WILLIS ABBOT

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Aircraft and Submarines The Story of the Invention, Development, and Present-Day Uses of War's Newest Weapons:

Содержание

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PREFACE

Not since gunpowder was first employed in warfare has so revolutionary a contribution to the science of slaughtering men been made as by the perfection of aircraft and submarines. The former have had their first employment in this world-wide war of the nations. The latter, though in the experimental stage as far back as the American Revolution, have in this bitter contest been for the first time brought to so practical a stage of development as to exert a really appreciable influence on the outcome of the struggle.

Comparatively few people appreciate how the thought of navigating the air's dizziest heights and the sea's gloomiest depths

has obsessed the minds of inventors. From the earliest days of history men have grappled with the problem, yet it is only within two hundred years for aircraft and one hundred for submarines that any really intelligent start has been made upon its solution. The men who really gave practical effect to the vague theories which others set up – in aircraft the Wrights, Santos-Dumont, and Count Zeppelin; in submarines Lake and Holland – are either still living, or have died so recently that their memory is still fresh in the minds of all.

In this book the author has sketched swiftly the slow stages by which in each of these fields of activity success has been attained. He has collated from the immense mass of records of the activities of both submarines and aircraft enough interesting data to show the degree of perfection and practicability to which both have been brought. And he has outlined so far as possible from existing conditions the possibilities of future usefulness in fields other than those of war of these new devices.

The most serious difficulty encountered in dealing with the present state and future development of aircraft is the rapidity with which that development proceeds. Before a Congressional Committee last January an official testified that grave delay in the manufacture of airplanes for the army had been caused by the fact that types adopted a scant three months before had become obsolete, because of experience on the European battlefields, and later inventions before the first machines could be completed. There may be exaggeration in the statement but it is largely true.

Neither the machines nor the tactics employed at the beginning of the war were in use in its fourth year. The course of this evolution, with its reasons, are described in this volume.

Opportunities for the peaceful use of airplanes are beginning to suggest themselves daily. After the main body of this book was in type the Postmaster-General of the United States called for bids for an aërial mail service between New York and Washington – an act urged upon the Government in this volume. That service contemplates a swift carriage of first-class mail at an enhanced price – the tentative schedule being three hours, and a postage fee of twenty-five cents an ounce. There can be no doubt of the success of the service, its value to the public, and its possibilities of revenue to the post-office. Once its usefulness is established it will be extended to routes of similar length, such as New York and Boston, New York and Buffalo, or New York and Pittsburgh. The mind suggests no limit to the extension of aërial service, both postal and passenger, in the years of industrial activity that shall follow the war.

In the preparation of this book the author has made use of many records of personal experiences of those who have dared the air's high altitudes and the sea's stilly depths. For permission to use certain of these he wishes to express his thanks to the Century Co., for extracts from *My Airships* by Santos-Dumont; to Doubleday, Page & Co., for extracts from *Flying for France*, by James R. McConnell; to Charles Scribner's Sons, for material drawn from *With the French Flying Corps*, by Carroll Dana

Winslow; to *Collier's Weekly*, for certain extracts from interviews with Wilbur Wright; to *McClure's Magazine*, for the account of Mr. Ray Stannard Baker's trip in a Lake submarine; to Hearst's International Library, and to the *Scientific American*, for the use of several illustrations.

W. J. A.
New York, 1918.

THE CONQUEST OF THE AIR

CHAPTER I
INTRODUCTORY

It was at Mons in the third week of the Great War. The grey-green German hordes had overwhelmed the greater part of Belgium and were sweeping down into France whose people and military establishment were all unprepared for attack from that quarter. For days the little British army of perhaps 100,000 men, that forlorn hope which the Germans scornfully called "contemptible," but which man for man probably numbered more veteran fighters than any similar unit on either side, had been stoutly holding back the enemy's right wing and fighting for the delay that alone could save Paris. At Mons they had halted, hoping that here was the spot to administer to von Kluck, beating upon their front, the final check. The hope was futile. Looking back upon the day with knowledge of what General French's army faced – a knowledge largely denied to him – it seems that the British escape from annihilation was miraculous. And indeed it was due to a modern miracle – the conquest of the air by man in the development of the airplane.

General French was outnumbered and in danger of being

flanked on his left flank. His right he thought safe, for it was in contact with the French line which extended eastward along the bank of the Somme to where the dark fortress of Namur frowned on the steeps formed by the junction of that river with the Meuse. At that point the French line bent to the south following the course of the latter river.

Namur was expected to hold out for weeks. Its defence lasted but three days! As a matter of fact it did not delay the oncoming Germans a day, for they invested it and drove past in their fierce assault upon Joffre's lines. Enormously outnumbered, the French were broken and forced to retreat. They left General French's right flank in the air, exposed to envelopment by von Kluck who was already reaching around the left flank. The German troops were ample in number to surround the British, cut them off from all support, and crush or capture them all. This indeed they were preparing to do while General French, owing to some mischance never yet explained, was holding his ground utterly without knowledge that his allies had already retired leaving his flank without protection.

When that fatal information arrived belatedly at the British headquarters it seemed like a death warrant. The right of the line had already been exposed for more than half-a-day. It was inexplicable that it had not already been attacked. It was unbelievable that the attack would not fall the next moment. But how would it be delivered and where, and what force would the enemy bring to it? Was von Kluck lulling the British into a

false sense of security by leaving the exposed flank unmenaced while he gained their rear and cut off their retreat? Questions such as these demanded immediate answer. Ten years before the most dashing scouts would have clattered off to the front and would have required a day, perhaps more, to complete the necessary reconnaissance. But though of all nations, except of course the utterly negligent United States, Great Britain had least developed her aviation corps, there were attached to General French's headquarters enough airmen to meet this need. In a few minutes after the disquieting news arrived the beat of the propellers rose above the din of the battlefield and the airplanes appeared above the enemy's lines. An hour or two sufficed to gather the necessary facts, the fliers returned to headquarters, and immediately the retreat was begun.

It was a beaten army that plodded back to the line of the Marne. Its retreat at times narrowly approached a rout. But the army was not crushed, annihilated. It remained a coherent, serviceable part of the allied line in the successful action speedily fought along the Marne. But had it not been for the presence of the airmen the British expeditionary force would have been wiped out then and there.

The battle of Mons gave the soldiers a legend which still persists – that of the ghostly English bowmen of the time of Edward the Black Prince who came back from their graves to save that field for England and for France. Thousands of simple souls believe that legend to-day. But it is no whit more

unbelievable than the story of an army saved by a handful of men flying thousands of feet above the field would have been had it been told of a battle in our Civil War. The world has believed in ghosts for centuries and the Archers of Mons are the legitimate successors of the Great Twin Brethren at the Battle of Lake Regillus. But Cæsar, Napoleon, perhaps the elder von Moltke himself would have scoffed at the idea that men could turn themselves into birds to spy out the enemy's dispositions and save a sorely menaced army.

When this war has passed into history it will be recognized that its greatest contributions to military science have been the development and the use of aircraft and submarines. There have, of course, been other features in the method of waging war which have been novel either in themselves, or in the gigantic scale upon which they have been employed. There is, for example, nothing new about trench warfare. The American who desires to satisfy himself about that need only to visit the Military Park at Vicksburg, or the country about Petersburg or Richmond, to recognize that even fifty years ago our soldiers understood the art of sheltering themselves from bullet and shrapnel in the bosom of Mother Earth. The trench warfare in Flanders, the Argonne, and around Verdun has been novel only in the degree to which it has been developed and perfected. Concrete-lined trenches, with spacious and well-furnished bomb-proofs, with phonographs, printing presses, and occasional dramatic performances for lightening the soldiers' lot present an impressive elaboration of

the muddy ditches of Virginia and Mississippi. Yet after all the boys of Grant and Lee had the essentials of trench warfare well in mind half a century before Germany, France, and England came to grips on the long line from the North Sea to the Vosges.

Asphyxiating gas, whether liberated from a shell, or released along a trench front to roll slowly down before a wind upon its defenders, was a novelty of this war. But in some degree it was merely a development of the "stinkpot" which the Chinese have employed for years. So too the tear-bomb, or lachrymatory bomb, which painfully irritated the eyes of all in its neighbourhood when it burst, filling them with tears and making the soldiers practically helpless in the presence of a swift attack. These two weapons of offence, and particularly the first, because of the frightful and long-continuing agony it inflicts upon its victims, fascinated the observer, and awakened the bitter protests of those who held that an issue at war might be determined by civilized nations without recourse to engines of death and anguish more barbaric than any known to the red Indians, or the most savage tribes of Asia. Neither of these devices, nor for that matter the cognate one of fire spurted like a liquid from a hose upon a shrinking enemy, can be shown to have had any appreciable effect upon the fortunes of any great battle. Each, as soon as employed by any one belligerent, was quickly seized by the adversary, and the respiratory mask followed fast upon the appearance of the chlorine gas. Whatever the outcome of the gigantic conflict may be, no one will claim that any of these

devices had contributed greatly to the result.

But the airplane revolutionized warfare on land. The submarine has made an almost equal revolution in naval warfare.

Had the airplane been known in the days of our Civil War some of its most picturesque figures would have never risen to eminence or at least would have had to win their places in history by efforts of an entirely different sort. There is no place left in modern military tactics for the dashing cavalry scout of the type of Sheridan, Custer, Fitz Lee, or Forrest. The airplane, soaring high above the lines of the enemy, brings back to headquarters in a few hours information that in the old times took a detachment of cavalry days to gather. The "screen of cavalry" that in bygone campaigns commanders used to mask their movements no longer screens nor masks. A general moves with perfect knowledge that his enemy's aircraft will report to their headquarters his roads, his strength, and his probable destination as soon as his vanguard is off. During the Federal advance upon Richmond, Stonewall Jackson, most brilliant of the generals of that war, repeatedly slipped away from the Federal front, away from the spot where the Federal commanders confidently supposed him to be, and was found days later in the Valley of the Shenandoah, threatening Washington or menacing the Union rear and its communications. The war was definitely prolonged by this Confederate dash and elusiveness – none of which would have been possible had the Union forces possessed an aviation corps.

It is yet to be shown conclusively that as offensive engines

aircraft have any great value. The tendency of the military authorities of every side to minimize the damage they have suffered makes any positive conclusion on this subject difficult and dangerous at this moment. The airplane by day or the Zeppelin by night appears swiftly and mysteriously, drops its bombs from a height of several thousand feet, and takes its certain flight through the boundless sky to safety. The aggressor cannot tell whether his bombs have found a fitting target. He reports flaming buildings left behind him, but whether they are munition factories, theatres, or primary schools filled with little children he cannot tell. Nor does he know how quickly the flames were extinguished, or the amount of damage done. The British boast of successful air raids upon Cuxhaven, Zeebrugge, Essen, and Friedrichshaven. But if we take German official reports we must be convinced that the damage done was negligible in its relation to the progress of the war. In their turn the Germans brag mightily of the deeds of their Zeppelins over London, and smaller British towns. But the sum and substance of their accomplishment, according to the British reports, has been the slaughter and mutilation of a number of civilians – mostly women and children – and the bloody destruction of many humble working-class homes.

At this writing, December, 1917, it is not recorded that any battleship, munition factory, any headquarters, great government building, or fortress has been destroyed or seriously injured by the activities of aircraft of either type. This lack of precise

information may be due to the censor rather than to any lack of great deeds on the part of airmen. We do know of successful attacks on submarines, though the military authorities are chary about giving out the facts. But as scouts, messengers, and guides for hidden batteries attacking unseen targets, aviators have compelled the rewriting of the rules of military strategy. About this time, however, it became apparent that the belligerents intended to develop the battleplanes. Particularly was this true of the Allies. The great measure of success won by the German submarines and the apparent impossibility of coping adequately with those weapons of death once they had reached the open sea, led the British and the Americans to consider the possibility of destroying them in their bases and destroying the bases as well. But Kiel and Wilhelmshaven were too heavily defended to make an attack by sea seem at all practicable. The lesser ports of Zeebrugge and Ostend had been successfully raided from the air and made practically useless as submarine bases. Discussion therefore was strong of making like raids with heavier machines carrying heavier guns and dropping more destructive bombs upon the two chief lurking places of the submarines. While no conclusion had been reached as to this strategy at the time of the publication of this book, both nations were busy building larger aircraft probably for use in such an attack.

The submarine has exerted upon the progress of the war an influence even more dominant than that of aircraft. It has been a positive force both offensive and defensive. It has

been Germany's only potent weapon for bringing home to the British the privations and want which war entails upon a civilian population, and at the same time guarding the German people from the fullest result of the British blockade. It is no overstatement to declare that but for the German submarines the war would have ended in the victory of the Allies in 1916.

We may hark back to our own Civil War for an illustration of the crushing power of a superior navy not qualified by any serviceable weapon in the hands of the weaker power.

Historians have very generally failed to ascribe to the Federal blockade of Confederate ports its proportionate influence on the outcome of that war. The Confederates had no navy. Their few naval vessels were mere commerce destroyers, fleeing the ships of the United States navy and preying upon unarmed merchantmen. With what was rapidly developed into the most powerful navy the world had ever seen, the United States Government from the very beginning of the war locked the Confederate States in a wall of iron. None might pass going in or out, except by stealth and at the peril of property and life. Outside the harbour of every seaport in the control of the Confederates the blockading men-of-war lurked awaiting the blockade runners. Their vigilance was often eluded, of course, yet nevertheless the number of cargoes that slipped through was painfully inadequate to meet the needs of the fenced-in States. Clothing, medicines, articles of necessary household use were denied to civilians. Cannon, rifles, saltpetre, and other munitions

of war were withheld from the Confederate armies. While the ports of the North were bustling with foreign trade, grass grew on the cobble-stoned streets along the waterfronts of Charleston and Savannah. Slow starvation aided the constant pounding of the Northern armies in reducing the South to subjection.

Had the Confederacy possessed but a few submarines of modern type this situation could not have persisted. Then, as today, neutral nations were eager to trade with both belligerents. There were then more neutrals whose interests would have compelled the observance of the laws of blockade, which in the present war are flagrantly violated by all belligerents with impunity. A submarine raid which would have sunk or driven away the blockading fleet at the entrance to a single harbour would have resulted in opening that harbour to the unrestricted uses of neutral ships until the blockade could be re-established and formal notice given to all powers – a formality which in those days, prior to the existence of cables, would have entailed weeks, perhaps months, of delay.

How serious such an interruption to the blockade was then considered was shown by the trepidation of the Union naval authorities over the first victories of the *Merrimac* prior to the providential arrival of the *Monitor* in Hampton Roads. It was then thought that the Confederate ram would go straight to Wilmington, Charleston, and Savannah, destroy or drive away the blockaders, and open the Confederacy to the trade of the world.

Even then men dreamed of submarines, as indeed they have since the days of the American Revolution. Of the slow development of that engine of war to its present effectiveness we shall speak more fully in later chapters. Enough now to say that had the Confederacy possessed boats of the U-53 type the story of our Civil War might have had a different ending. The device which the Allies have adopted to-day of blockading a port or ports by posting their ships several hundred miles away would have found no toleration among neutrals none too friendly to the United States, and vastly stronger in proportion to the power of this nation than all the neutrals to-day are to the strength of the Allies.

