AIRSHIPS AND BALLOONS

Uniform with this Volume

SEAPLANES AND FLYING-BOATS

ALL ABOUT AEROPLANES

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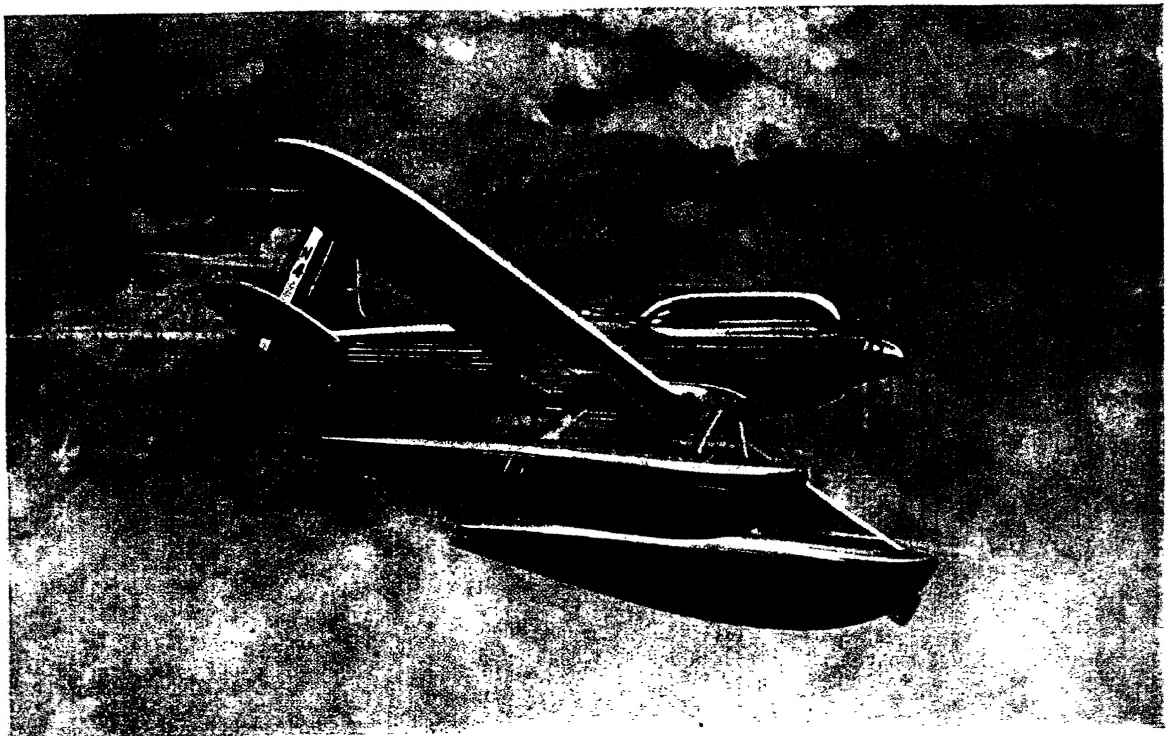

A Super-Marine Rolls-Royce. Frontispiece
Winner of 1931 Schneider Trophy. Speed, 407 miles per hour.

AIRSHIPS AND BALLOONS

by

G. GIBBARD JACKSON

Author of "The Story of the Liner," "From Post Boy to Air Mail," etc.

Illustrated with 2 Full Colour Plates and 6 Photographs

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CONTENTS

FIRST EFFORTS TOWARDS FLIGHT

GOING right back to the earliest days of which we have record, there are hints, if no more, of the belief that men ought to fly, and in some instances there are records of how men did fly.

When we come to examine closely these records of the past, we are compelled to say that they were based upon pretensions which were certainly not fulfilled; upon similar dreams to those of the people of to-day who seriously see no reason why we should not be blown to the moon in a rocket!

Looking backwards we are struck that at first the ancients believed that men would fly by the same method as birds, and that there was every reason to think that if only wings could be built resembling those of birds, sustained flights would be possible. A difficulty which became only too unsurmountable as time went on—that of maintaining a bodily action for lengthy periods to open and close the wings—was, apparently, not then envisaged.

Whilst this method of flight was counselled by many who never attempted it, the second line of approach was made; this was by using the known lifting power of gases which were lighter than the air.

Finally, and much later, some enthusiasts came

to the conclusion that flight would be best achieved by the building of a machine whose main feature was tne provision of sufficiently large surfaces to press down upon the air and thus lift the operator. In one sense the third alternative was an offshoot of the first, but it is worthy of note that experiments with what we may call bird-wing flight continued right beyond the middle of the nineteenth century, whilst the idea of a flying machine had so far matured that a design was available in the early years of the same century.

If we try to go back as far as possible, it is perhaps only natural that we should come up against some mythical flights which are as untrustworthy from a fact point of view as other remarkable happenings of a period when some men were like gods and acted in that belief.

Amongst the pioneers of mythical flight comes inevitably the name of Icarus. This bold fellow is said to have fashioned a pair of wings from the feathers of a bird, and then to have despaired of the means of fastening them to his body until he hit upon the idea of using wax. Either the heat of his body, or that of the sun—possibly both—melted the wax and bold Icarus came a cropper. Either he himself or his admirers claimed that he flew—and so we must leave it at that.

Then came Archytas and his toy pigeon, which we should suggest was nothing more or less than a silk or paper balloon filled with hot air or gas.

