea, the NC-3 after 1,250 miles of flight—the longest ever made over water up to that time—and the NC-1 after more than 1,100 miles in the air.

The NC-1 with Bellinger and his crew was picked up on the morning of Saturday, May 17th, by a Greek steamer, the *Ionia*, and brought into Horta. Towers with the NC-3 tossed about for nearly sixty hours at sea and was not picked up until the following

Monday, when the public had begun to fear for his safety.

On Tuesday, May 20th, the NC-4 hopped off for the shortest leg of the flight, 150 miles from Horta to Ponta Delgada, where the fuel and supplies for the machines were. With favoring winds at her back, and with the lightest load she had carried, she covered the distance in one hour and forty-four minutes, an average speed of 86.7 nautical miles an hour, or more than 99 land miles. This was a new record for the seaplanes on the ocean flight.

Meanwhile Harry G. Hawker and Lieut.-Commander Mackenzie Grieve, the Sopwith team waiting so long at St. John's for a chance to fly, stimulated in their daring attempt by reports of American successes at the Azores, took-off on their flight straight across on the afternoon of Sunday, May 18th. All through that night he flew, when his engine began to give signs of overheating, due to a clogged water-filter. Early the next morning, about half-way across, Hawker decided that there was no chance to make the land, and began looking through the fog for a chance for a safe landing.

By zigzagging on the steamship courses for about two hours, with his engine hot but running well, he picked up the Danish steamer *Mary*, and pancaked on the water about two miles ahead of her. Because the little tramp steamer had no wireless, the world was kept waiting a week, before word was signaled to land that Hawker and Grieve were safe.

With the Sopwith team out of the race, it became evident that Commander Read and the NC-4 would actually win the honors for the first flight. On the morning of May 27th he started over his well-patrolled course of eight hundred miles, and, after a little less than ten hours of flight, brought his machine into the harbor before Lisbon, Portugal. Americans had crossed the ocean in the air, and the enthusiastic Portuguese capital turned out to do them every honor.

Read, however, rather than linger, pushed on again May 30th, in the midst of the celebration for his triumph on the last leg of his course to Plymouth, seven hundred and seventy-five nautical miles. Engine trouble, the first since the machine had left Chatham, developed, and at the end of two hours he was forced to land at the mouth of the Mondego River, about a hundred miles on his way. The trouble was a water leak. It was quickly repaired, and he started again, but decided to put up at Ferrol, Spain, two hundred miles farther on the course, for the night.

Early in the morning of May 31st Commander Read started from Ferrol for Plymouth, and at the end of seven hours and six minutes of flight came down in the harbor, where a warm reception was waiting for him. The actual flying time since leaving the Rockaway Naval Air Station was fifty-seven hours and sixteen minutes, and the average rate of flight was at a speed of sixty-eight nautical miles an hour.

VII

LANDING-FIELDS—THE IMMEDIATE NEED

THE immediate need, to establish aviation throughout the entire country, is a series of landing-fields from the Atlantic to the Pacific coast. These landing-fields should not be designed primarily for transcontinental flying-stations, but for city-to-city flying. There is going to be a great amount of aerial traffic from New York to San Francisco, to be sure, but the future of flying is in the linking up of cities a few hundred miles apart. The War Department has already taken steps, and will establish thirty-two fields in the country to encourage flying. Many more are needed.

Atlantic City is apparently the pioneer air port of the country, and for many reasons this is natural. There are political and social advantages which make Atlantic City ideal. Rules have been laid down for the coming and going of airships, and a field for land machines and water space for seaplanes have been laid out. A large aeronautical convention has already been held there.

Every city in the United States will have a landing-field and hangars for airplanes, as well as mechanics to care for them. Whether this is to be a private or public enterprise lies in the hands of the people handling such things. Much could be said for either type of establishment. The thing must come; it is as logical as one, two, three. There are some, perhaps, who remember the roars of derision which went up when the first automobile garage was established in their town. Such a thing was visionary—there would never be enough machines to make it pay!

There are many reasons why it is impossible to consider the use of city roofs, for the present, as suitable landing-places for airplanes. In fact, the first successful landing on a roof made by Jules Vedrines last January was hailed as a feat of almost unparalleled daring. He flew and landed on the roof of the Galeries Lafayette in Paris, and won a prize of $5,000 for doing it. The police of Paris refused to allow him to fly off the roof, and he was compelled to take his machine apart and lower it in an elevator.

The theory of flight, the laws which make it possible apparently to defy all laws of gravitation, make it impossible for us to depend on the roofs of buildings in large cities and landing-places. It will be a long time before the dreams of men who would establish landing-places on hotel roofs can come true. The progress of aeronautical development has been great enough so that there is no need to overemphasize it—to set ridiculous tasks which cannot be accomplished.