From the beginning of the Great War in Europe the fleets of the Teutonic alliance were locked up in port by the superior floating forces of the Entente. Such sporadic dashes into the arena of conflict as the one made by the German High Fleet, bringing on the Battle of Jutland, had but little bearing on the progress of the war. But the steady, persistent malignant activity of the German submarines had everything to do with it. They mitigated the rigidity of the British blockade by keeping the blockaders far from the ports they sought to seal. They preyed on the British fleets by sinking dreadnoughts, battleships, and cruisers in nearly all of the belligerent seas. If the British navy justified its costly power by keeping the German fleet practically imprisoned in its fortified harbours, the German submarines no less won credit and glory by keeping even that overwhelming

naval force restricted in its movements, ever on guard, ever in a certain sense on the defensive. And meanwhile these underwater craft so preyed upon British foodships that in the days of the greatest submarine activity England was reduced to husbanding her stores of food with almost as great thrift and by precisely the same methods as did Germany suffering from the British blockade.

Aircraft and submarines! Twin terrors of the world's greatest war! The development, though by no means the final development, of dreams that men of many nations have dreamed throughout the centuries! They are two of the outstanding features of the war; two of its legacies to mankind. How much the legacy may be worth in peaceful times is yet to be determined. The airplane and the dirigible at any rate seem already to promise useful service to peaceful man. Already the flier is almost as common a spectacle in certain sections of our country as the automobile was fifteen years ago. The submarine, for economic reasons, promises less for the future in the way of peaceful service, notwithstanding the exploits of the *Deutschland* in the ocean-carrying trade. But perhaps it too will find its place in industry when awakened man shall be willing to spend as much treasure, as much genius, as much intelligent effort, and as much heroic self-sacrifice in organizing for the social good as in the last four years he has expended in its destruction.

CHAPTER II
THE EARLIEST FLYING MEN

The conquest of the air has been the dream of mankind for uncounted centuries. As far back as we have historic records we find stories of the attempts of men to fly. The earliest Greek mythology is full of aeronautical legends, and the disaster which befell Icarus and his wings of wax when exposed to the glare of the midsummer sun in Greece, is part of the schoolboy's task in Ovid. We find like traditions in the legendary lore of the Peruvians, the East Indians, the Babylonians, even the savage races of darkest Africa. In the Hebrew scriptures the chief badge of sanctity conferred on God's angels was wings, and the ability to fly. If we come down to the mythology of more recent times we find our pious ancestors in New England thoroughly convinced that the witches they flogged and hanged were perfectly able to navigate the air on a broomstick – thus antedating the Wrights' experiments with heavier-than-air machines by more than 250 years.

It is an interesting fact, stimulating to philosophical reflection, that in the last decade more has been done toward the conquest of the air, than in the twenty centuries preceding it, though during all that period men had been dreaming, planning, and experimenting upon contrivances for flight. Moreover when success came – or such measure of success as has been won –

it came by the application of an entirely novel principle hardly dreamed of before the nineteenth century.

Some of the earlier efforts to master gravity and navigate the air are worthy of brief mention if only to show how persistent were the efforts from the earliest historic ages to accomplish this end. Passing over the legends of the time of mythology we find that many-sided genius, Leonardo da Vinci, early in the sixteenth century, not content with being a painter, architect, sculptor, engineer and designer of forts, offering drawings and specifications of wings which, fitted to men, he thought would enable them to fly. The sketches are still preserved in a museum at Paris. He modelled his wings on those of a bat and worked them with ropes passing over pulleys, the aviator lying prone, face downward, and kicking with both arms and legs with the vigour of a frog. There is, unhappily, no record that the proposition ever advanced beyond the literary stage – certainly none that Da Vinci himself thus risked his life. History records no one who kicked his way aloft with the Da Vinci device. But the manuscript which the projector left shows that he recognized the modern aviator's maxim, "There's safety in altitude." He says, in somewhat confused diction:

> The bird should with the aid of the wind raise itself to a great height, and this will be its safety; because although the revolutions mentioned may happen there is time for it to recover its equilibrium, provided its various parts are capable of strong resistance so that they may safely

withstand the fury and impetus of the descent.

The fallacy that a man could, by the rapid flapping of wings of any sort, overcome the force of gravity persisted up to a very recent day, despite the complete mathematical demonstration by von Helmholtz in 1878 that man could not possibly by his own muscular exertions raise his own weight into the air and keep it suspended. Time after time the "flapping wings" were resorted to by ambitious aviators with results akin to those attained by Darius Green. One of the earliest was a French locksmith named Besnier, who had four collapsible planes on two rods balanced across his shoulders. These he vigorously moved up and down with his hands and feet, the planes opening like covers of a book as they came down, and closing as they came up. Besnier made no attempt to raise himself from the ground, but believed that once launched in the air from an elevation he could maintain himself, and glide gradually to earth at a considerable distance. It is said that he and one or two of his students did in a way accomplish this. Others, however, experimenting with the same method came to sorry disaster. Among these was an Italian friar whom King James IV. of Scotland had made Prior of Tongland. Equipped with a pair of large feather wings operated on the Besnier principle, he launched himself from the battlements of Stirling Castle in the presence of King James and his court. But gravity was too much for his apparatus, and turning over and over in mid-air he finally landed ingloriously on a manure heap – at that period of nascent culture a very common feature of

the pleasure grounds of a palace. He had a soul above his fate however, for he ascribed his fall not to vulgar mechanical causes, but wholly to the fact that he had overlooked the proper dignity of flight by pluming his wings with the feathers of common barn-yard fowl instead of with plumes plucked from the wings of eagles!

In sharp competition with the aspiring souls who sought to fly with wings – the forerunners of the airplane devotees of to-day – were those who tried to find some direct lifting device for a car which should contain the aviators. Some of their ideas were curiously logical and at the same time comic. There was, for example, a priest, Le Père Galien of Avignon. He observed that the rarified air at the summit of the Alps was vastly lighter than that in the valleys below. What then was to hinder carrying up empty sacks of cotton or oiled silk to the mountain tops, opening them to the lighter air of the upper ranges, and sealing them hermetically when filled by it. When brought down into the valleys they would have lifting power enough to carry tons up to the summits again. The good Father's education in physics was not sufficiently advanced to warn him that the effort to drag the balloons down into the valley would exact precisely the force they would exert in lifting any load out of the valley – if indeed they possessed any lifting power whatsoever, which is exceedingly doubtful.

Another project, which sounded logical enough, was based on the irrefutable truth that as air has some weight – to be exact

14.70 pounds for a column one inch square and the height of the earth's atmosphere – a vacuum must be lighter, as it contains nothing, not even air. Accordingly in the seventeenth century, one Francisco Lana, another priest, proposed to build an airship supported by four globes of copper, very thin and light, from which all the air had been pumped. The globes were to be twenty feet in diameter, and were estimated to have a lifting force of 2650 pounds. The weight of the copper shells was put at 1030 pounds, leaving a margin of possible weight for the car and its contents of 1620 pounds. It seemed at first glance a perfectly reasonable and logical plan. Unhappily one factor in the problem had been ignored. The atmospheric pressure on each of the globes would be about 1800 tons. Something more than a thin copper shell would be needed to resist this crushing force and an adequate increase in the strength of the shells would so enhance their weight as to destroy their lifting power.

To tell at length the stories of attempt and failure of the earliest dabblers in aeronautics would be unprofitable and uninteresting. Not until the eighteenth century did the experimenters with lighter-than-air devices show any practical results. Not until the twentieth century did the advocates of the heavier-than-air machines show the value of their fundamental idea. The former had to discover a gaseous substance actually lighter, and much lighter, than the surrounding atmosphere before they could make headway. The latter were compelled to abandon wholly the effort to imitate the flapping of a bird's wings, and study rather the

method by which the bird adjusts the surface of its wings to the wind and soars without apparent effort, before they could show the world any promising results.

Nearly every step forward in applied science is accomplished because of the observation by some thoughtful mind of some common phenomenon of nature, and the later application of those observations to some useful purpose.

It seems a far cry from an ancient Greek philosopher reposing peacefully in his bath to a modern Zeppelin, but the connection is direct. Every schoolboy knows the story of the sudden dash of Archimedes, stark and dripping from his tub, with the triumphant cry of "Eureka!" – "I have found it!" What he had found was the rule which governed the partial flotation of his body in water. Most of us observe it, but the philosophical mind alone inquired "Why?" Archimedes' answer was this rule which has become a fundamental of physics: "A body plunged into a fluid is subjected by this fluid to a pressure from below to above equal to the weight of the fluid displaced by the body." A balloon is plunged in the air – a fluid. If it is filled with air there is no upward pressure from below, but if it is filled with a gas lighter than air there is a pressure upward equal to the difference between the weight of that gas and that of an equal quantity of air. Upon that fact rests the whole theory and practice of ballooning.

The illustration of James Watt watching the steam rattle the cover of a teapot and from it getting the rudimentary idea of the steam engine is another case in point. Sometimes however

the application of the hints of nature to the needs of man is rather ludicrously indirect. Charles Lamb gravely averred that because an early Chinaman discovered that the flesh of a pet pig, accidentally roasted in the destruction by fire of his owner's house, proved delicious to the palate, the Chinese for years made a practice of burning down their houses to get roast pig with "crackling." Early experimenters in aviation observed that birds flapped their wings and flew. Accordingly they believed that man to fly must have wings and flap them likewise. Not for hundreds of years did they observe that most birds flapped their wings only to get headway, or altitude, thereafter soaring to great heights and distances merely by adjusting the angle of their wings to the various currents of air they encountered.

In a similar way the earliest experimenters with balloons observed that smoke always ascended. "Let us fill a light envelope with smoke," said they, "and it will rise into the air bearing a burden with it." All of which was true enough, and some of the first balloonists cast upon their fires substances like sulphur and pitch in order to produce a thicker smoke, which they believed had greater lifting power than ordinary hot air.

In the race for actual accomplishment the balloonists, the advocates of lighter-than-air machines, took the lead at first. It is customary and reasonable to discard as fanciful the various devices and theories put forward by the experimenters in the Middle Ages and fix the beginning of practical aeronautical devices with the invention of hot-air balloons by the

Montgolfiers, of Paris, in 1783.

The Montgolfier brothers, Joseph and Jacques, were paper-makers of Paris. The family had long been famous for its development of the paper trade, and the many ingenious uses to which they put its staple. Just as the tanners of the fabled town in the Middle Ages thought there was "nothing like leather" with which to build its walls and gates, thereby giving a useful phrase to literature, so the Montgolfiers thought of everything in terms of paper. Sitting by their big open fireplace one night, so runs the story, they noticed the smoke rushing up the chimney. "Why not fill a big paper bag with smoke and make it lift objects into the air?" cried one. The experiment was tried next day with a small bag and proved a complete success. A neighbouring housewife looked in, and saw the bag bumping about the ceiling, but rapidly losing its buoyancy as the smoke escaped.

"Why not fasten a pan below the mouth of the bag," said she, "and put your fire in that? Its weight will keep the bag upright, and when it rises will carry the smoke and the pan up with it."

Acting upon the hint the brothers fixed up a small bag which sailed up into the air beyond recapture. After various experiments a bag of mixed paper and linen thirty-five feet in diameter was inflated and released. It soared to a height of six thousand feet, and drifted before the wind a mile or more before descending. The ascent took place at Avonay, the home at the time of the Montgolfiers, and as every sort of publicity was given in advance, a huge assemblage including many officials of high

estate gathered to witness it. A roaring fire was built in a pit over the mouth of which eight men held the great sack, which rolled, and beat about before the wind as it filled and took the form of a huge ball. The crowd was unbelieving and cynical, inclined to scoff at the idea that mere smoke would carry so huge a construction up into the sky. But when the signal was given to cast off, the balloon rose with a swiftness and majesty that at first struck the crowd dumb, then moved it to cheers of amazement and admiration. It went up six thousand feet and the Montgolfiers were at once elevated to almost an equal height of fame. The crowd which watched the experiment was wild with enthusiasm; the Montgolfiers elated with the first considerable victory over the force of gravity. They had demonstrated a principle and made their names immortal. What remained was to develop that principle and apply it to practical ends. That development, however, proceeded for something more than a century before anything like a practical airship was constructed.

But for the moment the attack on the forces which had kept the air virgin territory to man was not allowed to lag. In Paris public subscriptions were opened to defray the cost of a new and greater balloon. By this time it was known that hydrogen gas, or "inflammable air" as it was then called, was lighter than air. But its manufacture was then expensive and public aid was needed for the new experiment which would call at the outset for a thousand pounds of iron filings and 498 pounds of sulphuric acid wherewith to manufacture the gas.

The first experiment had been made in the provinces. This one was set for Paris, and in an era when the French capital was intellectually more alert, more eager for novelty, more interested in the advancement of physical science and in new inventions than ever in its long history of hospitality to the new idea. They began to fill the bag August 23, 1783 in the *Place des Victoires*, but the populace so thronged that square that two days later it was moved half filled to Paris's most historic point, the *Champ de Mars*. The transfer was made at midnight through the narrow dark streets of mediæval Paris. Eyewitnesses have left descriptions of the scene. Torch-bearers lighted on its way the cortège the central feature of which was the great bag, half filled with gas, flabby, shapeless, monstrous, mysterious, borne along by men clutching at its formless bulk. The state had recognized the importance of the new device and cuirassiers in glittering breastplates on horseback, and halbardiers in buff leather on foot guarded it in its transit through the sleeping city. But Paris was not all asleep. An escort of the sensation-loving rabble kept pace with the guards. The cries of the quarters rose above the tramp of the armed men. Observers have recorded that the passing cab drivers were so affected by wonder that they clambered down from their boxes and with doffed hats knelt in the highway while the procession passed.

The ascension, which occurred two days later, was another moving spectacle. In the centre of the great square which has seen so many historic pageants, rose the swaying, quivering

balloon, now filled to its full capacity of twenty-two thousand feet. Whether from the art instinct indigenous to the French, or some superstitious idea like that which impels the Chinese to paint eyes on their junks, the balloon was lavishly decorated in water colours, with views of rising suns, whirling planets, and other solar bodies amongst which it was expected to mingle.

Ranks of soldiers kept the populace at a distance, while within the sacred precincts strolled the King and the ladies and cavaliers of his court treading all unconsciously on the brink of that red terror soon to engulf the monarchy. The gas in the reeling bag was no more inflammable than the air of Paris in those days just before the Revolution. With a salvo of cannon the guy-ropes were released and the balloon vanished in the clouds.

Benjamin Franklin, at the moment representing in France the American colonies then struggling for liberty, witnessed this ascension! "Of what use is a new-born child?" he remarked sententiously as the balloon vanished. 'Twas a saying worthy of a cautious philosopher. Had Franklin been in Paris in 1914 he would have found the child, grown to lusty manhood, a strong factor in the city's defence. It is worth noting by the way that so alert was the American mind at that period that when the news of the Montgolfiers' achievement reached Philadelphia it found David Rittenhouse and other members of the Philosophical Society already experimenting with balloons.