The two examples quoted above may be valueless as facts, but the mere record of them in ancient

chronicles proves very conclusively that men's thoughts had turned definitely to the problem of flight. Moreover, they constituted examples of either of the first two methods of flight which undoubtedly were tried, if not then, certainly later; the wings of birds, the aid of the balloon.

The churchmen of the Middle Ages appear to have been strangely fascinated with the problem of flight. Perhaps only naturally they thought and wrote rather than made practical attempts to achieve their end. Their circumstances would be against practical experiments, but as they were about the only educated men of their period, a period in which there was a distinct desire to look forward, their pronouncements are well worth examination.

One of these churchmen was Friar Roger Bacon, a man full of ideas and particularly interested in chemistry, in which he carried out many experiments. He conceived, amongst other things, the idea of a submarine, but he went far beyond anything we are likely to achieve in submersible craft, since he actually suggested that, to such perfection would they be brought, a new race of men would appear as a direct result, and that they would prefer to live under the sea rather than upon or near it!

Air conquest was constantly exercising the mind of this friar. He studied the heavens carefully, and came to the conclusion that there was a kind of aerial sea in which the clouds were the ships. He went on to argue that the clouds must have some definite weight, yet they could be supported, hence the sea

of air. Between the earth and that sea Bacon imagined there was a space which might be difficult to pass, but once passed then all would be fair sailing.

But how ? Bacon solved that point too—theoretically—by suggesting the construction of a large hollow globe of copper, or other suitable metal. He went on, "The globe being wrought extremely thin, and then filled with liquid fire, it will float upwards and voyage to and fro."

There is no record of Bacon's theories being translated into experiments, but it is a point of interest to reflect that the modern airship has much in common with that hollow globe; instead of liquid fire think of hydrogen or helium gas.

If we concede that Bacon had the germ of the airship, the monk Lana, who lived about four centuries later, went a step further in its theoretical evolution by suggesting that, instead of one metal globe four should be built, and these, having had the air expelled, would rise. To them was to be attached an ordinary sailing boat, which would then be able to sail with the clouds instead of upon the water beneath them.

Even the glider was envisaged by these enterprising churchmen, one of whom, using still the idea of wings made from birds' feathers, announced his intention of flying to France from Scotland. A tremendous glide indeed, but such was the Abbot Damian's faith in his wings that he took off—so the story says—from the eminence upon which Stirling Castle is built, and came badly to earth as the assembled crowd fully

expected him to do. Despite his injuries, the good priest was quite happy, and even optimistic.

As they set his broken leg he exclaimed: "Woe is me! Had my wings been fashioned from eagles' feathers, I should have flown in perfect safety!"

That great Italian genius, Leonardo da Vinci, was also fascinated by the possibility of man conquering the air. Whilst it is doubtful whether his machines were even begun, elaborate drawings were made. These showed very clearly that Da Vinci had studied closely the flight of birds, and knew something about air resistance, since the wings of the embryo machine were to be collapsible. They were to fold on the upward stroke of the flyer and to open upon the downward stroke.

In Britain, Francis Bacon, writing of most things, must needs take up the problem of flight, and, with his usual acumen, has something well worth while to say generally, though one of his conclusions was demonstrably wrong. This was that birds accomplished their flight not on account of their wings, but because the whole of their bodies were clothed in feathers. It would appear that the philosopher came to this conclusion from watching a single feather floating and travelling in the breeze; ergo if one feather would float and possessed a minute lifting power many should possess greater properties in sustaining weight.

Another Italian, Fauste Veranzio, comes next in our record of pioneer airmen. He is credited with having flown from the top of St. Mark's, Venice, alighting safely. Flown perhaps is hardly the word

here, since the descent must have had something in common with that effected to-day with a parachute. An old print shows Veranzio coming down, and his apparatus was something like an umbrella, though actually it may have been designed on the winged principle.

Another approach to flight was suggested by Laurentus, whose idea it was to collect a quantity of swan's eggs, empty them carefully of their contents, and then fill them with powdered sulphur. Next they were to be exposed to the heat of the sun, and he prophesied that once a sufficiently high temperature was reached the eggs would ascend rapidly. Apparently Laurentus would have linked the shells and then obtained his lifting power from their combined effort. In any case nothing came of the plan.

There came a time when a very crude steam engine was evolved, and, seeing one, Bishop Wilkins, of Chester, hailed the engine as the real aid to flight. The Bishop had already been keenly interested in the possibilities of flight, and he was one of the first to discard the prevalent idea that when flight was achieved it would be by emulating birds. Instead, Wilkins boldly advocated flying machines, and, when he saw the power of the steam engine, he went further, and suggested that if this motive force could be added, then flight would become a perfectly normal affair. Nothing came of the Bishop's plan, but notice particularly how another of these thoughtful churchmen was anticipating, by whole centuries, the day when steam would be applied to flying machines. Although

a steam engine for flight seems very obsolete and impracticable because of its weight, we have to consider two facts: first, that had the petrol motor not been discovered, it is more than likely that the protagonists of flight would have proceeded to use steam for aircraft motor power; secondly, that steam as applied to the motor-car, and to the rail steam car, exerts an enormous power for a much less weight than was the case only fifty years ago. High-pressure boilers and the introduction of light-weight metals have revolutionised the steam engine.

All over the world the problem of flight was exercising the brains of clever men. In various ways experiments were being carried out, but for the most part they consisted of what we might very well term parachute descents rather than attempts at actual flight. Some of the descents ended in disaster, but, as a rule, they were successful because only short distances were attempted. The apparatus was usually sufficiently well designed to break an experimenter's fall if it did not allow him to make the descent he desired.