We shall not see the business man flying to his office in the city from his country estate—unless some landing-field is built on the lower end of Manhattan Island as has been proposed. The Chamber of Commerce of the State of New York has taken up the matter of legislation to make landing-fields possible, and it must go through. The business man ought, in the near future, to be able to use the airplane for quick trips to Albany. It would save hours over rail time, and here the airplane has a wonderful field of usefulness.

Airplanes have made the trip from Washington to New York in very quick time, only to have to go on to Mineola to land on the airdrome there. It takes nearly an hour to come in from Mineola, but even at that the saving of time is still considerable. The speed and efficiency of airplane travel to and from New York and other cities is materially affected by the lack of landing-fields close to the business section of the city.

There must be a large field, broad in every dimension, to permit the landing and taking-off of airplanes. A machine must get up flying speed running across the ground before it gets into the air. The flying speed varies with the type of machine, and it may be estimated that most machines take-off and land at a speed of from forty-five to sixty miles an hour. The air must be passing through their planes at this speed before they will begin to fly, and it takes a little run to get up flying speed. Similarly, when an airplane lands, it must lose its flying speed gradually. It may glide to within a few feet of the ground, and then "flatten out" just off the ground and run along until it loses its speed, the air no longer passes over its planes fast enough to support it, and it drops to the ground.

Such are the limitations which the necessity for speed in airplane flight imposes. Compare the paper dart flying through the air. As long as it moves quickly it will fly. Or a kite, that will fly when the wind is strong enough. The airplane creates its own wind to support itself.

There are four forces acting on an airplane in flight, and they must be properly overcome and balanced. There is lift, the upward force exerted on the planes by the passage of air over their surfaces; and drift, the resistance to the passing of an airplane, the retarding force acting opposite to the direction of motion. Then thrust, the forward effort of a machine exerted by a propeller pushing or pulling. And finally gravity.

The primary conditions of flight are that lift made by the planes shall be equal to the force of gravity, and that the forward thrust must be equal to the drift. At that point a machine will sustain flight—a fairly simple thing on paper. But the times that machines have stalled in the air, with their motors full on because their pilots have failed to sustain flight, have let the force of gravity overcome lift, are too numerous to mention.

That dart, if pointed at a proper angle and let loose, will fly; its lift will overcome the force of gravity, even though it has no motive power of its own. An airplane without an engine could be pushed off the Palisades at flying speed, and a skilful pilot could bring it to a reasonably safe landing at the foot. Flight does depend on motion, but motion does not depend on motive power. Given a sufficiently high altitude, the mere act of dropping through the air creates motion, and this motion will sustain flight.

An airplane is in no particular danger in the air if the motor stops—provided it is in an open stretch of country with plenty of fields. Instinctively the pilot will nose down and glide, and on that glide he will find himself maintaining flying speed. He can turn and maneuver his machine, and pick out almost any field near at hand. The only limitations are that he cannot glide more than five times his height, and when he comes down to the ground he must stop gliding and land. He must land on anything that presents itself, a field if he has good judgment; if not, then a barn or swamp or woods. He must land when the end of his glide brings him to the ground.

This is commonly termed a "forced landing," and in every sense of the word it is one. There is no pilot of any extensive flying experience who has not had to make a forced landing. Ninety out of a hundred are perfectly orderly safe landings; the odd ones are occasionally crashes. Incidentally it may be said that forced-landing practice by flying pupils is the most beneficial which may be imagined. It teaches control over a machine as nothing else will. It may be carried out from any height, shutting off the motor, picking out a field, gliding for it, turning and twisting to get into proper position as regards the wind, and "giving her the gun" just at the fence and flying on.

A forced landing over the country is safe, but over a city it is the most deadly thing imaginable. For a machine caught with a "dud" engine over New York there is no escape but a terrific crash in the city streets, against the side of some building, with danger to the pilot and the people in the street below. There has been no motor made by the hand of man which would not let a pilot down at some unexpected time. The instance of Major Woods, starting on his flight across the Atlantic, and forced to come down to the Irish Sea is one example. The NC-4, American naval seaplane, had a forced landing at sea, a hundred miles from Chatham, Massachusetts, on the first leg of the Atlantic flight from this side. Its engines had been carefully cleaned and tested, and yet they failed. Harry G. Hawker's engine failed him half-way from Newfoundland to Ireland and let him down into the sea, from which he was picked up by the greatest good luck.