A curious sequel attended the descent of the Montgolfier craft which took place in a field fifteen miles from Paris. Long before

the days of newspapers, the peasants had never heard of balloons, and this mysterious object, dropping from high heaven into their peaceful carrot patch affrighted them. Some fled. Others approached timidly, armed with the normal bucolic weapons – scythes and pitchforks. Attacked with these the fainting monster, which many took for a dragon, responded with loud hisses and emitted a gas of unfamiliar but most pestiferous odour. It suggested brimstone, which to the devout in turn implied the presence of Satan. With guns, flails, and all obtainable weapons they fell upon the emissary of the Evil One, beat him to the ground, crushed out of him the vile-smelling breath of his nostrils, and finally hitched horses to him and dragged him about the fields until torn to tatters and shreds.

When the public-spirited M. Charles who had contributed largely to the cost of this experiment came in a day or two to seek his balloon he found nothing but some shreds of cloth, and some lively legends of the prowess of the peasants in demolishing the devil's own dragon.

The government, far-sightedly, recognizing that there would be more balloons and useful ones, thereupon issued this proclamation for the discouragement of such bucolic valour:

> A discovery has been made which the government deems it wise to make known so that alarm may not be occasioned to the people. On calculating the different weights of inflammable and common air it has been found that a balloon filled with inflammable air will rise toward heaven

> until it is in equilibrium with the surrounding air; which may not happen till it has attained to a great height. Anyone who should see such a globe, resembling the moon in an eclipse, should be aware that far from being an alarming phenomenon it is only a machine made of taffetas, or light canvas covered with paper, that cannot possibly cause any harm and which will some day prove serviceable to the wants of society.

Came now the next great step in the progress of aeronautics. It had been demonstrated that balloons could lift themselves. They had even been made to lift dumb animals and restore them to earth unhurt. But if the conquest of the air was to amount to anything, men must go aloft in these new machines. Lives must be risked to demonstrate a theory, or to justify a calculation. Aeronautics is no science for laboratory or library prosecution. Its battles must be fought in the sky, and its devotees must be willing to offer their lives to the cause. In that respect the science of aviation has been different from almost any subject of inquiry that has ever engaged the restless intellect of man, unless perhaps submarine navigation, or the invention of explosives. It cannot be prosecuted except with a perfect willingness to risk life. No doubt this is one of the reasons why practical results seemed so long in the coming. Nor have men been niggardly in this enforced sacrifice. Though no records of assured accuracy are available, the names of forty-eight aeronauts who gave up their lives in the century following the Montgolfiers' invention are recorded. That record ended in 1890. How many have since perished,

particularly on the battlefields of Europe where aircraft are as commonplace as cannon, it is too early yet to estimate.

After the success of the ascension from the *Champ de Mars*, the demand at once arose for an ascension by a human being. It was a case of calling for volunteers. The experiments already made showed clearly enough that the balloon would rise high in air. Who would risk his life soaring one thousand feet or more above the earth, in a flimsy bag, filled with hot air, or inflammable gas, without means of directing its course or bringing it with certainty and safety back to a landing place? It was a hard question, and it is interesting to note that it was answered not by a soldier or sailor, not by an adventurer, or devil-may-care spirit, but by a grave and learned professor of physical science, Pilatre de Rozier. Presently he was joined in his enterprise by a young man of the fashionable world and sporting tastes, the Marquis d'Arlandes. Aristocratic Paris took up aviation in the last days of the eighteenth century, precisely as the American leisure class is taking it up in the first days of the twentieth.

The balloon for this adventure was bigger than its predecessors and for the first time a departure was taken from the spherical variety – the gas bag being seventy-four feet high, and forty-eight feet in diameter. Like the first Montgolfier balloons it was to be inflated with hot air, and the car was well packed with bundles of fuel with which the two aeronauts were to fill the iron brazier when its fires went down. The instinct for art and decoration,

so strong in the French mind, had been given full play by the constructors of this balloon and it was painted with something of the gorgeousness of a circus poster.

A tremendous crowd packed the park near Paris whence the ascent was made. Always the spectacle of human lives in danger has a morbid attraction for curiosity seekers, and we have seen in our own days throngs attracted to aviation congresses quite as much in the expectation of witnessing some fatal disaster, as to observe the progress made in man's latest conquest over nature. But in this instance the occasion justified the widest interest. It was an historic moment – more epoch-making than those who gathered in that field in the environs of Paris could have possibly imagined. For in the clumsy, gaudy bag, rolling and tossing above a smoky fire lay the fundamentals of those great airships that, perfected by the persistence of Count Zeppelin, have crossed angry seas, breasted fierce winds, defied alike the blackest nights and the thickest fogs to rain their messages of death on the capital of a foe.

Contemporary accounts of this first ascension are but few, and those that have survived have come down to us in but fragmentary form. It was thought needful for two to make the ascent, for the car, or basket, which held the fire hung below the open mouth of the bag, and the weight of a man on one side would disturb the perfect equilibrium which it was believed would be essential to a successful flight. The Marquis d'Arlandes in a published account of the brief flight, which sounds rather as

if the two explorers of an unknown element were not free from nervousness, writes:

"Our departure was at fifty-four minutes past one, and occasioned little stir among the spectators. Thinking they might be frightened and stand in need of encouragement I waved my arm."

This solicitude for the fears of the spectators, standing safely on solid earth while the first aeronauts sailed skywards, is characteristically Gallic. The Marquis continues:

> M. de Rozier cried: "You are doing nothing, and we are not rising." I stirred the fire and then began to scan the river, but Pilatre again cried: "See the river. We are dropping into it!" We again urged the fire, but still clung to the river bed. Presently I heard a noise in the upper part of the balloon, which gave a shock as though it had burst. I called to my companion: "Are you dancing?" The balloon by this time had many holes burnt in it and using my sponge I cried that we must descend. My companion however explained that we were over Paris and must now cross it; therefore raising the fire once more we turned south till we passed the Luxembourg, when, extinguishing the flames, the balloon came down spent and empty.

If poor Pilatre played the part of a rather nervous man in this narrative he had the nerve still to go on with his aeronautical experiments to the point of death. In 1785 he essayed the crossing of the English Channel in a balloon of his own design, in which he sought to combine the principles of the gas and hot-

air balloons. It appears to have been something like an effort to combine nitro-glycerine with an electric spark. At any rate the dense crowds that thronged the coast near Boulogne to see the start of the "Charles – Montgolfier" – as the balloon was named after the originators of the rival systems – saw it, after half an hour's drift out to sea, suddenly explode in a burst of flame. De Rozier and a friend who accompanied him were killed. A monument still recalls their fate, which however is more picturesquely recorded in the signs of sundry inns and cafés of the neighbourhood which offer refreshment in the name of *Les Aviateurs Perdus*.

Thereafter experimenters with balloons multiplied amazingly. The world thought the solution of the problem of flight had been found in the gas bag. Within two months a balloon capable of lifting eighteen tons and carrying seven passengers ascended three thousand feet at Lyons, and, though sustaining a huge rent in the envelope, because of the expansion of the gas at that height, returned to earth in safety. The fever ran from France to England and in 1784, only a year after the first Montgolfier experiments, Lunardi, an Italian aeronaut made an ascension from London which was viewed by King George III. and his ministers, among them William Pitt. But the early enthusiasm for ballooning quickly died down to mere curiosity. It became apparent to all that merely to rise into the air, there to be the helpless plaything of the wind, was but a useless and futile accomplishment. Pleasure seekers and mountebanks

used balloons for their own purposes, but serious experimenters at once saw that if the invention of the balloon was to be of the slightest practical value some method must be devised for controlling and directing its flight. To this end some of the brightest intellects of the world directed their efforts, but it is hardly overstating the case to say that more than a century passed without any considerable progress toward the development of a dirigible balloon.

But even at the earlier time it was evident enough that the Quaker philosopher, from the American Colonies, not yet the United States, whose shrewd and inquiring disposition made him intellectually one of the foremost figures of his day, foresaw clearly the great possibilities of this new invention. In letters to Sir Joseph Banks, then President of the Royal Society of London, Franklin gave a lively account of the first three ascensions, together with some comments, at once suggestive and humorous, which are worth quoting:

> Some think [he wrote of the balloon] Progressive Motion on the Earth may be advanc'd by it, and that a Running Footman or a Horse slung and suspended under such a Globe so as to have no more of Weight pressing the Earth with their Feet than Perhaps 8 or 10 Pounds, might with a fair Wind run in a straight Line across Countries as fast as that Wind, and over Hedges, Ditches and even Waters. It has been even fancied that in time People will keep such Globes anchored in the Air to which by Pullies they may draw up Game to be preserved in the Cool and Water to be

> frozen when Ice is wanted. And that to get Money it will be contriv'd, by running them up in an Elbow Chair a Mile high for a guinea, etc., etc.

With his New England lineage Franklin could hardly have failed of this comparison: "A few Months since the Idea of Witches riding through the Air upon a broomstick, and that of Philosophers upon a Bag of Smoke would have appeared equally impossible and ridiculous."

To-day when aircraft are the eyes of the armies in the greatest war of history, and when it appears that, with the return of peace, the conquest of the air for the ordinary uses of man will be swiftly completed, Franklin's good-humoured plea for the fullest experimentation is worth recalling. And the touch of piety with which he concludes his argument is a delightful example of the whimsical fashion in which he often undertook to bolster up a mundane theory with a reference to things supernatural.

> I am sorry this Experiment is totally neglected in England, where mechanic Genius is so strong. I wish I could see the same Emulation between the two Nations as I see between the two Parties here. Your Philosophy seems to be too bashful. In this Country we are not so much afraid of being laught at. If we do a foolish thing, we are the first to laugh at it ourselves, and are almost as much pleased with a *Bon Mot* or a *Chanson*, that ridicules well the Disappointment of a Project, as we might have been with its success. It does not seem to me a good reason to decline prosecuting a new Experiment which apparently increases

the power of Man over Matter, till we can see to what Use that Power may be applied. When we have learnt to manage it, we may hope some time or other to find Uses for it, as men have done for Magnetism and Electricity, of which the first Experiments were mere Matters of Amusement.

This Experience is by no means a trifling one. It may be attended with important Consequences that no one can foresee. We should not suffer Pride to prevent our progress in Science.

Beings of a Rank and Nature far superior to ours have not disdained to amuse themselves with making and launching Balloons, otherwise we should never have enjoyed the Light of those glorious objects that rule our Day & Night, nor have had the Pleasure of riding round the Sun ourselves upon the Balloon we now inhabit.

B. Franklin.

The earliest experimenters thought that oars might be employed to propel and direct a balloon. The immediate failure of all endeavours of this sort, led them, still pursuing the analogy between a balloon and a ship at sea, to try to navigate the air with sails. This again proved futile. It is impossible for a balloon, or airship to "tack" or manœuvre in any way by sail power. It is in fact a monster sail itself, needing some other power than the wind to make headway or steerage way against the wind. The sail device was tested only to be abandoned. Only when a trail rope dragging along the ground or sea is employed does the sail offer sufficient resistance to the wind to sway the balloon's course this

way or that. And a trailer is impracticable when navigating great heights.

For these reasons the development of the balloon lagged, until Count Zeppelin and M. Santos-Dumont consecrated their fortunes, their inventive minds, and their amazing courage to the task of perfecting a dirigible. In a book, necessarily packed with information concerning the rapid development of aircraft which began in the last decade of the nineteenth century and was enormously stimulated during the war of all the world, the long series of early experiments with balloons must be passed over hastily. Though interesting historically these experiments were futile. Beyond having discovered what could *not* be done with a balloon the practitioners of that form of aeronautics were little further along in 1898 when Count Zeppelin came along with the first plan for a rigid dirigible than they were when Blanchard in 1786, seizing a favourable gale drifted across the English Channel to the French shore, together with Dr. Jefferies, an American. It was just 124 years later that Bleriot, a Frenchman, made the crossing in an airplane independently of favouring winds. It had taken a century and a quarter to attain this independence.

In a vague way the earliest balloonists recognized that power, independent of wind, was necessary to give balloons steerage way and direction. Steam was in its infancy during the early days of ballooning, but the efforts to devise some sort of an engine light enough to be carried into the air were untiring. Within

a year after the experiments of the Montgolfier brothers, the suggestion was made that the explosion of small quantities of gun-cotton and the expulsion of the resulting gases might be utilized in some fashion to operate propelling machinery. Though the suggestion was not developed to any useful point it was of interest as forecasting the fundamental idea of the gas engines of to-day which have made aviation possible – that is, the creation of power by a series of explosions within the motor.

In the effort to make balloons dirigible one of the first steps was to change the form from the spherical or pear-shaped bag to a cylindrical, or cigar-shape. This device was adopted by the brothers Robert in France as early as 1784. Their balloon further had a double skin or envelope, its purpose being partly to save the gas which percolated through the inner skin, partly to maintain the rigidity of the structure. As gas escapes from an ordinary balloon it becomes flabby, and can be driven through the air only with extreme difficulty. In the balloon of the Robert brothers air could from time to time be pumped into the space between the two skins, keeping the outer envelope always fully distended and rigid. In later years this idea has been modified by incorporating in the envelope one large or a number of smaller balloons or "balloonets," into which air may be pumped as needed.

The shape too has come to approximate that of a fish rather than a bird, in the case of balloons at least. "The head of a cod and the tail of a mackerel," was the way Marey-Monge, the French aeronaut described it. Though most apparent in

dirigible balloons, this will be seen to be the favourite design for airplanes if the wings be stripped off, and the body and tail alone considered. Complete, these machines are not unlike a flying fish.

In England, Sir George Cayley, as early as 1810 studied and wrote largely on the subject of dirigibles but, though the English call him the "father of British aeronautics," his work seems to have been rather theoretical than practical. He did indeed demonstrate mathematically that no lifting power existed that would support the cumbrous steam-engine of that date, and tried to solve this dilemma by devising a gas engine, and an explosive engine. With one of the latter, driven by a series of explosions of gunpowder, each in a separate cell set off by a detonator, he equipped a flying machine which attained a sufficient height to frighten Cayley's coachman, whom he had persuaded to act as pilot. The rather unwilling aviator, fearing a loftier flight, jumped out and broke his leg. Though by virtue of this martyrdom his name should surely have descended to fame with that of Cayley it has been lost, together with all record of any later performances of the machine, which unquestionably embodied some of the basic principles of our modern aircraft, though it antedated the first of these by nearly a century.

We may pass over hastily some of the later experiments with dirigibles that failed. In 1834 the Count de Lennox built an airship 130 feet long to be driven by oars worked by man power. When the crowd that gathered to watch the ascent found that

the machine was too heavy to ascend even without the men, they expressed their lively contempt for the inventor by tearing his clothes to tatters and smashing his luckless airship. In 1852, another Frenchman, Henry Giffard, built a cigar-shaped balloon 150 feet long by 40 feet in diameter, driven by steam. The engine weighed three hundred pounds and generated about 3 H. – P. – about 1/200 as much power as a gas engine of equal weight would produce. Even with this slender power, however, Giffard attained a speed, independent of the wind, of from five to seven miles an hour – enough at least for steerage way. This was really the first practical demonstration of the possibilities of the mechanical propulsion of balloons. Several adaptations of the Giffard idea followed, and in 1883 Renard and Krebs, in a fusiform ship, driven by an electric motor, attained a speed of fifteen miles an hour. By this time inventive genius in all countries – save the United States which lagged in interest in dirigibles – was stimulated. Germany and France became the great protagonists in the struggle for precedence and in the struggle two figures stand out with commanding prominence – the Count von Zeppelin and Santos-Dumont, a young Brazilian resident in Paris who without official countenance consecrated his fortune to, and risked his life in, the service of aviation.