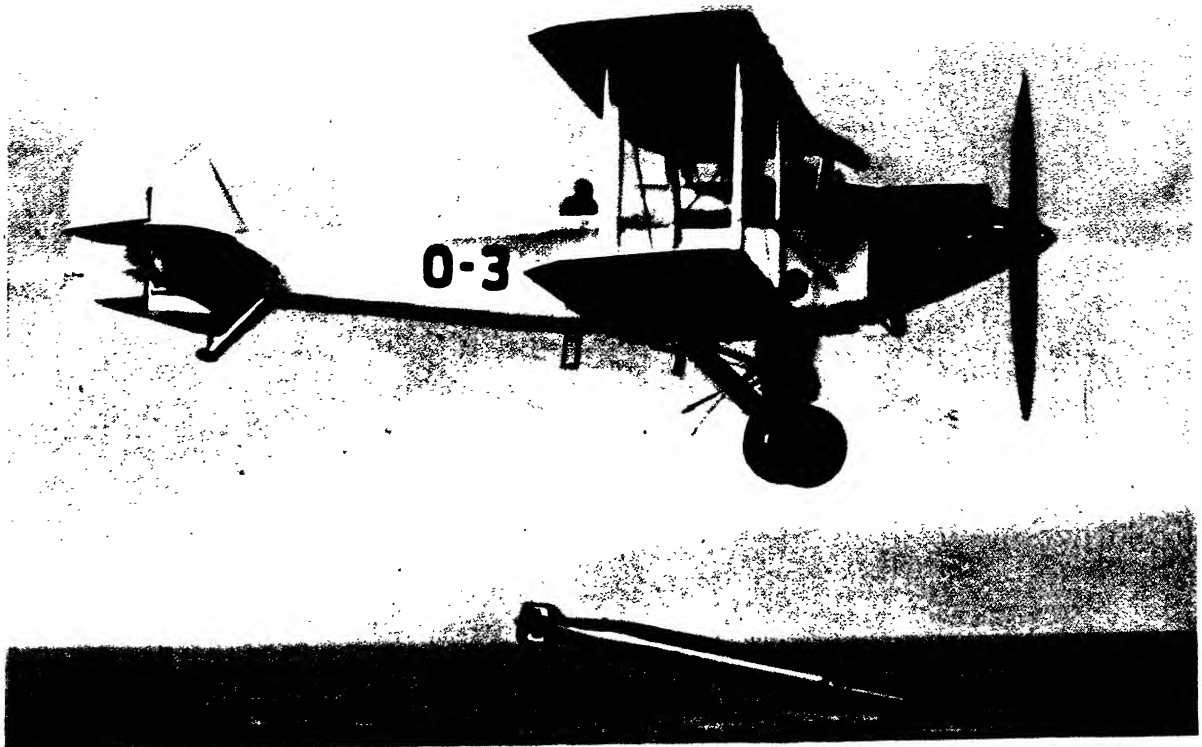
There were model flying machines made and exhibited, and these attracted a good deal of attention, particularly in Germany, where to-day the engineless 'plane has still the greatest following.

There were many treatises written to prove this and that with regard to flight. It was one of those strange turns in fate that very often the writer of a treatise, having published his views as to the impracticability of such and such a thing being accomplished in the air, awoke one morning to find that the impossible had been

made possible by some one of whom he had never heard; of whom it was true that he was working out a practical machine to do the thing which the other fellow was writing down as impossible of achievement. One such case comes to mind in the case of Besnier, a locksmith, who, having conceived the idea of wings worked by the arms and the legs, set to work to make such a machine. Whilst he was doing it he read a treatise by an Italian which stated that it would for ever be impossible for a man to leave the ground and fly by means of any kind of wings. Next we read that Besnier, by means of his hollow, paddle-like wings actually lifted himself from the ground and flew up on to the roof of a house. Another account reverses the operation, but there is substantial reason for believing that Besnier did produce a flying machine of a sort, because there are accounts extant dealing with wandering showmen who had pirated Besnier's invention, and who were wont to exhibit their skill upon the machines at the village fairs.

In the eighteenth century interest quickened still further in men's efforts towards flight. For the most part the earlier experiments in that century were of the parachute order. The Marquis de Becqueville was particularly keen on parachute descents, and beginning with slight elevations he went on to choose some descents which excited considerable perturbation, and yet attracted great crowds for their enjoyment.

The marquis had at least one unpleasant adventure with his parachute. He had calculated to descend in the gardens of the Tuileries where there was a vast



By Courtesy of] *[Vickers (Aviation) Ltd*

A "Vildebeeste" Torpedo Bomber.

crowd of Parisians to see him. He did not allow sufficiently for the strong wind, and, instead of alighting gracefully on the lawn, as he had previously done, he came down right on the brink of the Seine, narrowly escaping a ducking through the intervention of a washerwoman's bench, with which he came into collision.

Blanchard, another Frenchman, about the same period produced a curious winged car in which it is said he made a few trips. It could not have been a real success, or we should know more about it. We quote the fact—or fiction—to show the manner in which men's minds were running towards this absorbing problem of flight.

They were really great days, and although completely overshadowed by the events of recent years, they marked a period of considerable effort and of faith in the future of air travel, though not yet could the pioneers claim much progress, nor could they envisage what was likely to happen in the realm of the air.