That is one of the most exasperating and human things about a gasolene-engine. It is efficient, but not thoroughly dependable. The best of them are liable to break down at the most needed moment, due to a hundred causes outside of the control of a mechanic or pilot. Care and rigid inspection will reduce the possibilities, but engine failure cannot yet be eliminated.

That is one of the principal reasons why the roofs of buildings around big cities are so dangerous. The sides of a building drop away from the roof. An error in judgment and the machine is over the edge.

It is even more dangerous to take-off. An airplane motor is ten times as likely to develop a weakness while it is cold. A motor starting a flight is never well warmed up, and fifty feet from the edge of the roof it may give out, with awful consequences. As a practicable thing, roofs are at present impossible. There is not a flying-officer in the world who will not agree.

An interesting series of experiments has been carried out in England on what has been known as the helicopter machine. This machine is not dependent upon speed to fly, but merely on engine power applied through a propeller of great pitch. The idea is not new, but is along the lines specified by Orville Wright when he said that a kitchen table could fly if it had a good enough engine.

The effort is being made to make a machine which can hover, can hold itself in the air by brute force of its propeller blades beating the air. The thing sounds impossible to adapt, say some aeronautical engineers. Those who have seen the experiments, however, express great optimism.

A machine of this sort would land and take-off in a very small space, and might be adapted to use around cities. It might even make flying over cities safe but for the human equation of the engine again. This machine is dependent on engine power. Apparently there would be two engines, or two driving mechanisms, one operating the lifting propeller and the other the pulling propeller.

For the present the great need is for landing-fields as near the heart of most American cities as possible. There should be quick transportation to the business section provided, as well as hangars and mechanics. When that is done we may very well say that aerial transportation for passengers and freight is an accomplished fact.

VIII

THE AIRPLANE'S BROTHER

AT the end of 108 hours and 12 minutes of sustained flight, more than four days, the British dirigible R-34 swung into Roosevelt Field, came to anchor, and finished the first flight of the Atlantic by a lighter-than-air airship. To the wondering throngs which went down Long Island to see her huge gray bulk swinging lazily in the wind, with men clinging in bunches, like centipedes, to her anchor ropes, and her red, white, and blue-tipped rudder turning idly, she was more than a great big balloon, but a forerunner of times to come. She had come to us, a pioneer over the sea lanes which are to be thronged with the swift dirigibles of the future plying their easy way from America to Europe.

The performance of the R-34, undertaken in the line of duty, has eclipsed all the previous records made by dirigibles and is, in fact, a promise of bigger things to come. There was that Zeppelin, which cruised for four days and nights down into German East Africa and out again, carrying twenty-five tons of ammunition and medicine for the Germans who were surrounded and obliged to surrender before help arrived.

The R-34 started from East Fortune, Scotland, on Wednesday, July 2, 1919, at 2.48 o'clock in the morning, British summer time, and arrived, after an adventurous voyage, at Mineola, Sunday, July 6, at 9.54 A.M., American summer time. She had clear sailing until she hit the lower part of Nova Scotia on Saturday. Electrical storms, which the dirigible rode out, and also heavy head winds, kept her from making any progress, and used up the gasolene. About noon of Saturday the gasolene situation became acute, and Major G. H. Scott, her commander, sent a wireless message to the United States Navy Department at Washington, asking for destroyers to stand by in the Bay of Fundy in case the gasolene should run short and the airship get out of control. Destroyers were immediately despatched, but in the next few hours the weather improved, and the ship was able to continue on her journey. It was feared, however, she might run out of fuel before reaching Long Island, and mechanics were sent to Chatham and to Boston to pick her up in case of trouble.

The big ship surprised everybody by appearing over Long Island about nine o'clock Sunday morning. The officer in charge of the landing party having gone to Boston, expecting her arrival there, Major John Pritchard "stepped down" in a parachute from the airship, and, landing lightly, took charge of the landing of the big machine.

An approaching cyclone, which would have made it almost impossible to handle the airship at Mineola, was responsible for a rather hurried start back at midnight of Wednesday, July 9th. She visited Broadway in the midst of the midnight glare, turned over Forty-second Street a little after one o'clock in the morning, and put out to sea and her home airdrome. The voyage back was mostly with favoring winds, and she landed at Pulham, the airship station in Norfolk, after 75 hours and 3 minutes of flight. The voyage back was practically without incident except for the failure of one engine, which in no way held back the airship. She was turned off her course to East Fortune by reports that there were storms and head winds which might hold her back in case she kept on her way.