CHAPTER III
THE SERVICES OF SANTOS-DUMONT

In his book *My Airships* the distinguished aviator A. Santos-Dumont tells this story of the ambition of his youth and its realization in later days:

> I cannot say at what age I made my first kites, but I remember how my comrades used to tease me at our game of "pigeon flies." All the children gather round a table and the leader calls out "Pigeon Flies! Hen flies! Crow flies! Bee flies!" and so on; and at each call we were supposed to raise our fingers. Sometimes, however, he would call out "Dog flies! Fox flies!" or some other like impossibility to catch us. If any one raised a finger then he was made to pay a forfeit. Now my playmates never failed to wink and smile mockingly at me when one of them called "Man flies!" for at the word I would always raise my finger very high, as a sign of absolute conviction, and I refused with energy to pay the forfeit. The more they laughed at me the happier I was, hoping that some day the laugh would be on my side.
>
> Among the thousands of letters which I received after winning the Deutsch prize (a prize offered in 1901 for sailing around the Eiffel Tower) there was one that gave me peculiar pleasure. I quote from it as a matter of curiosity:
>
> "Do you remember, my dear Alberto, when we played

together 'Pigeon Flies!'? It came back to me suddenly when the news of your success reached Rio. 'Man flies!' old fellow! You were right to raise your finger, and you have just proved it by flying round the Eiffel Tower.

"They play the old game now more than ever at home; but the name has been changed, and the rules modified since October 19, 1901. They call it now 'Man flies!' and he who does not raise his finger at the word pays the forfeit."

The story of Santos-Dumont affords a curious instance of a boy being obsessed by an idea which as a man he carried to its successful fruition. It offers also evidence of the service that may accrue to society from the devotion of a dilettante to what people may call a "fad," but what is in fact the germ of a great idea needing only an enthusiast with enthusiasm, brains, and money for its development. Because the efforts of Santos-Dumont always smacked of the amateur he has been denied his real place in the history of aeronautics, which is that of a fearless innovator, and a devoted worker in the cause.

Born on one of those great coffee plantations of Brazil, where all is done by machinery that possibly can be, Santos-Dumont early developed a passion for mechanics. In childhood he made toy airplanes. He confesses that his favourite author was Jules Verne, that literary idol of boyhood, who while writing books as wildly imaginative as any dime tale of redskins, or nickel novel of the doings of "Nick Carter" had none the less the spirit of prophecy that led him to forecast the submarine, the automobile, and the navigation of the air. At fifteen Santos-Dumont saw his

first balloon and marked the day with red.

> I too desired to go ballooning [he writes]. In the long sun-bathed Brazilian afternoons, when the hum of insects, punctuated by the far-off cry of some bird lulled me, I would lie in the shade of the veranda and gaze into the fair sky of Brazil where the birds fly so high and soar with such ease on their great outstretched wings; where the clouds mount so gaily in the pure light of day, and you have only to raise your eyes to fall in love with space and freedom. So, musing on the exploration of the aërial ocean, I, too, devised airships and flying-machines in my imagination.

From dreaming, the boy's ambitions rapidly developed into actions. Good South Americans, whatever the practice of their northern neighbours, do not wait to die before going to Paris. At the age of eighteen the youth found himself in the capital of the world. To his amazement he found that the science of aeronautics, such as it was, had stopped with Giffard's work in 1852. No dirigible was to be heard of in all Paris. The antiquated gas ball was the only way to approach the upper air. When the boy tried to arrange for an ascension the balloonist he consulted put so unconscionable a price on one ascent that he bought an automobile instead – one of the first made, for this was in 1891 – and with it returned to Brazil. It was not until six years later that, his ambition newly fired by reading of Andrée's plans for reaching the Pole in a balloon, Santos-Dumont took up anew his ambition to become an aviator. His own account of his first

ascent does not bear precisely the hall-mark of the enthusiast too rapt in ecstasy to think of common things. "I had brought up," he notes gravely, "a substantial lunch of hard-boiled eggs, cold roast beef and chicken, cheese, ice cream, fruits and cakes, champagne, coffee, and chartreuse!"

The balloon with its intrepid voyagers nevertheless returned to earth in safety.

A picturesque figure, an habitué of the clubs and an eager sportsman, Santos-Dumont at once won the liking of the French people, and attracted attention wherever people gave thought to aviation. Liberal in expenditure of money, and utterly fearless in exposing his life, he pushed his experiments for the development of a true dirigible tirelessly. Perhaps his major fault was that he learned but slowly from the experiences of others. He clung to the spherical balloon long after the impossibility of controlling it in the air was accepted as unavoidable by aeronauts. But in 1898 having become infatuated with the performances of a little sixty-six pound tricycle motor he determined to build a cigar-shaped airship to fit it, and with that determination won success.

Amateur he may have been, was indeed throughout the greater part of his career as an airman. Nevertheless Santos-Dumont has to his credit two very notable achievements.

He was the first constructor and pilot of a dirigible balloon that made a round trip, that is to say returned to its starting place after rounding a stake at some distance – in this instance the Eiffel Tower, 3-½ miles from St. Cloud whence Santos-Dumont started

and whither he returned within half an hour, the time prescribed.

This was not, indeed, the first occasion on which a round trip, necessitating operation against the wind on at least one course, had been made. In 1884 Captain Renard had accomplished this feat for the first time with the fish-shaped balloon *La France*, driven by an electric motor of nine horse-power. But though thus antedated in his exploit, Santos-Dumont did in fact accomplish more for the advancement and development of dirigible balloons. To begin with he was able to use a new and efficient form of motor destined to become popular, and capable, as the automobile manufacturers later showed, of almost illimitable development in the direction of power and lightness. Except for the gasoline engine, developed by the makers of motor cars, aviation to-day would be where it was a quarter of a century ago.

Moreover by his personal qualities, no less than by his successful demonstration of the possibilities inherent in the dirigible, Santos-Dumont persuaded the French Government to take up aeronautics again, after abandoning the subject as the mere fad of a number of visionaries.

Turning from balloons to airplanes the Brazilian was the first aviator to make a flight with a heavier-than-air machine before a body of judges. This triumph was mainly technical. The Wrights had made an equally notable flight almost a year before but not under conditions that made it a matter of scientific record.

But setting aside for the time the work done by Santos-Dumont with machines heavier than air, let us consider his

triumphs with balloons at the opening of his career. He had come to France about forty years after Henry Giffard had demonstrated the practicability of navigating a balloon 144 feet long and 34 feet in diameter with a three-horse-power steam-engine. But no material success attended this demonstration, important as it was, and the inventor turned his attention to captive balloons, operating one at the Paris Exposition of 1878 that took up forty passengers at a time. There followed Captain Renard to whose achievement we have already referred. He had laid down as the fundamentals of a dirigible balloon these specifications:

> A cigar, or fishlike shape.
>
> An internal sack or ballonet into which air might be pumped to replace any lost gas, and maintain the shape of the balloon.
>
> A keel, or other longitudinal brace, to maintain the longitudinal stability of the balloon and from which the car containing the motor might be hung.
>
> A propeller driven by a motor, the size and power of both to be as great as permitted by the lifting power of the balloon.
>
> A rudder capable of controlling the course of the ship.

Santos-Dumont adopted all of these specifications, but added to them certain improvements which gave his airships – he built five of them before taking his first prize – notable superiority over that of Renard. To begin with he had the inestimable advantage of having the gasoline motor. He further lightened

his craft by having the envelope made of Japanese silk, in flat defiance of all the builders of balloons who assured him that the substance was too light and its use would be suicidal. "All right," said the innovator to his favourite constructor, who refused to build him a balloon of that material, "I'll build it myself." In the face of this threat the builder capitulated. The balloon was built, and the silk proved to be the best fabric available at that time for the purpose. A keel made of strips of pine banded together with aluminum wire formed the backbone of the Santos-Dumont craft, and from it depended the car about one quarter of the length of the balloon and hung squarely amidships. The idea of this keel occurred to the inventor while pleasuring at Nice. Later it saved his life.

One novel and exceedingly simple device bore witness to the ingenuity of the inventor. He had noticed in his days of free ballooning that to rise the aeronaut had to throw out sand-ballast; to descend he had to open the valves and let out gas. As his supply of both gas and sand was limited it was clear that the time of his flight was necessarily curtailed every time he ascended or descended. Santos-Dumont thought to husband his supplies of lifting force and of ballast, and make the motor raise and lower the ship. It was obvious that the craft would go whichever way the bow might be pointed, whether up or down. But how to shift the bow? The solution seems so simple that one wonders it ever perplexed aviators. From the peak of the bow and stern of his craft Santos-Dumont hung long ropes caught in the centre by

lighter ropes by which they could be dragged into the car. In the car was carried a heavy bag of sand, which so long as it was there held the ship in a horizontal plane. Was it needful to depress the bow? Then the bow rope was hauled in, the bag attached, and swung out to a position where it would pull the forward tip of the delicately adjusted gas bag toward the earth. If only a gentle inclination was desired the bag was not allowed to hang directly under the bow, but was held at a point somewhere between the car and the bow so that the pull would be diagonal and the great cylinder would be diverted but little from the horizontal. If it were desired to ascend, a like manipulation of the ballast on the stern rope would depress the stern and point the bow upwards. For slight changes in direction it was not necessary even to attach the sand bag. Merely drawing the rope into the car and thus changing the line of its "pull" was sufficient.

The Deutsch prize which stimulated Santos-Dumont to his greatest achievements with dirigibles was a purse of twenty thousand dollars, offered by Mr. Henry Deutsch, a wealthy patron of the art of aviation. Not himself an aviator, M. Deutsch greatly aided the progress of the air's conquest. Convinced that the true solution of the problem lay in development of the gasoline engine, he expended large sums in developing and perfecting it. When he believed it was sufficiently developed to solve the problem of directing the flight of balloons he offered his prize for the circuit of the Eiffel Tower. The conditions of the contest were not easy. The competitor had to sail from the

Aero Club at St. Cloud, pass twice over the Seine which at that point makes an abrupt bend, sail over the Bois de Boulogne, circle the Tower, and return to the stopping place within a half an hour. The distance was about seven miles, and it is noteworthy that in his own comment on the test Santos-Dumont complains that that required an average speed of fifteen miles an hour of which he could not be sure with his balloon. To-day dirigibles make sixty miles an hour, and airplanes not infrequently reach 130 miles. Moreover there could be no picking of a day on which atmospheric conditions were especially good. Mr. Deutsch had stipulated that the test must be made in the presence of a Scientific Commission whose members must be notified twenty-four hours in advance. None could tell twenty-four hours ahead what the air might be like, and as for utilizing the aviator's most favourable hour, the calm of the dawn, M. Santos-Dumont remarked: "The duellist may call out his friends at that sacred hour, but not the airship captain."

The craft with which the Brazilian first strove to win the Deutsch prize he called *Santos-Dumont No. V.* It was a cylinder, sharp at both ends, 109 feet long and driven by a 12-horse-power motor. A new feature was the use of piano wire for the support of the car, thus greatly reducing the resistance of the air which in the case of the old cord suspensions was almost as great as that of the balloon itself. Another novel feature was water ballast tanks forward and aft on the balloon itself and holding together twelve gallons. By pulling steel wires in the car the aviator could

open the stop-cocks. The layman scarcely appreciates the very slight shift in ballast which will affect the stability of a dirigible. The shifting of a rope a few feet from its normal position, the dropping of two handfuls of sand, or release of a cup of water will do it. A humorous writer describing a lunch with Santos-Dumont in the air says: "Nothing must be thrown overboard, be it a bottle, an empty box or a chicken bone without the pilot's permission."

After unofficial tests of his "No. 5" in one of which he circled the Tower without difficulty, Santos-Dumont summoned the Scientific Commission for a test. In ten minutes he had turned the Tower, and started back against a fierce head-wind, which made him ten minutes late in reaching the time-keepers. Just as he did so his engine failed, and after drifting for a time his ship perched in the top of a chestnut tree on the estate of M. Edmond Rothschild. Philosophical as ever the aeronaut clung to his craft, dispatched an excellent lunch which the Princess Isabel, Comtesse d'Eu, daughter of Dom Pedro, the deposed Emperor of Brazil, sent to his eyrie in the branches, and finally extricated himself and his balloon – neither much the worse for the accident. He had failed but his determination to win was only whetted.

The second trial for the Deutsch prize like the first ended in failure, but that failure was so much more dramatic even than the success which attended the third effort that it is worth telling and can best be told in M. Santos-Dumont's own words. The

quotation is from his memoir, *My Airships*:

> And now I come to a terrible day – 8th of August, 1901. At 6:30 A.M. in presence of the Scientific Commission of the Aero Club, I started again for the Eiffel Tower.
>
> I turned the tower at the end of nine minutes and took my way back to St. Cloud; but my balloon was losing hydrogen through one of its two automatic gas valves whose spring had been accidentally weakened.
>
> I had perceived the beginning of this loss of gas even before reaching the Eiffel Tower, and ordinarily, in such an event, I should have come at once to earth to examine the lesion. But here I was competing for a prize of great honour and my speed had been good. Therefore I risked going on.
>
> The balloon now shrunk visibly. By the time I had got back to the fortifications of Paris, near La Muette, it caused the suspension wires to sag so much that those nearest to the screw-propeller caught in it as it revolved.
>
> I saw the propeller cutting and tearing at the wires. I stopped the motor instantly. Then, as a consequence, the airship was at once driven back toward the tower by the wind which was strong.
>
> At the same time I was falling. The balloon had lost much gas. I might have thrown out ballast and greatly diminished the fall, but then the wind would have time to blow me back on the Eiffel Tower. I therefore preferred to let the airship go down as it was going. It may have seemed a terrific fall to those who watched it from the ground but to me the worst detail was the airship's lack of equilibrium. The half-empty balloon, fluttering its empty end as an elephant waves

his trunk, caused the airship's stern to point upward at an alarming angle. What I most feared therefore was that the unequal strain on the suspension wires would break them one by one and so precipitate me to the ground.

Why was the balloon fluttering an empty end causing all this extra danger? How was it that the rotary ventilator was not fulfilling its purpose in feeding the interior air balloon and in this manner swelling out the gas balloon around it? The answer must be looked for in the nature of the accident. The rotary ventilator stopped working when the motor itself stopped, and I had been obliged to stop the motor to prevent the propeller from tearing the suspension wires near it when the balloon first began to sag from loss of gas. It is true that the ventilator which was working at that moment had not proved sufficient to prevent the first sagging. It may have been that the interior balloon refused to fill out properly. The day after the accident when my balloon constructor's man came to me for the plans of a "No. 6" balloon envelope I gathered from something he said that the interior balloon of "No. 5," not having been given time for its varnish to dry before being adjusted, might have stuck together or stuck to the sides or bottom of the outer balloon. Such are the rewards of haste.