France has always taken a prominent part in the conquest of the air; and thus it came about that whilst experiments were being made in parachute descents, and Blanchard was thinking about, if not actually experimenting with, his flying machine, two brothers were conducting a series of experiments in a French village which were destined to have more far-reaching effects than anything so far attempted.

The brothers Montgolfier were paper makers, and apparently they manufactured bags of that material.

Or it may have been that the bags were made at home for their amusement. These bags were placed upon the floor, the lower edge lighted, and then they became balloonets with the shortest of lives, since as they ascended they were destroyed. Children often play in the same manner as these rather serious Frenchmen were playing, though quite possibly they assured their friends that these were indeed scientific experiments.

In any case the brothers learnt something which decided them to go ahead on more ambitious lines. The bags were sent upward by hot air; suppose the bags were greatly enlarged and instead of being set on fire the flames were kept from the bag, would it not be possible to put the action of the hot air to some practical use?

The next step was to place the enlarged paper bags over a chafing-dish of charcoal which had no flames to destroy the inflammable material. So soon as the bags were filled with hot air they ascended from table or floor, touched the ceiling and then as the air within cooled, they sank gracefully to the ground again.

Here, indeed, was the real practical beginning of the lighter-than-air craft, though it is true that a great deal of strenuous work had yet to be accomplished. In this the brothers Montgolfier certainly took their share, and the balloonist of the nineteenth century owed much to their patient efforts in the eighteenth.

The next step was to make even larger bags and conduct experiments out of doors, but here the Frenchmen met with a very real difficulty; it was that the

heat within the balloonets cooled off so rapidly that their ascent was a feeble one.

This difficulty, like others, only spurred the experimenters on. They decided to attach the chafing-dish to their balloonets and when this was done quite good ascents were made ; in addition, it was proved that the hot air, if maintained, had a considerable lifting power.

From these experiments the brothers went steadily on with much greater containers until they felt themselves equal to launching out upon a really ambitious scheme.

THE EVOLUTION OF THE BALLOON

FROM the tiny paper bags, with which the Montgolfier brothers began their experiments, to the huge balloon of to-day, marks a very great advance. But the balloon of the present, so rarely seen now with so many virile competitors in the realm of the air, is substantially that of a century ago, so that the real evolution of the balloon may be compressed within a space of a little more than fifty years.

The success of the early experiments of the Montgolfiers was a constant urge to them to go on with something far greater than the paper and silk toys with which they had become so immersed.

On April the 25th, 1783, a huge captive balloon, having a cubic capacity of 23,000 feet, and made from fine linen, was inflated. The inflation was accomplished over a pit, but the balloon carried a heating arrangement at the neck of the opening. It had been suggested that experiments should be carried out with it whilst held captive by many willing arms. But when the countrymen felt the enormous lifting power of the envelope, and realised that it was still increasing, it is not surprising that they lost heart for their enterprise. The fainthearted let go, and even the stalwarts could not endure the prospect of soaring aloft without any

support. Thus it was that the captive became free, and was soon scudding along in the wind.

Although the Montgolfier balloon did not have a very long journey, it attained a height of something like 1200 feet. Such a height is thought nothing of to-day with our quick climbing aeroplanes, but then it was considered truly marvellous, and also that a balloon, escaping from strong men, should make its own descent rather more than a mile away. This was attributable to the rapid cooling down of the hot air within the envelope, and also the fact that the small fire placed at the neck quickly burned itself out.

This balloon is said to have shared the unmerited fate of so many other pioneer inventions. Either from superstition, or from a belief that the writhing mass was alive, it was attacked by the field workers. With their forks and spades they soon made sad havoc with the balloon that had been so carefully planned and so soundly constructed.

Another account says that the Montgolfier balloon was not attacked, and that it made at least one more ascent, coming down successfully in a vineyard without damaging the young vines which had just been planted.

In all these early records there is confusion, and the story of one experiment is mixed with that of another, until it is difficult to get at the real facts.

What is certain, however, is that the experiments of the Montgolfier brothers in the little village of Annoncay attracted the attention of people in high places, who brought them under the notice of the king. In addition, several scientists were then studying

aerostatics, and they approached the Montgolfiers directly, urging them to bring one of their balloons to Paris for demonstration purposes.

From this point progress became rapid, and soon there were other designers and makers of balloons. One of these, designed by a scientist named Charles, depended upon hydrogen instead of the usual hot air for lifting purposes. The idea was undoubtedly correct ; unfortunately, neither the designer nor the builders quite appreciated the difficulty of getting sufficient supplies of hydrogen gas. It was made from sulphuric acid and iron filings, and it took many days before it could be certified that the envelope had as much gas as it needed, great trouble being experienced from the leaking apparatus which had been fitted up for supplying it.

Excitement was roused to fever heat by the stories which went the rounds. Quite a number were spread to endeavour to prove that the whole business was a hoax, whilst others were told that all kinds of people intended to make an aerial trip. The Place des Victories was so thronged with an excited crowd that the balloon was surreptitiously removed during the night to the more secure Champ de Mars.

From this famous meeting place of all Paris, the balloon was finally set adrift, and went on its journeyings amidst the plaudits of the crowd. It came finally to the earth at Gonesse, a spot fifteen miles from the capital. Here, it is recorded, it was torn to pieces by the countryfolk, though it is quite possible that an explosion of the hydrogen had ripped open the envelope.