The voyage was probably the most significant in the history of flying. It brought home to the public the possibilities of the airship for ocean commerce as nothing else could have done. The ship remained in the air longer than any previous airship, and pointed the way clear to commercial flying. It is, in fact, only considered a matter of time before companies are started to carry passengers and mails across the Atlantic at a price that would offer serious competition to the fastest steamships.

The airship has been very much neglected by popular favor. Its physical clumsiness, its lack of sporting competition in comparison with the airplane which must fight to keep itself up in the air, its lack of romance as contrasted with that of the airplane in war, have all tended to cast somewhat of a shadow over the lighter-than-air vessel and cause the public to pass it by without interest. It is a very real fact, therefore, that very few people realize either the services of the airship in the war or its possibilities for the future.

During the war the airship was invaluable in the ceaseless vigil for the submarine. England early stretched a cordon of airship guards all about her coasts and crippled the U-boats' work thereby. The airship had a greater range of vision and a better downward view than any sea-vessel; it could travel more slowly, watch more closely, stay out much longer, than any other vessel of the air. The British credit their airships with several successful attacks on submarines, but they give them a far greater place in causing a fear among the under-sea boats which drove them beneath the surface and greatly limited their efficiency.

The German Zeppelins, on the other hand, stand out in public imagination as a failure in the war, especially because the British shortly established an airplane barrage which proved to be their masters. This view is correct only in so far as it applies to interior raiding, for which, indeed, the Zeppelin was not designed. How untrue it is of the Zeppelin as the outpost for the German fleet British officers will readily admit. Indeed, they credit them with the escape of the German fleet at Jutland, one of the deepest regrets in British naval history. As eyes for the German fleet in the North Sea, the Zeppelins, with their great cruising range and power of endurance, proved almost invaluable.

Airships have, then, behind them a rich heritage and before them a bright future.

Much work that the airplane can do they cannot do; while, on the other hand, much work that they can do the airplane cannot. The two services are essentially different and yet essentially complementary. Between them they offer nearly every facility and method of travel in the air which could be desired. Each must be equally developed in order to increase the efficiency and the value of the other.

The great difference, of course, between the airplane and the airship is that the former sustains itself as a heavier-than-air vessel by the lifting power of the air in relation to a body driven hard against it by its powerful engines, while the latter sustains itself as a lighter-than-air body because of the large amount of air displaced by a huge envelop loaded with gas much lighter than the air itself. The contrast is obvious; one vessel is small, agile, and very fast; the other is slow and clumsy. The airship cannot attain anything like the speed of the airplane, nor can it go so high or maneuver so quickly, but on the other hand, at least for the immediate present, it can stay afloat very much longer and carry much greater weight.

Moreover, the airship has certain other easily perceptible advantages over the airplane. Ordinarily an airship need not fly at much more than a thousand feet, which not only makes far less cold traveling than at higher altitudes, but also allows the passengers to enjoy the view far better than from an airplane, whence the world below looks like a dull contour map. An airship also flies on an even keel; it does not bank as an airplane does nor does it climb or descend so quickly.

At present airship travel gives a greater feeling of comfort and security. Sleeping is a calm experience; moving about comparatively simple. Also there is less noise than in an airplane where the engines beat incessantly and the wind rushes through the wires and struts. An airship has no wires and can at the same time slow down and even shut off its engine, so that it need be no more noisy than a motor-car. Engine failure also is not so serious as in an airplane, for the gas-bag will always keep the ship up until there has been a chance for repairs.

Up to the present, too, the airship is less of a fair-weather flier than the airplane. A surprising record has been attained in the war by British airships, as is shown by the fact that in 1918, a year of execrable weather, there where only nine days during which their vessels were not up. This is, of course, in considerable contrast to airplanes as at present developed, but it may reasonably be expected that the latter will very soon develop to the same point of independence of the weather.

Of course, the great difficulty of airships has been their ungainly size and the difficulty of housing them. The sheds, particularly those for the Zeppelins, have been most costly, but the British have recently developed a system of mooring masts which make much of this expense unnecessary. If such a device can be successfully put into every-day use it will enormously increase the ease of loading and unloading passengers, which now makes for considerable discomfort and loss of time.

Some of the plans for future airships are unbelievable to one who has not followed their development carefully. Already there is planned in England a monster ship known as the "ten million," for the reason that it will have a gas capacity of ten million cubic feet, over four times that of the largest Zeppelin. The length is placed at 1,100 feet, the speed at 95 miles an hour, the cruising range 20,000 miles, and the cost at about $1,000,000. As a matter of actual practice, however, the best division of the space and lifting power of this airship would be for it to carry a crew of about 20, a useful load of 200 passengers or 150 tons of merchandise, and 50 tons of petrol, which would give it a non-stop run of about 5,000 miles.