I was falling. At the same time the wind was carrying me toward the Eiffel Tower. It had already carried me so far that I was expecting to land on the Seine embankment beyond the Trocadero. My basket and the whole of the keel had already passed the Trocadero hotels, and had my balloon been a spherical one it would have cleared the building. But

now at the last critical moment, the end of the long balloon that was still full of gas came slapping down on the roof just before clearing it. It exploded with a great noise; struck after being blown up. This was the terrific explosion described in the newspaper of the day.

I had made a mistake in my estimate of the wind's force, by a few yards. Instead of being carried on to fall on the Seine embankment, I now found myself hanging in my wicker basket high up in the courtyard of the Trocadero hotels, supported by my airship's keel, that stood braced at an angle of about forty-five degrees between the courtyard wall above and the roof of a lower construction farther down. The keel, in spite of my weight, that of the motor and machinery, and the shock it had received in falling, resisted wonderfully. The thin pine scantlings and piano wires of Nice (the town where the idea of a keel first suggested itself) had saved my life!

After what seemed tedious waiting, I saw a rope being lowered to me from the roof above. I held to it and was hauled up, when I perceived my rescuers to be the brave firemen of Paris. From their station at Passy they had been watching the flight of the airship. They had seen my fall and immediately hastened to the spot. Then, having rescued me, they proceeded to rescue the airship.

The operation was painful. The remains of the balloon envelope and the suspension wires hung lamentably; and it was impossible to disengage them except in strips and fragments!

The later balloon "No. VI." with which Santos-Dumont won

the Deutsch prize may fairly be taken as his conception of the finished type of dirigible for one man. In fact his aspirations never soared as high as those of Count Zeppelin, and the largest airship he ever planned – called "the *Omnibus*" – carried only four men. It is probable that the diversion of his interest from dirigibles to airplanes had most to do with his failure to carry his development further than he did. "No. VI." was 108 feet long, and 20 feet in diameter with an eighteen-horse-power gasoline engine which could drive it at about nineteen miles an hour. Naturally the aeronaut's first thought in his new construction was of the valves. The memory of the anxious minutes spent perched on the window-sill of the Trocadero Hotel or dangling like a spider at the end of the firemen's rope were still fresh. The ballonet which had failed him in "No. V." was perfected in its successor. Notwithstanding the care with which she was constructed the prize-winner turned out to be a rather unlucky ship. On her trial voyage she ran into a tree and was damaged, and even on the day of her greatest conquest she behaved badly. The test was made on October 1, 1901. The aeronaut had rounded the Tower finely and was making for home when the motor began to miss and threatened to stop altogether. While Santos-Dumont was tinkering with the engine, leaving the steering wheel to itself, the balloon drifted over the Bois de Boulogne. As usual the cool air from the wood caused the hydrogen in the balloon to contract and the craft dropped until it appeared the voyage would end in the tree tops. Hastily shifting his weights

the aeronaut forced the prow of the ship upwards to a sharp angle with the earth. Just at this moment the reluctant engine started up again with such vigour that for a moment the ship threatened to assume a perpendicular position, pointing straight up in the sky. A cry went up from the spectators below who feared a dire catastrophe was about to end a voyage which promised success. But with incomparable *sang-froid* the young Brazilian manipulated the weights, restored the ship to the horizontal again without stopping the engines, and reached the finishing stake in time to win the prize. Soon after it was awarded him the Brazilian Government presented him with another substantial prize, together with a gold medal bearing the words: *Por ceos nunca d'antes navegados* ("Through heavens hitherto unsailed").

In a sense the reference to the heavens is a trifle over-rhetorical. Santos-Dumont differed from all aviators (or pilots of airplanes) and most navigators of dirigibles in always advocating the strategy of staying near the ground. In his flights he barely topped the roofs of the houses, and in his writings he repeatedly refers to the sense of safety that came to him when he knew he was close to the tree tops of a forest. This may have been due to the fact that in his very first flight in a dirigible he narrowly escaped a fatal accident due to flying too high. As he descended, the gas which had expanded now contracted. The balloon began to collapse in the middle. Cords subjected to unusual stress began to snap. The air pump, which should have pumped the ballonet full of air to keep the balloon rigid failed to work. Seeing that he

was about to fall into a field in which his drag rope was already trailing the imperilled airman had a happy thought. Some boys were there flying kites. He shouted to them to seize his rope and run against the wind. The balloon responded to the new force like a kite. The rapidity of its fall was checked, and its pilot landed with only a serious shaking.

But thereafter Santos-Dumont preached the maxim – rare among airmen – "Keep near the ground. That way lies safety!" Most aviators however, prefer the heights of the atmosphere, as the sailor prefers the wide and open sea to a course near land.

After winning the Deutsch prize, Santos-Dumont continued for a time to amuse himself with dirigibles. I say "amuse" purposely, for never did serious aeronaut get so much fun out of a rather perilous pastime as he. In his "No. IX." he built the smallest dirigible ever known. The balloon had just power enough to raise her pilot and sixty-six pounds more beside a three-horse-power motor. But she attained a speed of twelve miles an hour, was readily handled, and it was her owner's dearest delight to use her for a taxicab, calling for lunch at the cafés in the Bois, and paying visits to friends upon whom he looked in, literally, at their second-story windows. He ran her in and out of her hangar as one would a motor-car from its garage. One day he sailed down the Avenue des Champs Élysées at the level of the second-and third-story windows of the palaces that line that stately street. Coming to his own house he descended, made fast, and went in to *déjeuner*, leaving his aërial cab without. In the city

streets he steered mainly by aid of a guide rope trailing behind him. With this he turned sharp corners, went round the Arc de Triomphe, and said: "I might have guide-roped under it had I thought myself worthy." On occasion he picked up children in the streets and gave them a ride.

Though before losing his interest in dirigibles Santos-Dumont carried the number of his construction up to ten, he cannot be said to have devised any new and useful improvements after his "No. VI." The largest of his ships was "No. X.," which had a capacity of eighty thousand cubic feet – about ten times the size of the little runabout with which he played pranks in Paris streets. In this balloon he placed partitions to prevent the gas shifting to one part of the envelope, and to guard against losing it all in the event of a tear. The same principle was fundamental in Count Zeppelin's airships. In 1904 he brought a dirigible to the United States expecting to compete for a prize at the St. Louis Exposition. But while suffering exasperating delay from the red-tape which enveloped the exposition authorities, he discovered one morning that his craft had been mutilated almost beyond repair in its storage place. In high dudgeon he left at once for Paris. The explanation of the malicious act has never been made clear, though many Americans had an uneasy feeling that the gallant and sportsman-like Brazilian had been badly treated in our land. On his return to Paris he at once began experimenting with heavier-than-air machines. Of his work with them we shall give some account later.

Despite his great personal popularity the airship built by Santos-Dumont never appealed to the French military authorities. Probably this was largely due to the fact that he never built one of a sufficient size to meet military tests. The amateur in him was unconquerable. While von Zeppelin's first ship was big enough to take the air in actual war the Frenchman went on building craft for one or two men – good models for others to seize and build upon, but nothing which a war office could actually adopt. But he served his country well by stimulating the creation of great companies who built largely upon the foundations he had laid.

First and greatest of these was the company formed by the Lebaudy Brothers, wealthy sugar manufacturers. Their model was semi-rigid, that is, provided with an inflexible keel or floor to the gas bag, which was cigar shaped. The most successful of the earlier ships was 190 feet long, with a car suspended by cables ten feet below the balloon and carrying the twin motors, together with passengers and supplies. Although it made many voyages without accident, it finally encountered what seems to be the chief peril of dirigible balloons, being torn from its moorings at Châlons and dashed against trees to the complete demolition of its envelope. Repaired in eleven weeks she was taken over by the French Department of War, and was in active service at the beginning of the war. Her two successors on the company's building ways were less fortunate. *La Patrie*, after many successful trips, and manœuvres with the troops, was

insecurely moored at Verdun, the famous fortress where she was to have been permanently stationed. Came up a heavy gale. Her anchors began to drag. The bugles sounded and the soldiers by hundreds rushed from the fort to aid. Hurled along by the wind she dragged the soldiers after her. Fearing disaster to the men the commandant reluctantly ordered them to let go. The ship leaped into the black upper air and disappeared. All across France, across that very country where in 1916 the trenches cut their ugly zigzags from the Channel to the Vosges, she drifted unseen. By morning she was flying over England and Wales. Ireland caught a glimpse of her and days thereafter sailors coming into port told of a curious yellow mass, seemingly flabby and disintegrating like the carcass of a whale, floating far out at sea.

Her partner ship *La République* had a like tragic end. She too made many successful trips, and proved her stability and worth. But one day while manœuvring near Paris one of her propellers broke and tore a great rent in her envelope. As the *Titanic*, her hull ripped open by an iceberg, sunk with more than a thousand of her people, so this airship, wounded in a more unstable element, fell to the ground killing all on board.

Two airships were built in France for England in 1909. One, the *Clement-Bayard II.*, was of the rigid type and built for the government; the other, a *Lebaudy*, was non-rigid and paid for by popular subscriptions raised in England by the *Morning Post*. Both were safely delivered near London having made their voyages of approximately 242 miles each at a speed exceeding

forty miles an hour. These were the first airships acquired for British use.

In the United States the only serious effort to develop the dirigible prior to the war, and to apply it to some definite purpose, was made not by the government but by an individual. Mr. Walter Wellman, a distinguished journalist, fired by the effort of Andrée to reach the North Pole in a drifting balloon, undertook a similar expedition with a dirigible in 1907. A balloon was built 184 feet in length and 52 feet in diameter, and was driven by a seventy-to eighty-horse-power motor. A curious feature of this craft was the guide rope or, as Wellman called it, the equilibrator, which was made of steel, jointed and hollow. At the lower end were four steel cylinders carrying wheels and so arranged that they would float on water or trundle along over the roughest ice. The idea was that the equilibrator would serve like a guide rope, trailing on the water or ice when the balloon hung low, and increasing the power of its drag if the balloon, rising higher, lifted a greater part of its length into the air. Wellman had every possible appliance to contribute to the safety of the airship, and many believe that had fortune favoured him the glory of the discovery of the Pole would have been his. Unhappily he encountered only ill luck. One season he spent at Dane's Island, near Spitzenberg whence Andrée had set sail, waiting vainly for favourable weather conditions. The following summer, just as he was about to start, a fierce storm destroyed his balloon shed and injured the balloon. Before necessary repairs

could be accomplished Admiral Peary discovered the Pole and the purpose of the expedition was at an end. Wellman, however, had become deeply interested in aeronautics and, balked in one ambition, set out to accomplish another. With the same balloon somewhat remodelled he tried to cross the Atlantic, setting sail from Atlantic City, N. J., October 16, 1911. But the device on which the aeronaut most prided himself proved his undoing. The equilibrator, relied upon both for storage room and as a regulator of the altitude of the ship, proved a fatal attachment. In even moderate weather it bumped over the waves and racked the structure of the balloon with its savage tugging until the machinery broke down and the adventurers were at the mercy of the elements. Luckily for them after they had been adrift for seventy-two hours, and travelled several hundred miles they were rescued by the British steamer *Trent*. Not long after Wellman's chief engineer Vanniman sought to cross the Atlantic in a similar craft but from some unexplained cause she blew up in mid-air and all aboard were lost.

Neither Great Britain nor the United States has reason to be proud of the attitude of its government towards the inventors who were struggling to subdue the air to the uses of man. Nor has either reason to boast much of its action in utterly ignoring up to the very day war broke that aid to military service of which Lord Kitchener said, "One aviator is worth a corps of cavalry." It will be noted that to get its first effective dirigible Great Britain had to rely upon popular subscriptions drummed up by a newspaper.

That was in 1909. To-day, in 1917, the United States has only one dirigible of a type to be considered effective in the light of modern standards, though our entrance upon the war has caused the beginning of a considerable fleet. In aviation no less than in aerostatics the record of the United States is negligible. Our country did indeed produce the Wright Brothers, pioneers and true conquerors of the air with airplanes. But even they were forced to go to France for support and indeed for respectful attention.

So far as the development of dirigible balloons is concerned there is no more need to devote space to what was done in England and the United States than there was for the famous chapter on Snakes in Iceland.

CHAPTER IV
THE COUNT VON ZEPPELIN

The year that witnessed the first triumphs of Santos-Dumont saw also the beginning of the success of his great German rival, the Count von Zeppelin. These two daring spirits, struggling to attain the same end, were alike in their enthusiasm, their pertinacity, and their devotion to the same cause. Both were animated by the highest patriotism. Santos-Dumont offered his fleet to France to be used against any nation except those of the two Americas. He said: "It is in France that I have met with all my encouragement; in France and with French material I have made all my experiments. I excepted the two Americas because I am an American."

Count Zeppelin for his part, when bowed down in apparent defeat and crushed beneath the burden of virtual bankruptcy, steadily refused to deal with agents of other nations than Germany – which at that time was turning upon him the cold shoulder. He declared that his genius had been exerted for his own country alone, and that his invention should be kept a secret from all but German authorities. A secret it would be to-day, except that accident and the fortunes of war revealed the intricacies of the Zeppelin construction to both France and England.

Santos-Dumont had the fire, enthusiasm, and resiliency of

youth; Zeppelin, upon whom age had begun to press when first he took up aeronautics, had the dogged pertinacity of the Teuton. Both were rich at the outset, but Zeppelin's capital melted away under the demands of his experimental workshops, while the ancestral coffee lands of the Brazilian never failed him.

Of the two Zeppelin had the more obstinacy, for he held to his plan of a rigid dirigible balloon even in face of its virtual failure in the supreme test of war. Santos-Dumont was the more alert intellectually for he was still in the flood tide of successful demonstration with his balloons when he saw and grasped the promise of the airplane and shifted his activities to that new field in which he won new laurels.

Zeppelin won perhaps the wider measure of immediate fame, but whether enduring or not is yet to be determined. His airships impressive, even majestic as they are, have failed to prove their worth in war, and are yet to be fully tested in peace. That they remain a unique type, one which no other individual nor any other nation has sought to copy, cannot be attributed wholly to the jealousy of possible rivals. If the monster ship, of rigid frame, were indeed the ideal form of dirigible it would be imitated on every hand. The inventions of the Wrights have been seized upon, adapted, improved perhaps by half a hundred airplane designers of every nation. But nobody has been imitating the Zeppelins.

That, however, is a mere passing reflection. If the Zeppelin has not done all in war that the sanguine German people expected of it, nevertheless it is not yet to be pronounced an entire failure.

And even though a failure in war, the chief service for which its stout-hearted inventor designed it, there is still hope that it may ultimately prove better adapted to many ends of peace than the airplanes which for the time seem to have outdone it.