The chief point of interest for us in this ascent is that it followed within four months of the first ascent of the Montgolfier's linen balloon; thus it would appear that others were actually at work on the same problem before the Montgolfiers set their balloon free. If not, then all we can say is that there was no loss of time in following up the experiments at Annoncay.

Within a month of the ascent of the Charles balloon, in which the brothers Robert had a very large share. the Montgolfiers had something far more imposing ready for an ascent. There are many pictures of this balloon extant, and upon all are shown the very elaborate decorations. Even in those early days arresting designs drawn on the large scale had their publicity value.

The question of carrying passengers in this large balloon was carefully considered, and though doubtless there would have been volunteers forthcoming had they been invited, the Montgolfiers were cautious. They had faith in the lifting power of their envelope, which was inflated fully in a fraction of the time taken with previous models, but they did not feel that the present balloon should be given the burden of human passengers. There remained the animal world, and it was contended that if some farmyard habitants were sent aloft and lost their lives in the ascent, or more probably in the descent, it was only anticipating their fate by a few weeks or months. Thus it came about that a larger basket than had originally been selected was fitted, and into it was loaded a sheep, a cockerel

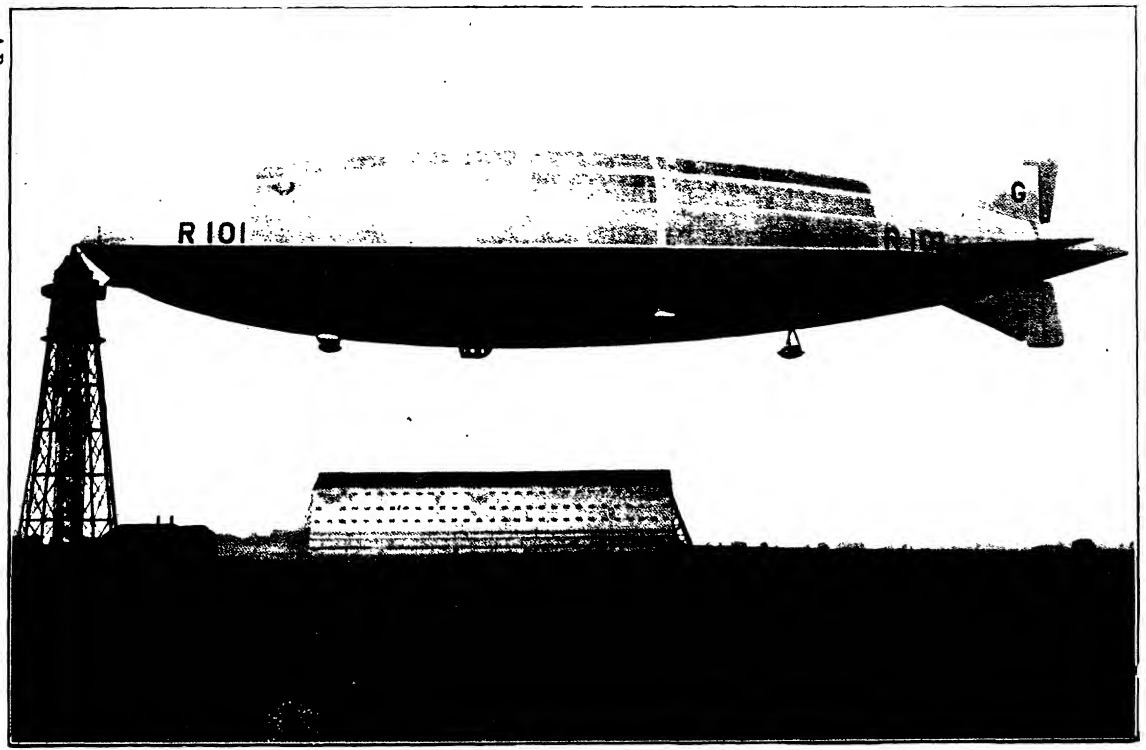
and a duck, with sufficient food to keep them employed whilst the trip was in progress.

The ascent was made from the grounds of Versailles, and it was witnessed by the king, his queen and a very large crowd. With what seemed a tremendous velocity the balloon shot upwards when released, and it quickly attained a height estimated at 1500 feet, and then was seen to be making for Vaucresson, distant two miles. Here, the hot air failed to keep the envelope buoyant, and so, after eight minutes in the air, the Montgolfier balloon came gently to earth, the passengers being found quite happy and still feeding. One account says that the cockerel was injured in the descent, his wing sustaining some slight damage. An onlooker acquitted the balloon of all blame in this connection because he saw the sheep kick the bird just as the ascent began !

We can scarcely appreciate the excitement occasioned by this successful balloon voyage. In an age of present marvels those of the past seem rather tame, and thus two miles with livestock seems a paltry trip in comparison with those which were to come later on by balloon, which, in turn, were to be eclipsed by those thrilling trips by aeroplane and airship, of which more anon.

Here, however, was the definite start of ballooning as a practical sport, since it has never been a commercial proposition.