Airship travel would undoubtedly be expensive. The gas alone to maintain such a vessel as described is expected to cost about $30 an hour, which, added to the original investment for the ship and its house and the wages of the crew and the 200 or more skilled men at each station, would come up to a high figure. At the same time, the airship would not afford the element of very high speed which is so certain to justify any expense which may have to be put into the airplane. Nevertheless, with the improvements that are sure to come, with the ability to reach places not touched by other methods of travel, the freedom from all the delays, inconveniences, and expense of transshipment, this preliminary charge will be largely compensated for.

Those who sponsor the airship urge that it will be used almost exclusively for long-distance flights beyond the range of the ordinary airplane and very little for short local flights. For transatlantic travel, for instance, it is being particularly pressed, as ships even of to-day have all the capacity for such a voyage, without the dangers which might surround an airplane if its sustaining engine power were to give out.

There are several records which would easily justify it. Besides the flight across the Atlantic by the R-34 and the four-day trip of the German airship from Bulgaria to Africa and back, a British airship during the war stayed up for 50 hours and 55 minutes, and another, just after the armistice, stayed up for 61 hours. An American naval dirigible a short time after the armistice made a flight from New York to Key West, 1,200 miles, at 40 miles an hour, for 29½ hours, with one stop at Hampton Roads. As an example of some of the difficulties of airship travel, this landing was possible only after the ship had circled the town and dropped a message asking the people to go to a large field near by and catch the dirigible drag-net when it approached the ground. Even at that, however, the time of less than a day and a quarter for what is usually a very arduous train trip from New York down the coast to Florida gives some indication of the possibilities of this method of travel when properly developed.

Practically all the new airships contemplated look to a much greater speed than the pre-war speed of about 40 miles an hour. It is not at all uncertain that they will not run up as high as 100 miles, though at the present time that figure is extreme. But granted that they no more than double the pre-war speed and reach the actual figure contemplated of about 75 miles an hour, they still would triple the best passenger-steamer speed, which would make them a matter of the utmost importance in all long ocean voyages.

Just how the balance will be struck between airplanes and airships is a big question. It is interesting to note, however, that the supporters of the airship have worked out a general theory that the lighter-than-air vessel with its already demonstrated cruising and weight-carrying capacity will be used for all long routes, and for that almost exclusively, while the heavier-than-air vessel, with its great speed and facility for maneuvering, will be used for local flights. This, in their viewpoint, would mean that the world would be girded by great lanes of airships, fed from a few main centers by swift-scurrying airplanes radiating in from every direction.

IX

THE CALL OF THE SKIES

THE day of the air has undoubtedly come. The old order of the world has been entirely changed. A new life is breaking in over the near horizon. Almost in a moment the span of the world has shrunk to a quarter of its former size, so that where before we thought in terms of countries very soon we must think in terms of continents. The world is shortly to be linked up as it never has been before, till the great continents are brought as near as were the near-by nations of the past years.

Any one who doubts the future of aviation should realize the helplessness of the science after the armistice because of the complete lack of international laws to make possible its application in Europe, where it was most highly developed. With men and machines ready, they had to hold to the ground largely because there was in force no treaties assuring them the right to cross frontiers. The broad plans for international routes were held up because aviation itself was so big in its expanse that it could not meet its just fulfilment within national lines.

As a result a new law must be written. The law of the air will be one of the most intricate and the most fascinating in the world. It presents problems never before presented and covers a scope paralleled only by the laws of the sea. Very fortunately, however, aerial international law may be written at the very start of the science by a common international standard and practice, thus obviating the greatest part of the divergences which long years of habit have grafted into the maritime laws of the various nations. The slate is clean so that uniformity may be assured in a law which is soon to come into the most vital touch with the daily lives of the nations.

Who, for instance, owns the air above the various nations? Obviously the individual landowner has rights, especially as to freedom from damage. The nation also has rights, especially for its protection and for police work. How high, however, does this jurisdiction go? Some assert that a maximum altitude should be set, say five thousand feet, above which the air would be as free as the seas; others that each nation must have unqualified control to the limit of the ether.

Then comes the question of passports, customs, registration, safety precautions, and damages. As already shown, the man on the ground is helpless against the airplane which chooses to defy him. People and goods can cross national lines by the air without passports or customs. There will be no main ports of entry as in sea or train commerce, and it is too much to think that any nation can patrol its whole aerial frontier in all its various air strata. Undesirable immigrants or small precious freight can be smuggled in with the greatest ease through the route of the air.