Stout-hearted indeed the old *Luftgraaf*– "Air Scout" – as the Germans call him, was. His was a Bismarckian nature, reminiscent of the Iron Chancellor alike physically and mentally. In appearance he recalls irresistibly the heroic figure of Bismarck, jack-booted and cuirassed at the Congress of Vienna, painted by von Werner. Heir to an old land-owning family, ennobled and entitled to bear the title *Landgraf*, Count von Zeppelin was a type of the German aristocrat. But for his title and aristocratic rank he could never have won his long fight for recognition by the bureaucrats who control the German army. In youth he was anti-Prussian in sentiment, and indeed some of his most interesting army experiences were in service with the army of South Germany against Prussia and her allied states. But all that was forgotten in the national unity that followed the defeat of France in 1872.

Before that, however, the young count – he was born in 1838 – had served with gallantry, if not distinction, in the Union Army in our Civil War, had made a balloon ascension on the fighting line, had swum in the Niagara River below the falls, being rescued with difficulty, and together with two Russian officers and some Indian guides had almost starved in trying to discover the source of the Mississippi River – a spot which can now be visited

without undergoing more serious hardships than the upper berth in a Pullman car.

It was at the siege of Paris that Zeppelin's mind first became engaged with the problem of aërial navigation. From his post in the besieging trenches he saw the almost daily ascent of balloons in which mail was sent out, and persons who could pay the price sought to escape from the beleaguered city. As a colonel of cavalry, he had been employed mainly in scouting duty throughout the war. He was impressed now with the conviction that those globes, rising silently into the air, above the enemy's cannon shot and drifting away to safety would be the ideal scouts could they but return with their intelligence. Was there no way of guiding these ships in the air, as a ship in the ocean is guided? The young soldier was hardly home from the war when he began to study the problem. He studied it indeed so much to the exclusion of other military matters that in 1890 the General Staff abruptly dismissed him from his command. They saw no reason why a major-general of cavalry should be mooning around with balloons and kites like a schoolboy.

The dismissal hurt him, but deterred him in no way from the purpose of his life. Indeed the fruit of his many years' study of aeronautic conditions was ready for the gathering at this very moment. On the surface of the picturesque Lake Constance, on the border line between Germany and Switzerland, floated a huge shed, open to the water and more than five hundred feet long. In it, nearing completion, floated the first Zeppelin airship.

In the long patient study which the Count had given to his problem he had reached the fixed conclusion that the basis of a practical dirigible balloon must be a rigid frame over which the envelope should be stretched. His experiments were made at the same time as those of Santos-Dumont, and he could not be ignorant of the measure of success which the younger man was attaining with the non-rigid balloon. But it was a fact that all the serious accidents which befell Santos-Dumont and most of the threatened accidents which he narrowly escaped were fundamentally caused by the lack of rigidity in his balloon. The immediate cause may have been a leaky valve permitting the gas to escape, or a faulty air-pump which made prompt filling of the ballonet impossible. But the effect of these flaws was to deprive the balloon of its rigidity, cause it to buckle, throwing the cordage out of gear, shifting stresses and strains, and resulting in ultimate breakdown.

Whether he observed the vicissitudes of his rival or not, Count Zeppelin determined that the advantages of a rigid frame counted for more than the disadvantage of its weight. Moreover that disadvantage could be compensated for by increasing the size, and therefore the lifting power of the balloon. In determining upon a rigid frame the Count was not a pioneer even in his own country. While his experiments were still under way, a rival, David Schwartz, who had begun, without completing, an airship in St. Petersburg, secured in some way aid from the German Government, which was at the moment coldly repulsing

Zeppelin. He planned and built an aluminum airship but died before its completion. His widow continued the work amidst constant opposition from the builders. The end was one of the many tragedies of invention. Nobody but the widow ever believed the ship would rise from its moorings. It was in charge of a man who had never made an ascent. To his amazement and to the amazement of the spectators the engine was hardly started when the ship mounted and made headway against a stiff breeze. On the ground the spectators shouted in wonder; the widow, overwhelmed by this reward for her faith in her husband's genius, burst into tears of joy. But the amateur pilot was no match for the situation. Affrighted to find himself in mid-air, too dazed to know what to do, he pulled the wrong levers and the machine crashed to earth. The pilot escaped, but the airship which had taken four years to build was irretrievably wrecked. The widow's hopes were blasted, and the way was left free for the Count von Zeppelin.

Freed, though unwillingly, from the routine duties of his military rank, Zeppelin thereafter devoted himself wholly to his airships. He was fifty-three years old, adding one more to the long list of men who found their real life's work after middle age. With him was associated his brother Eberhard, the two forming a partnership in aeronautical work as inseparable as that of Wilbur and Orville Wright. Like Wilbur Wright, Eberhard von Zeppelin did not live to witness the fullest fruition of the work, though he did see the soundness of its principles thoroughly established and

in practical application. There is a picturesque story that when Eberhard lay on his death-bed his brother, instead of watching by his side, took the then completed airship from its hangar, and drove it over and around the house that the last sounds to reach the ears of his faithful ally might be the roar of the propellers in the air – the grand pæan of victory.

Though Count von Zeppelin had begun his experiments in 1873 it was not until 1890 that he actually began the construction of his first airship. The intervening years had been spent in constructing and testing models, in abstruse calculations of the resistance of the air, the lifting power of hydrogen, the comparative rigidity and weight of different woods and various metals, the power and weight of the different makes of motors. In these studies he spent both his time and his money lavishly, with the result that when he had built a model on the lines of which he was willing to risk the construction of an airship of operative size, his private fortune was gone. It is the common lot of inventors. For a time the Count suffered all the mortification and ignominy which the beggar, even in a most worthy cause, must always experience. Hat in hand he approached every possible patron with his story of certain success if only supplied with funds with which to complete his ship. A stock company with a capital of $225,000 of which he contributed one half, soon found its resources exhausted and retired from the speculation. Appeals to the Emperor met with only cold indifference. An American millionaire newspaper owner, resident in Europe, sent

contemptuous word by his secretary that he "had no time to bother with crazy inventors." That was indeed the attitude of the business classes at the moment when the inventors of dirigibles were on the very point of conquering the obstacles in the way of making the navigation of air a practical art. A governmental commission at Berlin rejected with contempt the plans which Zeppelin presented in his appeal for support. Members of that commission were forced to an about-face later and became some of the inventor's sturdiest champions. But in his darkest hour the government failed him, and the one friendly hand stretched out in aid was that of the German Engineers' Society which, somewhat doubtfully, advanced some funds to keep the work in operation.

With this the construction of the first Zeppelin craft was begun. Though there had been built up to the opening of the war twenty-five "Zeps" – nobody knows how many since – the fundamental type was not materially altered in the later ones, and a description of the first will stand for all. In connection with this description may be noted the criticisms of experts some of which proved only too well founded.

The first Zeppelin was polygonal, 450 feet long, 78 broad, and 66 feet high. This colossal bulk, equivalent to that of a 7500-ton ship necessary to supply lifting power for the metallic frame, naturally made her unwieldy to handle, unsafe to leave at rest, outside of a sheltering shed, and a particularly attractive target for artillery in time of war. Actual action indeed proved that to be safe from the shells of anti-aircraft guns, the Zeppelins were

forced to fly so high that their own bombs could not be dropped with any degree of accuracy upon a desired target.

The balloon's frame is made of aluminum, the lightest of metals, but not the least costly. A curious disadvantage of this construction was made apparent in the accident which destroyed *Zeppelin IV*. That was the first of the airships to be equipped with a full wireless outfit which was used freely on its flight. It appeared that the aluminum frame absorbed much of the electricity generated for the purpose of the wireless. The effect of this was two-fold. It limited the radius of operation of the wireless to 150 miles or less, and it made the metal frame a perilous storehouse of electricity. When *Zeppelin IV*. met with a disaster by a storm which dragged it from its moorings, the stored electricity in her frame was suddenly released by contact with the trees and set fire to the envelope, utterly destroying the ship.

The balloon frame was divided into seventeen compartments, each of which held a ballonet filled with hydrogen gas. The purpose of this was similar to the practice of dividing a ship's hulls into compartments. If one or more of the ballonets, for any reason, were injured the remainder would keep the ship afloat. The space between the ballonets and the outer skin was pumped full of air to keep the latter taut and rigid. Moreover it helped to prevent the radiation of heat to the gas bags from the outer envelope whose huge expanse, presented to the sun, absorbed an immense amount of heat rays.

Two cars were suspended from the frame of the Zeppelin,

forward and aft, and a corridor connected them. A sliding weight was employed to raise or depress the bow. In each car of the first Zeppelin was a sixteen-horse-power gasoline motor, each working two screws, with four foot blades, revolving one thousand times a minute. The engines were reversible, thus making it possible to work the propellers against each other and aid materially in steering the ship. Rudders at bow and stern completed the navigating equipment.

In the first Zeppelins, the corridor connecting the two cars was wholly outside the frame and envelope of the car. Later the perilous experiment was tried of putting it within the envelope. This resulted in one of the most shocking of the many Zeppelin disasters. In the case of the ship *L-II.*, built in 1912, the corridor became filled with gas that had oozed out of the ballonets. At one end or the other of the corridor this gas, then mixed with air, came in contact with fire, – perhaps the exhaust of the engines, – a violent explosion followed while the ship was some nine hundred feet aloft, and the mass of twisted and broken metal, with the flaming envelope, fell to the ground carrying twenty-eight men, including members of the Admiralty Board, to a horrible death.

But to return to the first Zeppelin. Her trial was set for July 2, 1900, and though the immediate vicinity of the floating hangar was barred to the public by the military authorities, the shores and surface of the lake were black with people eager to witness the test. Boats pulled out of the wide portal the huge cigar-

shaped structure, floating on small rafts, its polished surface of pegamoid glittering in the sun. As large as a fair-sized ocean steamship, it looked, on that little lake dotted with pleasure craft, like a leviathan. Men were busy in the cars, fore and aft. The mooring ropes were cast off as the vessel gained an offing, and ballast being thrown out she began to rise slowly. The propellers began to whir, and the great craft swung around breasting the breeze and moved slowly up the lake. The crowd cheered. Count von Zeppelin, tense with excitement, alert for every sign of weakness watched his monster creation with mingled pride and apprehension. Two points were set at rest in the first two minutes – the lifting power was great enough to carry the heaviest load ever imposed upon a balloon and the motive power was sufficient to propel her against an ordinary breeze. But she was hardly in mid-air when defects became apparent. The apparatus for controlling the balancing weight got out of order. The steering lines became entangled so that the ship was first obliged to stop, then by reversing the engines to proceed backwards. This was, however, a favourable evidence of her handiness under untoward circumstances. After she had been in the air nearly an hour and had covered four or five miles, a landing was ordered and she dropped to the surface of the lake with perfect ease. Before reaching her shed, however, she collided with a pile – an accident in no way attributable to her design – and seriously bent her frame.

The story told thus baldly does not sound like a record of

glorious success. Nevertheless not Count Zeppelin alone but all Germany was wild with jubilation. *Zeppelin I.* had demonstrated a principle; all that remained was to develop and apply this principle and Germany would have a fleet of aërial dreadnoughts that would force any hostile nation to subjection. There was little or no discussion of the application of the principle to the ends of peace. It was as an engine of war alone that the airship appealed to the popular fancy.

But at the time that fancy proved fickle. With a few repairs the airship was brought out for another test. In the air it did all that was asked for it, but it came to earth – or rather to the surface of the lake – with a shock that put it out of commission. When Count Zeppelin's company estimated the cost of further repairs it gave a sigh and abandoned the wreck. Thereupon the pertinacious inventor laid aside his tools, got into his old uniform, and went out again on the dreary task of begging for further funds.

It was two years before he could take up again the work of construction. He lectured, wrote magazine articles, begged, cajoled, and pleaded for money. At last he made an impression upon the Emperor who, indeed, with a keen eye for all that makes for military advantage, should have given heed to his efforts long before. Merely a letter of approval from the all-powerful Kaiser was needed to turn the scale and in 1902 this was forthcoming. The factories of the empire agreed to furnish materials at cost price, and sufficient money was soon forthcoming to build a

second ship. This ship took more than two years to build, was tested in January, 1906, made a creditable flight, and was dashed to pieces by a gale the same night!

The wearisome work of begging began again. But this time the Kaiser's aid was even more effectively given and in nine months *Zeppelin III.* was in the air. More powerful than its predecessors it met with a greater measure of success. On one of its trials a propeller blade flew off and penetrated the envelope, but the ship returned to earth in safety. In October, 1906, the Minister of War reported that the airship was extremely stable, responded readily to her helm, had carried eleven persons sixty-seven miles in two hours and seventeen minutes, and had made its landing in ease and safety. Accepted by the government "No. III." passed into military service and Zeppelin, now the idol of the German people, began the construction of "No. IV."

That ship was larger than her predecessors and carried a third cabin for passengers suspended amidships. Marked increase in the size of the steering and stabling planes characterized the appearance of the ship when compared with earlier types. She was at the outset a lucky ship. She cruised through Alpine passes into Switzerland, and made a circular voyage carrying eleven passengers and flying from Friedrichshaven to Mayence and back via Basle, Strassburg, Mannheim, and Stuttgart. The voyage occupied twenty-one hours – a world's record. The performance of the ship on both voyages was perfection. Even in the tortuous Alpine passes which she was forced to navigate on her trip to

Lucerne she moved with the steadiness and certainty of a great ship at sea. The rarification of the air at high altitudes, the extreme and sudden variations in temperature, the gusts of wind that poured from the ice-bound peaks down through the narrow canyons affected her not at all. When to this experience was added the triumphant tour of the six German cities, Count von Zeppelin might well have thought his triumph was complete.

But once again the cup of victory was dashed from his lips. After his landing a violent wind beat upon the ship. An army of men strove to hold her fast, while an effort was made to reduce her bulk by deflation. That effort, which would have been entirely successful in the case of a non-rigid balloon, was obviously futile in that of a Zeppelin. Not the gas in the ballonets, but the great rigid frame covered with water-proofed cloth constituted the huge bulk that made her the plaything of the winds. In a trice she was snatched from the hands of her crew and hurled against the trees in a neighbouring grove. There was a sudden and utterly unexpected explosion and the whole fabric was in flames. The precise cause of the explosion will always be in doubt, but, as already pointed out, many scientists believe that the great volume of electricity accumulated in the metallic frame was suddenly released in a mighty spark which set fire to the stores of gasoline on board.

With this disaster the iron nerve of the inventor was for the first time broken. It followed so fast upon what appeared to be a complete triumph that the shock was peculiarly hard to bear.

It is said that he broke down and wept, and that but for the loving courage and earnest entreaties of his wife and daughter he would then have abandoned the hope and ambition of his life. But after all it was but that darkest hour which comes just before the dawn. The demolition of "No. IV." had been no accident which reflected at all upon the plan or construction of the craft – unless the great bulk of the ship be considered a fundamental defect. What it did demonstrate was that the Zeppelin, like the one-thousand-foot ocean liner, must have adequate harbour and docking facilities wherever it is to land. The one cannot safely drop down in any convenient meadow, any more than the other can put into any little fishing port. Germany has learned this lesson well enough and since the opening of the Great War her territory is plentifully provided with Zeppelin shelters at all strategic points.