A voyage having been accomplished with animals, naturally suggested that the next should be with human passengers. The King of France had an easy solution for the next step. He said, " In prison, condemned

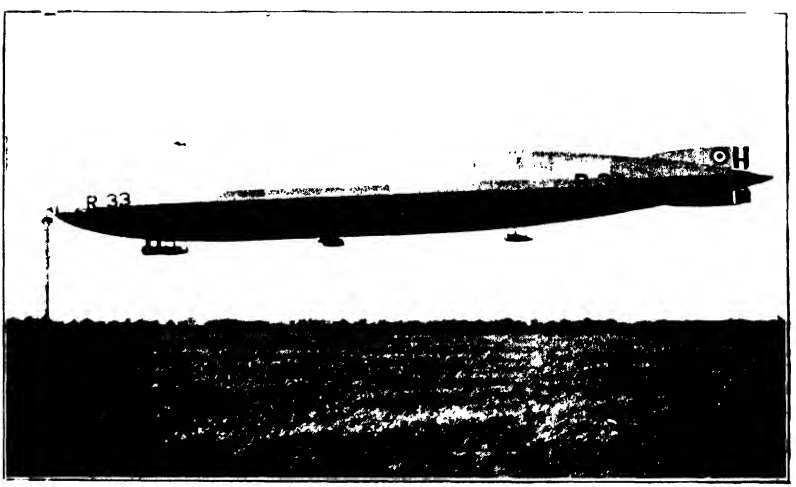


[By courtesy of Flight.

The R-101 at Mooring Mast at Cardington.

[By courtesy of Flight.

Balloons at Ranelagh when ballooning was a sport.



[By courtesy of Flight.

Airship R-33 at Mooring Mast.

to early death, are several felons. Why not send two of them up in a balloon ? If they come down in safety I will pardon them, and they shall go free for having proved as a fact what we already suspect may be possible. If they are killed—why, we shall be saved that trouble and expense ! "

Fortunately for the future of aviation the king did not have his own way. Several of his courtiers pointed out that this was too great an honour for jail-birds, and that if the thing could be done, it should be an honour reserved for men of credit.

So enthusiastic were these French airmen that, within a month of the ascent of the animal and birds, Pilatre de Rozier, a son of Metz, had offered his services for ascents with captive balloons, and very quickly he demonstrated that they were quite safe, and also that the fire beneath the neck of the envelope could be kept burning in mid-air without difficulty and without any appreciable danger.

This was a valuable point learned, for whilst many of the enthusiasts of that period still believed that hydrogen was better than hot air, they admitted the difficulty in providing it. Chopped hay and wool were used to burn in the basket of the hot air balloon.

De Rozier was joined in his ascents by de Villette, and this marked another step forward, since it proved the lifting power of the balloon, and it freed one of the airmen to give his sole attention to the fire.

Within a few weeks de Rozier felt so sure of himself that he volunteered to make a free ascent, an offer which created tremendous interest and not a little

apprehension for the safety of the bold aviator. Even the Montgolfiers, whose balloon he was to use, were rather uneasy, and they compromised by suggesting that further trial should first be made with a captive balloon.

This was agreed to, doubtless because de Rozier knew perfectly well that if all went swimmingly he could cut the rope at any favourable moment. He was joined in this ascent by the Marquis d'Arlandes, and they went aloft from the Dauphin's garden in the Bois de Boulogne.

This ascent was quite as successful as its predecessors had been, but there were some present who felt distinctly uneasy because the wind increased steadily in force, and it was observed further that the rope which held the balloon captive was chafing against the envelope. Suddenly a gust of wind carried the rope into such a position that it cut badly into the thin silken cover, and there was a ripping sound.

Had the balloon now collapsed as most of the spectators expected, that must have been the end of the bold airmen. But they so contrived matters that the descent was carried through with care, and they alighted none the worse for their adventure aloft.

The accident had the usual effect on the pessimists, and they were very loud in protesting against these dangerous practices. Even the optimistic, seeing the narrow escape of the two men, were now inclined to the view that the balloon could never be more than a toy, and a rather dangerous one at that.

De Rozier and his companion were made of the

true stuff from which all real aviators are fashioned. They appealed forthwith to the ladies assembled, begging the aid of their needles. The ladies responded nobly, and, already used to fine needlework in connection with their tapestry, they sewed up the rent so neatly that, within a couple of hours, the damage had not only been made good, but only a sharp-eyed individual could possibly have detected the join.

Again the balloon was inflated, and remembering that it was the mooring rope that had caused the trouble, de Rozier called out for it to be let free.

By two o'clock the first real balloon voyage had begun, with de Rozier and d'Arlandes rapidly mounting above the trees, whilst the balloon headed directly for Paris, which was reached in perfect safety.

The balloon was now travelling at a great height, estimated to be 3000 feet, and soon the Seine was crossed, not far from the Champ de Mars. It was at this point that it was decided to replenish the fire At once the effect of the added fuel was noticeable, and the airmen felt that they were being lifted by some great invisible hand hundreds of feet higher still. For a few moments they were rather alarmed, but quickly they appreciated one very important fact; it was that height depended upon heat, and if they wished to descend, they had the means at their command. Quite obviously they had only to let out their fire and the cooling air within the envelope would do the rest. There might, however, be some danger in too rapid a cooling of this buoyant air, so the aviators decided that they would descend slowly by the simple

expedient of gradually reducing their hot air, this by feeding the fire very cautiously and watching the result.

Having crossed Paris they found themselves amongst the hills which centre round the district now known as Montmartre. The spot was marked for them by two windmills on neighbouring elevations, and between them lay some fields—now thickly covered with houses. Here, then, seemed the ideal spot for a descent, and they landed in perfect safety, but possessing such black faces from their fire that the country folk were greatly affrighted, wondering whether these were beings from the nether regions, even though they had descended from the skies!

Without delay the friends separated, each to get into clean clothes, after a very necessary bath.