Obviously the most elaborate international rules are necessary. Planes must have some method of international registration and license, just as in a more limited sense ships on the seas have what amounts to an international status. Landing-fields must be established and open to foreign planes, each nation providing some kind of reciprocal landing rights to other nations. Arrangements must be made so that if a monkey-wrench drops out of a plane a mile or two up in the air proper damages can be collected. For such things there is to-day but little precedent in law.

This but sketches the problems. It shows, however, how closely this new science will bind the world together and obliterate national lines and nationalistic feelings. As the sea has been the great civilizer of the past, so the air will be the great civilizer of the future. Through it men will be brought most intimately in touch with one another and forced to learn to live together as they have not been forced to live together before. The artificial barriers that have stood so firm between nations in the past are now swept away and a great common medium of intercommunication opened.

Let it not be understood that all this will take place overnight. Far from it, for the experience of the war has taught only too well that the organization of an air force takes time and patience. Up to date the essential fact is that the science, the value, and the possibilities of flight have been proved in a thousand different ways. Vistas of travel and experience have been opened up which but a few months ago would have seemed fanciful. Everywhere men are dreaming dreams of the future which challenge one's deepest imagination. Already

Caproni, the great Italian inventor, has signed a contract to carry mails from Genoa to Rio Janeiro.

Now comes news of an airplane with room for ninety-two passengers. Engine power and wing space have gone on increasing in a dazzling way till one is almost afraid to guess what the future may hold. But, omitting all prophecy, the actual accomplishments to date are so stupendous that there is no need to speculate as to the future. If all technical development were to stop just where it stands, the factories and workshops of the world could well be occupied for years in turning out the machines necessary for the work awaiting them. Scientific development has gone so infinitely far ahead of actual production that as yet aviation is not being put to a fraction of its use.

Even more serious, however, is the general public failure to realize the gift which is within their reach. Flying was first a circus stunt and later a war wonder. The solid practical accomplishments have been lost sight of in the weird or the spectacular. People who marveled when a British plane climbed up nearly six miles into the air, or 30,000 feet, where its engine refused to run and its observer fainted, failed generally to analyze what the invasion of this new element would mean in the future of mankind.

What is now needed is a big, broad imagination to seize hold of this new thing and galvanize it into actual every-day use. There are many skeptics, of course, many who point out, for instance, that the element of cost is prohibitive. This is both fallacious in reasoning and untrue in fact. A modern two-seated airplane, even to-day, costs not over $5,000, or about the price of a good automobile. Very soon, with manufacturing costs standardized and the elements of newness worn off, this price will fall as sharply as it has already fallen during the war.

But what, after all, is cost in comparison with time? Modern civilization will pay dearly for any invention which will increase ever so little its hours of effectiveness. The great German liners before the war lavished money without stint to save a day or two in crossing the Atlantic. The limited express trains between New York, Boston, Washington, and Chicago have for years made money by carrying busy men a few hours more quickly to their destination. What will not be paid if these times of travel can be reduced practically to half?

The element of danger has been reduced

to a minimum and will be still more reduced as emphasis is laid on safety rather than war-time agility. Many men, of course, will meet their death in the air, just as in the early days many men met their death in ships and in railroad trains, but this will not be a deterrent if the goal is worth attaining. There will be accidents in learning to fly, there will be accidents of foolhardiness and of collision or in landing, but they will decrease to the vanishing-point as experience grows. Already the air routes which have been established have a high record of success and freedom from fatalities.

The great need of aviation to-day is faith—faith among the people, among the manufacturers, among the men who will give it its being. Its success is as inevitable as that day follows night, but the question of when that success is attained, now or generations from now, is dependent on the vision which men put into it. If they are apathetic and unreasonable, if they chafe at details or expect too much, it will be held back. If, on the other hand, they go to meet it with confidence, with coolness, and with a realization both of its difficulties and its potentialities, its success will be immediate.

The task is one of the greatest, the most vital, and the most promising which mankind has ever faced. With the general theories proved and demonstrated, the great crisis of invention has passed, and the slow, unspectacular process of development and application has set in. Now has come the time for serious, sober thought, for careful, analytical planning, for vision combined with hopefulness. It is well in these early days, when flight is with the general public a very special and occasional event, to remember what has happened since Watt developed the steam-engine only a few generations ago, when Columbus set the first ship westward, or when America's first train ran over its rough tracks near the Quincy quarries.

The development of aviation will be world-wide and will include all sorts and races of men. The nations all start pretty much abreast. Those which developed war air services have an advantage in material and experience, but this is a matter only for the moment. The main lines of progress are now pretty widely known and the field is wide open to those who have the imagination to enter it. There is practically no handicap at this early stage which cannot be overcome with ease.