Fortunately for the Count the German people judged his latest reverse more justly than he did. They saw the completeness of the triumph which had preceded the disaster and recognized that the latter was one easily guarded against in future. Enthusiasm ran high all over the land. Begging was no longer necessary. The Emperor, who had heretofore expressed rather guarded approval of the enterprise, now flung himself into it with that enthusiasm for which he is notable. He bestowed upon the Count the Order of the Black Eagle, embraced him in public three times, and called aloud that all might hear, "Long life to his Excellency, Count Zeppelin, the Conqueror of the Air." He never wearied of

assuring his hearers that the Count was the "greatest German of the century." With such august patronage the Count became the rage. Next to the Kaiser's the face best known to the people of Germany, through pictures and statues, was that of the inventor of the Zeppelin. The pleasing practice of showing affection for a public man by driving nails into his wooden effigy had not then been invented by the poetic Teutons, else von Zeppelin would have outdone von Hindenburg in weight of metal.

The story that Zeppelin had refused repeated offers from other governments was widely published and evoked patriotic enthusiasm. With it went shrewd hints that in these powerful aircraft lay the way to overcome the hated English navy, and even to carry war to the very soil of England. It was then eight years before the greatest war of history was to break out, but even at that date hatred of England was being sedulously cultivated among the German people by those in authority.

As a result of this national attitude Count Zeppelin's enterprise was speedily put on a sound financial footing. Though "No. IV." had been destroyed by an accident it had been the purpose of the government to buy her, and $125,000 of the purchase price was now put at the disposal of the Count von Zeppelin. A popular Zeppelin fund of $1,500,000 was raised and expended in building great works. Thenceforward there was no lack of money for furthering what had truly become a great national interest.

But the progress of the construction of Zeppelins for the next few years was curiously compounded of success

and failure. Fate seemed to have decreed to every Zeppelin triumph a disaster. Each mischance was attributed to exceptional conditions which never could happen again, but either they did occur, or some new but equally effective accident did. Outside of Germany, where the public mind had become set in an almost idolatrous confidence in Zeppelin, the great airships were becoming a jest and a byword notwithstanding their unquestioned accomplishments. Indeed when the record was made up just before the declaration of war in 1914 it was found that of twenty-five Zeppelins thus far constructed only twelve were available. Thirteen had been destroyed by accident – two of them modern naval airships only completed in 1913. The record was not one to inspire confidence.

In 1909, during a voyage in which he made nine hundred miles in thirty-eight hours, the rumour was spread that von Zeppelin would continue it to Berlin. Some joker sent a forged telegram to the Kaiser to that effect signed "Zeppelin." It was expected to be the first appearance of one of the great ships at the capital, and the Emperor hastened to prepare a suitable welcome. A great crowd assembled at the Templehoff Parade Ground. The Berlin Airship Battalion was under orders to assist in the landing. The Kaiser himself was ready to hasten to the spot should the ship be sighted. But she never appeared. If von Zeppelin knew of the exploit which rumour had assigned to him – which is doubtful – he could not have carried it out. His ship collided with a tree – an accident singularly frequent in the Zeppelin records – so

disabling it that it could only limp home under half power. A rather curt telegram from his Imperial master is said to have been Count von Zeppelin's first intimation that he had broken an engagement.

However, he kept it two months later, flying to Berlin, a distance of 475 miles. He was greeted with mad enthusiasm and among the crowd to welcome him was Orville Wright the American aviator. It is a curious coincidence that on the day the writer pens these words the New York newspapers contain accounts of Mr. Wright's proffer of his services, and aeronautical facilities, to the President in case an existing diplomatic break with Germany should reach the point of actual war. Mr. Wright accompanied his proffer by an appeal for a tremendous aviation force, "but," said he, "I strongly advise against spending any money whatsoever on dirigible balloons of any sort."

Thereafter the progress of Count von Zeppelin was without interruption for any lack of financial strength. His great works at Friedrichshaven expanded until they were capable of putting out a complete ship in eight weeks. He was building, of course, primarily for war, and never concealed the fact that the enemy he expected to be the target of his bomb throwers was England. What the airships accomplished in this direction, how greatly they were developed, and the strength and weakness of the German air fleet, will be dwelt upon in another chapter.

But, though building primarily for military purposes, Zeppelin did not wholly neglect the possibilities of his ship for non-

military service. He built one which made more than thirty trips between Munich and Berlin, carrying passengers who paid a heavy fee for the privilege of enjoying this novel form of travel. The car was fitted up like our most up-to-date Pullmans, with comfortable seats, bright lights, and a kitchen from which excellent meals were served to the passengers. The service was not continued long enough to determine whether it could ever be made commercially profitable, but as an aid to firing the Teutonic heart and an assistance in selling stock it was well worth while. The spectacle of one of these great cars, six hundred or more feet long, floating grandly on even keel and with a steady course above one of the compact little towns of South Germany, was one to thrill the pulses.

But the ill luck which pursued Count von Zeppelin even in what seemed to be his moments of assured success was remorseless. In 1912 he produced the monster *L-I*, 525 feet long, 50 feet in diameter, of 776,900 cubic feet capacity, and equipped with three sets of motors, giving it a speed of fifty-two miles an hour. This ship was designed for naval use and after several successful cross-country voyages she was ordered to Heligoland, to participate in naval manœuvres with the fleet there stationed. One day, caught by a sudden gust of wind such as are common enough on the North Sea, she proved utterly helpless. Why no man could tell, her commander being drowned, but in the face of the gale she lost all control, was buffeted by the elements at their will, and dropped into the sea where she was a total

loss. Fifteen of her twenty-two officers and men were drowned. The accident was the more inexplicable because the craft had been flying steadily overland for nearly twelve months and had covered more miles than any ship of Zeppelin construction. It was reported that her captain had said she was overloaded and that he feared that she would be helpless in a gale. But after the disaster his mouth was stopped by the waters of the North Sea.

This calamity was not permitted long to stand alone. Indeed one of the most curious facts about the Zeppelin record is the regular, periodical recurrence of fatal accidents at almost equal intervals and apparently wholly unaffected by the growing perfection of the airships. While *L-I* was making her successful cross-country flights, *L-II* was reaching completion at Friedrichshaven. She was shorter but bulkier than her immediate predecessor and carried engines giving her nine hundred horse power, or four hundred more than *L-I.* On its first official trip this ship exploded a thousand feet in air, killing twenty-eight officers and men aboard, including all the officials who were conducting the trials. The calamity, as explained on an earlier page, was due to the accumulation of gas in the communicating passage between the three cars.

This new disaster left the faith and loyalty of the German people unshaken. But it did decidedly estrange the scientific world from Count von Zeppelin and all his works. It was pointed out, with truth, that the accident paralleled precisely one which had demolished the *Severo Pax* airship ten years earlier, and

which had caused French inventors to establish a hard and fast rule against incorporating in an airship's design any inclosed space in which waste gas might gather. This rule and its reason were known to Count von Zeppelin and by ignoring both he lent new colour to the charge, already current in scientific circles, that he was loath to profit by the experiences of other inventors.

Whether this feeling spread to the German Government it is impossible to say. Nor it is easy to estimate how much official confidence was shaken by it. The government, even before the war, was singularly reticent about the Zeppelins, their numbers and plans. It is certain that orders were not withheld from the Count. Great numbers of his machines were built, especially after the war was entered upon. But he was not permitted longer to have a monopoly of government aid for manufacturers of dirigibles. Other types sprung up, notably the Schutte-Lanz, the Gross, and the Parseval. But being first in the field the Zeppelin came to give its name to all the dirigibles of German make and many of the famous – or infamous – exploits credited to it during the war may in fact have been performed by one of its rivals.

It would be futile to attempt to enumerate all these rivals here. Among them are the semi-rigid Parseval and Gross types which found great favour among the military authorities during the war. The latter is merely an adaptation of the highly successful French ship the *Lebaudy*, but the Parseval is the result of a slow evolution from an ordinary balloon. It is wholly German, in conception and development, and it is reported that the Kaiser, secretly

disgusted that the Zeppelins, to the advancement of which he had given such powerful aid, should have recorded so many disasters, quietly transferred his interest to the new and simpler model. Despite the hope of a more efficient craft, however, both the Gross and the Parseval failed in their first official trials, though later they made good.

The latter ship was absolutely without any wooden or metallic structure to give her rigidity. Two air ballonets were contained in the envelope at bow and stern and the ascent and descent of the ship was regulated by the quantity of air pumped into these. A most curious device was the utilization of heavy cloth for the propeller blades. Limp and flaccid when at rest, heavy weights in the hem of the cloth caused these blades to stand out stiff and rigid as the result of the centrifugal force created by their rapid revolution. One great military advantage of the Parseval was that she could be quickly deflated in the presence of danger at her moorings, and wholly knocked down and packed in small compass for shipment by rail in case of need. To neither of these models did there ever come such a succession of disasters as befell the earlier Zeppelins. It is fair to say however that prior to the war not many of them had been built, and that both their builders and navigators had opportunity to learn from Count von Zeppelin's errors.

Among the chief German rivals to the Zeppelin is the Schutte-Lanz, of the rigid type, broader but not so long as the Zeppelin, framed of wood bound with wire and planned to carry a load of

five or six tons, or as many as thirty passengers. No. I of this type met its fate as did so many Zeppelins by encountering a storm while improperly moored. Called to earth to replenish its supply of gas it was moored to an anchor sunk six feet in the ground, and as an additional precaution three hundred soldiers were called from a neighbouring barracks to handle it. It seems to have been one of the advantages of Germany as a place in which to manœuvre dirigibles, that, even in time of peace, there were always several hundred soldiers available wherever a ship might land. But this force was inadequate. A violent gust tore the ship from their hands. One poor fellow instinctively clung to his rope until one thousand feet in the air when he let go. The ship itself hovered over the town for an hour or more, then descended and was dashed to pieces against trees and stone walls.

The danger which was always attached to the landing of airships has led some to suggest that they should never be brought to earth, but moored in mid-air as large ships anchor in midstream. It is suggested that tall towers be built to the top of which the ship be attached by a cable, so arranged that she will always float to the leeward of the tower. The passengers would be landed by gangplanks, and taken up and down the towers in elevators. Kipling suggests this expedient in his prophetic sketch *With the Night Mail*. The airship would only return to earth – as a ship goes into dry dock – when in need of repairs.

A curious mishap that threatened for a time to wreck the peace of the world, occurred in April, 1913, when a German Zeppelin

was forced out of its course and over French territory. The right of alien machines to pass over their territory is jealously guarded by European nations, and during the progress of the Great War the Dutch repeatedly protested against the violation of their atmosphere by German aviators. At the time of this mischance, however, France and Germany were at peace – or as nearly so as racial and historic antipathies would permit. Accordingly when officers of a brigade of French cavalry engaged in manœuvring near the great fortress of Luneville saw a shadow moving across the field and looking up saw a huge Zeppelin betwixt themselves and the sun they were astonished and alarmed. Signs and faint shouts from the aeronauts appeared to indicate that their errand was at least friendly, if not involuntary. The soldiers stopped their drill; the townspeople trooped out to the Champs de Mars where the phenomenon was exhibited and began excitedly discussing this suspicious invasion. Word was speedily sent to military headquarters asking whether to welcome or to repel the foe.

Meantime the great ship was drifting perilously near the housetops, and the uniformed officers in the cars began making signals to the soldiers below. Ropes were thrown out, seized by willing hands and made fast. The crew of Germans descended to find themselves prisoners. The international law was clear enough. The ship was a military engine of the German army. Its officers, all in uniform, had deliberately steered her into the very heart of a French fortress. Though the countries were at peace the act was technically one of war – an armed invasion

by the enemy. Diplomacy of course settled the issue peacefully but not before the French had made careful drawings of all the essential features of the Zeppelin, and taken copies of its log. As Germany had theretofore kept a rigid secrecy about all the details of Zeppelin construction and operation this angered the military authorities beyond measure. The unlucky officers who had shared in the accident were savagely told that they should have blown the ship up in mid-air and perished with it rather than to have weakly submitted it to French inspection. They suffered court-martial but escaped with severe reprimands.

The story of the dirigibles of France and Germany is practically the whole story of the development to a reasonable degree of perfection of the lighter-than-air machine. Other nations experimented somewhat, but in the main lagged behind these pioneers. Out of Spain indeed came a most efficient craft – the Astra-Torres, of which the British Government had the best example prior to the war, while both France and Russia placed large orders with the builders. How many finally went into service and what may have been their record are facts veiled in the secrecy of wartime. Belgium and Italy both produced dirigibles of distinctive character. The United States is alone at the present moment in having contributed nothing to the improvement of the dirigible balloon.

CHAPTER V
THE DEVELOPMENT OF THE AIRPLANE

The story of the development of the heavier-than-air machine – which were called aëroplanes at first, but have been given the simpler name of airplanes – is far shorter than that of the balloons. It is really a record of achievement made since 1903 when the plane built by Professor Langley of the Smithsonian Institution came to utter disaster on the Potomac. In 1917, at the time of writing this book, there are probably thirty distinct types of airplanes being manufactured for commercial and military use, and not less than fifty thousand are being used daily over the battlefields of Europe. No invention save possibly the telephone and the automobile ever attained so prodigious a development in so brief a time. Wise observers hold that the demand for these machines is yet in its infancy, and that when the end of the war shall lead manufacturers and designers to turn their attention to the commercial value of the airplane the flying craft will be as common in the air as the automobiles at least on our country roads.

The idea of flying like a bird with wings, the idea basicly underlying the airplane theory, is old enough – almost as old as the first conception of the balloon, before hydrogen

gas was discovered. In an earlier chapter some account is given of early experiments with wings. No progress was made along this line until the hallucination that man could make any headway whatsoever against gravity by flapping artificial wings was definitely abandoned. There was more promise in the experiments made by Sir George Cayley, and he was followed in the first half of the nineteenth century by half a dozen British experimenters who were convinced that a series of planes, presenting a fixed angle to the breeze and driven against it by a sufficiently powerful motor, would develop a considerable lifting power. This was demonstrated by Henson, in 1842, Stringfellow, in 1847, Wenham, who arranged his planes like slats in a Venetian blind and first applied the modern term "aeroplane" to his invention, and Sir Hiram Maxim, who built in 1890 the most complicated and impressive looking 'plane the world has yet seen. But though each of these inventors proved the theorem that a heavier-than-air machine could be made to fly, all failed to get practical results because no motor had then been invented which combined the necessary lightness with the generation of the required power.

In America we like to think of the brothers Wright as being the true inventors of the airplane. And indeed they did first bring it to the point of usefulness, and alone among the many pioneers lived to see the adoption of their device by many nations for serious practical use. But it would be unjust to claim for them entire priority in the field of the glider and the heavier-than-

air machine. Professor Langley preceded them with an airplane which, dismissed with ridicule as a failure in his day, was long after his death equipped with a lighter motor and flown by Glenn Curtis, who declared that the scientist had solved the problem, had only the explosive engine been perfected in his time.

Despite, however, the early period of the successful experiments of the Wrights and Professor Langley, it would be unjust for America to arrogate to herself entire priority in airplane invention. Any story of that achievement which leaves out Lilienthal, the German, and Pilcher, the Englishman, is a record in which the truth is subordinated to national pride.