Thus was the first aerial voyage safely accomplished, and the seemingly impossible proved quite possible. Man had conquered the air!

How little those conquerors envisaged what their victory meant, and of how, within a century, the balloon would be the only link between besieged Paris and the outer world; of how, within a century and a half, the world's greatest war would see the tremendous development of the airship—the lineal successor of the balloon—and those half cousins the aeroplane and seaplane, which altered entirely the whole run of history, making Britain no longer an island, but as vulnerable as the rest of Europe if considered in air terms.

But the next step forward was simply an attempt to beat the hot air balloon of the Montgolfiers, and it

was made by the brothers Robert, working in close connection with that ingenious fellow Charles.

A large hydrogen-filled balloon was employed with a car suspended from a hoop, which, in turn, was suspended by means of a net from the big envelope above. Here, indeed, the balloon was taking on its modern form with a vengeance!

Success was again the portion of the daring airmen, and the ascent of de Rozier was completely outclassed, both as regards height, length of voyage, and distance covered. There were, in fact, two ascents, for after Charles and Robert had covered twenty-seven miles in two hours from the start at Paris, they descended safely at Nesle. Whilst Robert was satisfied with his achievement, Charles was not. Having allowed his friend to depart, he determined to go aloft again. Failing to find a volunteer, and not bothering to replace by ballast the lost weight of his companion, Charles gave orders to let go, and he went aloft at such a tremendous speed, and to a height of at least two miles, that he suffered rather badly from air sickness. But what mattered this to an enthusiast having the time of his life? He fought down his sickness and remained aloft, entranced with the wonder of his achievement, for a lengthy period, varying, according to different accounts, from 12 to 24 hours. He certainly claimed to have witnessed two settings of the sun from his balloon.

The brothers rank high in the annals of air conquest. Charles improved the balloon very considerably, adding the top valve to the container, and evolving the hoop from which the car of the balloon was suspended.

FROM BALLOON TO AIRSHIP

ONCE it had been definitely established that balloon voyaging was both safe and exhilarating it had many devotees. Some might be termed amateurs, others were certainly professionals, who made a rather uncertain living from spectacular ascents.

Although the aeroplane has ousted the balloon from all but a very limited number of festive gatherings, it had a full century of development before its younger brother, the airship, and its cousin the aeroplane proved a greater attraction to both the public and the airman.

The airship of to-day depends very largely upon the balloonets which contain the gas within the big envelope. It is very interesting to find that the balloonet is much older than the airship, and was, in fact, applied to a balloon many years ago.

The story is told of how an American built his balloon on a new plan, using no less than 47 small balloonets filled with hydrogen. Underneath was suspended a small car, big enough for a single passenger. The first experiments were carried out by tethering the strange craft to a lengthy rope. Someone appears to have suggested that no useful results would be obtained, nor the cause of aviation advanced, unless

someone ventured aloft without the restraining rope. Volunteers were called for, but for a time none responded. The inventor of this aircraft does not appear to have been too impressed with its safety. At any rate, when a free ascent was undertaken, it was a carpenter who had been egged on to make it. One account says he was not only paid well for his enterprise, but that suitable provision was made for his family in case he failed to return.

Off went this bold carpenter of Philadelphia, and, after the first misgivings had been overcome, he rather enjoyed his aerial trip. The machine, or balloon, whichever we may like to call it, behaved quite well. But when a very wide river came in sight, and right across the path of the now fast travelling machine, the carpenter lost his nerve, and getting out his knife, stabbed several of the balloonets causing the machine to come quickly to earth, not a very great distance from the edge of the wide river.

How quickly the balloon habit spread may be judged when we are told that, following the first ascents in France in 1783, England also saw similar ascents in the closing months of the same year.

The first ascents in this country were made with passengerless hydrogen balloons, some of which travelled quite long distances before they came to ground again.

Scotland has advanced the claim for the first balloon ascent in Great Britain with a passenger aboard. Credit for this goes to Tytler, who, using a hot-air balloon, went towards the clouds from Comely

Gardens, Edinburgh, in August, 1784. After a flight of something under a mile, Tytler came down in the middle of the highway, very much to the surprise and perturbation of some horses.

The news travelled to England, and very soon afterwards a young Italian, Lunardi, made an ascent in a balloon of his own design. He went up from the Artillery Ground in London, taking with him a dog, a cat, and a pigeon. The latter was let loose, and after an hour and a half in the air, travelling slowly northwards, the plucky young aviator made a descent at South Mimms, Hertfordshire. The cat had suffered from the cold, and appears to have been rather a nuisance to the airman. At any rate he put her out and then went aloft again, finally descending at Standon, not far from Ware; here the curious may discover a commemorative stone of the first aerial voyage made over England.

There are some curious side-lights given by Lunardi concerning his heroic trip. It seems he took up with him a fairly large oar, possibly to attempt to steer his balloon. Either by accident or design the oar was thrown from the basket. A young lady who had been watching the balloon, with a great deal of amazement and perturbation, saw the oar leave the car and thought it could be none other than Lunardi. She was so distressed that she went home, took to her bed, and died very quickly!

It would be interesting to know what this young woman would have thought of Miss Amy Johnson and her lone flight, not quite a century and a half later.

Another incident balances the unhappy loss of life. As the balloon passed on its way a man was in court on trial for his life. The shouts from the streets as the balloon passed over caused an adjournment of the court, and when the judge came back he was so impressed by what he had seen that he felt it incumbent upon him to discharge the prisoner, uttering a grave warning as to the future.