There is, of course, an element of individual gamble to those who enter this competition. Undoubtedly there will be many failures, as in all new fields; failures come to those who put in capital as well as those who contribute their scientific knowledge. But by the same token there will be great successes both financially and scientifically. The prize that is being striven for is one of the richest that have ever been offered and the rewards will be in accordance. This has been the case at the birth of every great development in human progress and will undoubtedly be the case with the science of flight. Until a field becomes standardized it offers extremes on both sides rather than a dull, dreary, but safe average.

As aviation runs into every phase of activity it will require every kind of man—manufacturer, scientist, mechanic, and flier. It offers problems more interesting and more complex than almost any others in the world. The field is new and virgin, the demand world-wide, and the rewards great. For the flier there is all the joy of life in the air, above the chains of the earth, reaching out to new, unvisited regions, free to come and go for almost any distance at any level desired, a freedom unparalleled. For the manufacturer there is all the lure of a new product destined in a short time to be used as freely as the automobile of to-day; for the scientist there are problems of balance, meteorology, air pressure, engine power, wing spread, altitude effects, and the like in a bewildering variety; for the explorer, the geographer, the map-maker a wholly new field is laid open.

The best men of every type are needed to give aviation its full fruition. In Europe this is realized to a supreme degree. England especially, and also France and Italy, have put their best genius at work to fulfil the conquest of the air. Their progress is astonishing and should be a challenge to the New World. After the natural hiatus which followed the armistice the leading men have set to work with redoubled vigor to take first place in the air.

In twenty years' time our life of to-day will seem centuries old, just as to-day it is hard to realize that the automobile and motor-truck do not date back much over a generation. No change that has ever come in man's history will be so great as the change which takes him up off the ground and into the air. This swift and dazzling era that is so close upon us is hardly suspected by the great mass of people. The world will be both new and better for it. Less than the train or the motor-car will the airplane disturb its features. On the blue above white wings will glitter for a moment, a murmuring as of bees will be heard, and the traveler will be gone, the world unstained and pure. Meanwhile high in the clouds, perhaps lost to view of the earth, men will be speeding on at an unparalleled rate, guiding their course by the wireless which alone gives them connection with the world below.

Has there ever in all history been an appeal such as this?

ADDENDUM

A PAGE IN THE DICTIONARY FOR AVIATORS

WHAT is to become of all the new words, some of them with new meanings, the old words with new meanings, and the new words with old meanings, coined by the aviators of the American and British flying services in the war? Are they to die an early death from lack of nourishment and lack of use, or will they go forward, full-throated into the dictionary, where they may belong? Here are just a few of them, making a blushing début, so that it may be seen at once just how bad they are:

AEROBATICS—A newly coined word to describe aerial "stunting," which includes all forms of the sport of looping, spinning, and rolling. The term originated in the training schedule for pilots, and all pilots must take a course in aerobatics before being fully qualified.

AEROFOIL—Any plane surface of an airplane designed to obtain reaction on its surfaces from the air through which it moves. This includes all wing surface and most of the tail-plane surface.

AILERON—This is a movable plane, attached to the outer extremities of an airplane wing. The wing may be either raised or lowered by moving the ailerons. Raising the right wing, by depressing the right aileron, correspondingly lowers the left wing by raising the left aileron. They exercise lateral control of a machine.

BLIMP—A non-rigid dirigible balloon. The dirigible holds its shape due to the fact that its gas is pumped into the envelop to a pressure greater than the atmosphere. It can move through the air at forty miles an hour, but high speed will cause it to buckle in the nose.

BUMP—A rising or falling column of air which may be met while flying. A machine will be bumped up or bumped down on a bumpy day. A hot day over flat country, at noon, will generally be exceedingly bumpy.

CRASH—Any airplane accident. It may be a complete wreck or the plane may only be slightly injured by a careless landing. Crashes are often classified by the extent of damage. A class A crash, for instance, is a complete washout. A class D crash is an undercarriage and propeller broken.

DOPE—A varnish-like liquid applied to the linen or cotton wing fabrics. It is made chiefly of acetone, and shrinks the fabric around the wooden wing structure until it becomes as tight as a drum. The highly polished surface lessens friction of the plane through the air.

Drift—Head resistance encountered by the machine moving through the air. This must be overcome by the power of the engine. The term is also used in aerial navigation in its ordinary sense, and a machine flying a long stretch over water may drift off the course, due to winds of which the pilot has no knowledge.

Dud—A condition of being without life or energy. An engine may be dud; a day may be dud for flying. A shell which will not explode is a dud. A pilot may be a dud, without skill. It is almost a synonym for washout.