Otto Lilienthal and his brother Gustav – the two like the Wrights were always associated in their aviation work – had been studying long the problem of flight when in 1889 they jointly published their book *Bird Flight as the Basis of the Flying Art*. Their investigations were wholly into the problem of flight without a motor. At the outset they even harked back to the long-abandoned theory that man could raise himself by mere muscular effort, and Otto spent many hours suspended at the end of a rope flapping frantically a pair of wings before he abandoned this effort as futile. Convinced that the soaring or gliding of the birds was the feat to emulate, he made himself a pair of fixed, bat-like wings formed of a light fabric stretched over a willow frame. A tail composed of one vertical and one horizontal plane extended to the rear, and in the middle the aviator hung by his armpits, in an erect position. With this device he made some experimental

glides, leaping from slight eminences. With his body, which swung at will from its cushioned supports, he could balance, and even steer the fabric which supported him, and accomplished long glides against the wind. Not infrequently, running into the teeth of the breeze down a gentle slope he would find himself gently wafted into the air and would make flights of as much as three hundred yards, steering to either side, or rising and falling at will. He was even able to make a circuitous flight and return to his starting place – a feat that was not accomplished with a motor-driven airplane until years later. Lilienthal achieved it with no mechanical aid, except the wings. He became passionately devoted to the art, made more than two thousand flights, and at the time of his death had just completed a motor-driven airplane, which he was never able to test. His earlier gliding wings he developed into a form of biplane, with which he made several successful flights, but met his death in 1896 by the collapse of this machine, of the bad condition of which he had been warned.

Lilienthal was more of a factor in the conquest of the air than his actual accomplishments would imply. His persistent experiments, his voluminous writings, and above all his friendly and intelligent interest in the work of other and younger men won him a host of disciples in other lands who took up the work that dropped from his lifeless hands.

In England Percy S. Pilcher emulated the Lilienthal glides, and was at work on a motor-propelled machine when he was killed by the breakage of a seemingly unimportant part of his

machine. He was on the edge of the greater success, not to that moment attained by anyone, of building a true airplane propelled by motor. Many historians think that to Lilienthal and Pilcher is justly due the title "the first flying men." But Le Bris, a French sailor, utterly without scientific or technical equipment, as far back as 1854 had accomplished a wonderful feat in that line. While on a cruise he had watched an albatross that followed his ship day after day apparently without rest and equally without fatigue. His imagination was fired by the spectacle and probably having never heard of the punishment that befell the Ancient Mariner, he shot the albatross. "I took the wing," he wrote later, "and exposed it to the breeze, and lo, in spite of me, it drew forward into the wind; notwithstanding my resistance it tended to rise. Thus I had discovered the secret of the bird. I comprehend the whole mystery of flight."

A trifle too sanguine was sailor Le Bris, but he had just the qualities of imagination and confidence essential to one who sets forth to conquer the air. Had he possessed the accurate mind, the patience, and the pertinacity of the Wrights he might have beaten them by half a century. As it was he accomplished a remarkable feat, though it ended in somewhat laughable failure. He built an artificial bird, on the general plan of his albatross. The wings were not to flap, but their angles to the wind were controlled by a system of levers controlled by Le Bris, who stood up in the basket in the centre. To rise he required something like the flying start which the airplanes of to-day get on their bicycle wheels

before leaving the ground. As Le Bris had no motor this method of propulsion was denied him, so he loaded the apparatus in a cart, and fastened it to the rail by a rope knotted in a slip knot which a jerk from him would release. As they started men walked beside the cart holding the wings, which extended for twenty-five feet on either side. As the horses speeded up these assistants released their hold. Feeling the car try to rise under his feet Le Bris cast off the rope, tilted the front end of the machine, and to his joy began to rise steadily into the air. The spectators below cheered madly, but a note of alarm mingled with their cheers, and the untried aviator noticed a strange and inexplicable jerking of his machine. Peering down he discovered, to his amaze, a man kicking and crying aloud in deadly fear. It was evident that the rope he had detached from the cart had caught up the driver, who had thus become, to his intense dismay, a partner in the inventor's triumph. Indeed it is most possible that he contributed to that triumph for the ease and steadiness with which the machine rose to a height estimated at three hundred feet suggests that he may have furnished needed ballast – acted in fact as the tail to the kite. Humanity naturally impelled Le Bris to descend at once, which he did skilfully without injuring his involuntary passenger, and only slightly breaking one of the wings.

Had Le Bris won this success twenty years later his fame and fortune would have been secure. But in 1854 the time was not ripe for aeronautics. Le Bris was poor. The public responded but grudgingly to his appeals for aid. His next experiment was less

successful – perhaps for lack of the carter – and he ultimately disappeared from aviation to become an excellent soldier of France.

Perhaps had they not met with early and violent deaths, the Lilienthals and Pilcher might have carried their experiments in the art of gliding into the broader domain of power flight. This however was left to the two Americans, Orville and Wilbur Wright, who have done more to advance the art of navigating the air than all the other experimenters whose names we have used. The story of the Wright brothers is one of boyhood interest gradually developed into the passion of a lifetime. It parallels to some degree the story of Santos-Dumont who insisting as a child that "man flies" finally made it a fact. The interest of the Wrights was first stimulated when, in 1878, their father brought home a small toy, called a "helicopter," which when tossed in the air rose up instead of falling. Every child had them at that time, but curiously this one was like the seed which fell upon fertile soil. The boys went mad, as boys will, on the subject of flying. But unlike most boys they nurtured and cultivated the passion and it stayed with them to manhood. From helicopters they passed to kites, and from kites to gliders. By calling they were makers and repairers of bicycles, but their spare time was for years devoted to solving the problem of flight. In time it became their sole occupation and by it they won a fortune and world-wide fame. Their story forms a remarkable testimony to the part of imagination, pertinacity, and courage in winning success. After

years of tests with models, and with kites controlled from the ground, the brothers had worked out a type of glider which they believed, in a wind of from eighteen to twenty miles an hour, would lift and carry a man. But they had to find a testing ground. The fields near their home in Ohio were too level, and their firm unyielding surface was not attractive as a cushion on which to light in the event of disaster. Moreover the people round about were getting inquisitive about these grown men "fooling around" with kites and flying toys. To the last the Wrights were noted for their dislike of publicity, and it is entirely probable that the sneering criticisms of their "level headed" and "practical" neighbours had a good deal to do with rooting them in this distaste.

Low steep hills down the sides of which they could run and at the proper moment throw themselves upon their glider; a sandy soil which would at least lessen the shock of a tumble; and a vicinage in which winds of eighteen miles an hour or more is the normal atmospheric state were the conditions they sought. These they found at a little hamlet called Kitty-Hawk on the coast of North Carolina. There for uncounted centuries the tossing Atlantic had been throwing up its snowy sand upon the shore, and the steady wind had caught it up, piled it in windrows, rolled it up into towering hills, or carried it over into the dunes which extended far inland. It was a lonely spot, and there secure from observation the Wrights pitched their camp. For them it was a midsummer's holiday. Not at first did they

decide to make aviation not a sport but a profession. To their camp came visitors interested in the same study, among them Chanute, a well-known experimenter, and some of his associates. They had thought to give hours at a time to actual flight. When they closed their first season, they found that all their time spent in actual flight footed up less than an hour. Lilienthal, despite all he accomplished, estimated that he, up to a short time before his death, spent only about five hours actually in the air. In that early day of experimentation a glide covering one hundred feet, and consuming eight or ten seconds, was counted a triumph.

But the season was by no means wasted. Indeed such was the estimate that the Wrights put upon it that they folded their tents determined that when they returned the year following it would be as professionals, not amateurs. They were confident of their ability to build machines that would fly, though up to that time they had never mounted a motor on their aircraft.

In the clear hot air of a North Carolina midsummer the Wrights used to lie on their backs studying through glasses the methods of flight of the great buzzards – filthy scavenger birds which none the less soaring high aloft against a blue sky are pictures of dignity and grace.

> Bald eagles, ospreys, hawks, and buzzards give us daily exhibitions of their powers [wrote Wilbur Wright]. The buzzards were the most numerous, and were the most persistent soarers. They apparently never flapped except when it was absolutely necessary, while the eagles and

hawks usually soared only when they were at leisure. Two methods of soaring were employed. When the weather was cold and damp and the wind strong the buzzards would be seen soaring back and forth along the hills or at the edge of a clump of trees. They were evidently taking advantage of the current of air flowing upward over these obstructions. On such days they were often utterly unable to soar, except in these special places. But on warm clear days when the wind was light they would be seen high in the air soaring in great circles. Usually, however, it seemed to be necessary to reach a height of several hundred feet by flapping before this style of soaring became possible. Frequently a great number of them would begin circling in one spot, rising together higher and higher till finally they would disperse, each gliding off in whatever direction it wished to go. At such times other buzzards only a short distance away found it necessary to flap frequently in order to maintain themselves. But when they reached a point beneath the circling flock they began to rise on motionless wings. This seemed to indicate that rising columns of air do not exist everywhere, but that the birds must find them. They evidently watch each other and when one finds a rising current the others quickly make their way to it. One day when scarce a breath of wind was stirring on the ground we noticed two bald eagles sailing in circling sweeps at a height of probably five hundred feet. After a time our attention was attracted to the flashing of some object considerably lower down. Examination with a field-glass proved it to be a feather which one of the birds had evidently cast. As it seemed apparent that it would come

> to earth only a short distance away, some of our party started to get it. But in a little while it was noted that the feather was no longer falling, but on the contrary was rising rapidly. It finally went out of sight upward. It apparently was drawn into the same current in which the eagles were soaring and was carried up like the birds.

It was by such painstaking methods as these, coupled with the mathematical reduction of the fruits of such observations to terms of angles and supporting planes, that the Wrights gradually perfected their machine. The first airplane to which they fitted a motor and which actually flew has been widely exhibited in the United States, and is to find final repose in some public museum. Study it as you will you can find little resemblance in those rectangular rigid planes to the wings of a bird. But it was built according to deductions drawn from natural flight.

The method of progress in these preliminary experiments was, by repeated tests, to determine what form of airplane, and of what proportions, would best support a man. It was evident that for free and continuous flight it must be able to carry not only the pilot, but an engine and a store of fuel as well. Having, as they thought, determined these conditions the Wrights essayed their first flight at their home near Dayton, Ohio. It was a cold December day in 1903. The first flight, with motor and all, lasted twelve seconds; the fourth fifty-nine seconds. The handful of people who came out to witness the marvel went home jeering. In the spring of the next year a new flight was announced near

Dayton. The newspapers had been asked to send reporters. A crowd of perhaps fifty persons had gathered. Again fate was hostile. The engine worked badly and the airplane refused to rise. The crowd dispersed and the newspapermen, returning the next day, met only with another disappointment.

These repeated failures in public exhibitions resulted in creating general indifference to the real progress that the Wrights were making in solving the flight problem. While the gliding experiments at Kitty-Hawk were furnishing the data for the plans on which the tens of thousands of airplanes used in the European war were afterwards built, no American newspaper was sufficiently interested to send representatives to the spot. The people of the United States were supremely indifferent. Perhaps this was due to the fact that superficially regarded the machine the Wrights were trying to perfect gave promise of usefulness only in war or in sport. We are not either a warlike or a sporting people. Ready enough to adopt a new device which seems adapted for utilitarian purposes, as is shown by the rapid multiplication of automobiles, we leave sport to our professional ball players, and our military equipment to luck.

So after continued experimental flights in the open fields near Dayton had convinced them that the practical weaknesses in their machine had been eliminated, the Wrights packed up their flyer and went to France. Before so doing they tried to get encouragement from the United States Government, but failed. Neither the government nor any rich American was willing to

share the cost of further experiments. All that had been done was at their own cost, both in time and money. In France, whither they went in 1908, they had no coldness to complain of. It was then the golden day of aviation in the land which always afforded to the Knights of the Air their warmest welcome and their most liberal support. Two years had elapsed since Santos-Dumont, turning from dirigibles to 'planes, had made a flight of 238 yards. This the Wrights had at the time excelled at home but without attracting attention. France on the contrary went mad with enthusiasm, and claimed for the Brazilian the honour of first demonstrating the possibility of flight in a heavier-than-air machine. England, like the United States, was cold, clinging to the balloon long after all other nations had abandoned it. But France welcomed the Wrights with enthusiasm. They found rivals a-plenty in their field of effort. Santos-Dumont, Bleriot, Farman, Latham were all flying with airplanes, but with models radically different from that of the American brothers. Nevertheless the latter made an instant success.

From the moment they found that they had hit upon the secret of raising, supporting, and propelling an airplane, the Wrights made of their profession a matter of cold business. In many ways this was the best contribution they could possibly have made to the science of aviation, though their keen eye to the main chance did bring down on them a certain amount of ridicule. Europe laughed long at the *sang-froid* with which Wilbur Wright, having won the Michelin prize of eight hundred pounds, gave no heed to

the applause which the assembled throng gave him as the money was transferred to him with a neat presentation speech. Without a word he divided the notes into two packets, handed one to his brother Orville, and thrust the other into his own pocket. For the glory which attended his achievement he cared nothing. It was all in the day's work. Later in the course of trials of a machine for the United States Government at Fort Myer, just across the Potomac from Washington, the Wrights seriously offended a certain sort of public sentiment in a way which undoubtedly set back the encouragement of aviation by the United States Government very seriously.

In 1909, they had received a contract from the government for a machine for the use of the Signal Service. The price was fixed at $25,000, but a bonus of $2500 was to be paid for every mile above forty miles an hour made by the machine on its trial trip. That bonus looked big to the Wrights, but it cost the cause of aviation many times its face value in the congressional disfavour it caused. Aviation was then in its infancy in the United States. Every man in Congress wanted to see the flights. But Fort Myer, whose parade was to be the testing ground, was fully fourteen miles from the Capitol, and reached only most inconveniently from Washington by trolley, or most expensively by carriage or automobile. Day after day members of the House and Senate made the long journey across the Potomac. Time and again they journeyed back without even a sight of the flyer in the hangar. One after another little flaws discovered in the machine

led the aviators to postpone their flight. Investigating statesmen who thought that their position justified them in seeking special privileges were brusquely turned away by the military guard. The dusk of many a summer's night saw thousands of disappointed sightseers tramping the long road back to Washington. The climax came when on a clear but breezy day Wilbur Wright announced that the machine was in perfect condition and could meet its tests readily, but that in order to win a bigger bonus, he would postpone the flight for a day with less wind. All over Washington the threat was heard that night that Congress would vote no more money for aviation, and whether or not the incident was the cause, the sequence was that the American Congress was, until the menace of war with Germany in 1916, the most niggardly of all legislative bodies in its treatment of the flying corps. When the Wrights did finally fly they made a triumphant flight before twelve thousand spectators. The test involved crossing the Potomac, going down its north side to Alexandria, and then back to Fort Myer. Ringing cheers and the crashing strains of the military band greeted the return of the aviator, but oblivious to the enthusiasm Wilbur Wright stood beside his machine with pencil and pad computing his bonus. It figured up to five thousand dollars, and the reporters chronicled that the Wrights knew well the difference between solid coin and the bubble of reputation.

Конец ознакомительного фрагмента.