Flatten Out—To come out of a gliding angle into a horizontal glide a few feet from the ground before making a landing. The machine loses flying speed on a flat glide, and settles to the ground.

Flying Speed—Speed of a plane fast enough to create lift with its wing surfaces. This varies with the type of plane from forty-five miles an hour as a minimum to the faster scout machines which require seventy miles an hour to carry them through the air. When a machine loses flying speed, due to stalling, it is in a dangerous situation, and flying speed must be recovered by gliding, or the machine will fall into a spin and crash out of control.

Forced Landing—Any landing for reasons beyond the control of a pilot is known as a forced landing. Engine failure is chiefly responsible. Once the machine loses its power it must go into a glide to maintain its stability, and at the end of the glide it must land on water, trees, fields, or roofs of houses in towns.

FUSELAGE—This word, meaning the body of a machine, came over from the French. The cockpits, controls, and gasolene-tanks are usually carried in the fuselage.

HOP—Any flight in an airplane or seaplane is a hop. A hop may last five minutes or fifteen hours.

JOY-STICK—The control-stick of an airplane was invented by a man named Joyce, and for a while it was spoken of as the Joyce-stick, later being shortened to the present form. It operates the ailerons and elevators.

LANDFALL—A sight of land by a seaplane or dirigible which has been flying over an ocean course. An aviator who has been regulating his flight by instruments will check up his navigation on the first landfall.

PANCAKE—An extremely slow landing is known as a pancake landing. The machine almost comes to a stop about ten feet off the ground, and with the loss of her speed drops flat. There is little forward motion, and this kind of landing is used in coming down in plowed fields or standing grain. Julés Vedrines made his landing on the roof of the Galeries Lafayette in Paris by "pancaking."

Side-slip—The side movement of a plane as it goes forward. On an improperly made turn a machine may side-slip out—that is, in the direction of its previous motion, like skidding. It may side-slip in, toward the center of the turn, due to the fact that it is turned too steeply for the degree of the turn. Side-slipping on a straight glide is a convenient method of losing height before a landing.

Stall—A machine which has lost its flying speed has stalled. This does not mean that its engine has stopped, but in the flying sense of the word means that friction of the wing surfaces has overcome the power of the engine to drive the machine through the air. The only way out of a stall is to regain speed by nosing down. A machine which has lost its engine power will not stall if put into a glide, and it may be brought to a safe landing with care.

Strut—The upright braces between the upper and lower wings of a machine are called struts. They take the compression of the truss frame of the biplane or triplane. Each wing is divided into truss sections with struts.

S-turn—A gliding turn, made without the use of engine power. A machine forced to seek a landing will do a number of S-turns to maneuver itself into a good field.

Tail Spin—This is the most dreaded of all airplane accidents, and the most likely to be fatal. A machine out of control, due often to stalling and falling through the air, spins slowly as it drops nose first toward the ground. This is caused by the locking of the rudder and elevator into a spin-pocket on the tail, which is off center, and which receives the rush of air. The air passing through it gives it a twisting motion, and the machine makes about one complete turn in two or three hundred feet of fall, depending upon how tight the spin may be. The British speak of the spin as the spinning nose dive.

Take-off—This is the start of the machine in its flight. After a short run over the ground the speed of the machine will create enough lift so that the plane leaves the ground.

Taxi—To move an airplane or seaplane on land or water under its own power when picking out a starting-place, or coming in after a landing. This is not to be confused with the run for a start when the plane is getting up speed to fly, using all her power. The NC-4 "taxied" a hundred miles to Chatham after a forced landing, and the NC-3 came in two hundred and five miles to Ponta Delgada after she landed at sea.

Vertical Bank—In this position the machine is making a turn with one wing pointing directly to the ground, and its lateral axis has become vertical. The machine turns very quickly in a short space of air, and the maneuver is sometimes spoken of as a splitting vertical bank. In a vertical bank the elevators of a machine act as the rudder and the rudder as an elevator. The controls are reversed.

WASHOUT—Means anything which *was* but is not now—anything useless, anything that has lost its usefulness, anything that never was useful. Flying may be washed out; that is, stopped; a day may be a washout, a vacation; a machine may be a washout, wrecked beyond repair; a pilot may be a washout, useless as a pilot. It has a variety of meanings, and each one is obvious in its connection. The term became familiar to American fliers with the Royal Air Force.

ZOOM—To gain supernormal flying speed and then pull the machine up into the air at high speed. The rush of wind will zo-o-om in the ears of the pilot. It is a sport in the country to zoom on farmers, on houses and barns, nosing directly for the object on the ground and pulling up just in time to clear it with the undercarriage.

THE END