Lunardi became the popular hero of the hour, more especially when he visited other towns and gave successful demonstrations of aerial voyaging.

Blanchard, in France, had been busy with a flying machine some little time before the Montgolfier brothers were engaged upon balloon experiments. When he heard and then saw what could be done with lighter-than-air craft, he gave up all idea of the other attempts at flight, and threw himself into the development of the balloon.

Quickly Blanchard appreciated the very real disadvantage under which the balloon laboured—its inability to be steered. At first he thought this drawback might be overcome by means of oars. For a time he laboured at the perfection of a plan by which a clever piece of apparatus would not only allow the balloon to be steered, but might conceivably allow of its propulsion in any desired direction.

Blanchard made several ascents, and as he made one of them in the spring of 1784, he must be counted amongst the very earliest of air pioneers.

In connection with this ascent there is an interesting story told, and though nowadays little credence is

attached to the actual personality of the young officer concerned in the matter, there was a time when it was widely believed.

The story runs that, just as Blanchard was preparing to make his ascent from the Champ de Mars, a young officer rushed forward and begged to be taken as a passenger. Blanchard refused point-blank, knowing that his ascent might be endangered by the additional weight. The young officer then drew his sword and became very threatening until forcibly removed. The real point of the tale is that the young man was said to be none other than Napoleon! We may well believe that it was the kind of adventure which would have appealed to his impetuous temperament.

The success of Blanchard, and many other Frenchmen, with balloons, brought the question of their employment for military purposes very much to the fore. The French were reaching their apex as a military nation in the closing years of the eighteenth century, and it occurred to someone that the balloon offered many advantages to an army by which it might be employed.

Before the battle of Fleurus, in 1794, two balloon ascents were made, and some very important reconnaissances were carried out from their baskets. One military historian definitely credits the balloon with the success of the French arms on this occasion, pointing out that not only were the movements of the enemy made quite clear to the French generals, but the fact that the enemy knew he was under observation seemed to upset his plans.

FROM BALLOON TO AIRSHIP

The crossing of the English Channel by air was one of the earliest ambitions of balloonists, as later it became that of pilots of aeroplanes. It says much for the faith of the former that they actually attempted, and successfully attained their objective within two years of the first ascents with passenger balloons. The pioneer in this direction was the Frenchman Blanchard, and he had with him an American doctor named Jeffries. They decided that their chances of success would be greater if they ascended in England and tried to cross to Calais as offering the shortest stretch of water.

The balloon chosen was filled with hydrogen; a very fine ascent was made and the wind carried them seawards from Dover. But something went wrong—there are many views as to what it was—and the balloon began to sink when well over the Straits.

Ballast was thrown out, but still the water seemed to come nearer, followed baggage and instruments, and when there was nothing else to be heaved overboard, the aviators determined that their clothes must follow. Lightened considerably, the balloon rose again sufficiently to clear the water, and soon they were over French soil and a safe descent followed.

Pilatre de Rozier, one of the very first men to go aloft in a balloon, considered that the narrow escape of Blanchard was due to dependence upon hydrogen, and he therefore decided to attempt the crossing by means of an envelope which should have the dual lift given by hot air and hydrogen. Whether any one pointed out the danger of bringing two such agents

together we do not know, but certainly Rozier found another enthusiast who thought with him.

They ascended in safety, and the balloon began its course to the Channel; in this case it was to cross to England from France. Suddenly there was an explosion, and what had been a graceful balloon a moment ago was now a tangled mess of silk and ropes. It dropped like a stone, and two brave Frenchmen had paid that penalty which was to be exacted too often by attempting the dominion of the air.

The disaster stirred the impressionable Frenchmen, and they began to cast around for some safeguards against a repetition. A parachute was suggested as part of the equipment of every aviator, but so far no one seemed to have devised an efficient piece of apparatus. Before the eighteenth century closed Jacques Garnerin startled his fellows by announcing that he had designed a really efficient parachute, and that to prove it, he was prepared to make a descent from a balloon.

The brave fellow carried out his promise in 1797, and to the startled crowd below he appeared to be seeking certain death. He had made an ascent to a good height, and then he cut himself loose from the rope by which he and his apparatus were suspended, below the balloon. Down he came, for all the world like a lump of lead, and people began to scream, whilst others ran from the field. Then, when it seemed certain that another moment would see the dreadful end of Garnerin, he opened up his parachute and alighted smilingly amidst the terror-stricken crowd.

He at once explained that his "stunt" was not done to impress or to terrify the spectators, but that it was essential that he should fall quite clear of the balloon and its ropes before he opened his umbrella-like apparatus.

Thus Garnerin taught the first great lesson which to-day has to be learned by all parachutists—not to lose one's head and act too soon. Safety lies in choosing the right moment for the release of the lifebuoy of the air.

The spectacular crossing of the English Channel naturally suggested that wider stretches of water could be ventured successfully, and one of the first of such stretches was the Irish Sea. This was attempted in 1812 by Sadler, who went aloft in Ireland and was carried out to sea at such a pace that the voyage promised to be a very short one. As is so often the case, the wind proved a difficult servant, and then became an exacting master. Changing quickly, it flung the balloon back to sea at the moment when Sadler was considering the question of a pleasant descent on the neighbouring shore.

After some very exciting adventures he was ultimately seen and rescued by a ship, but not before he had been almost drowned.

In 1817 a son of Mr. Sadler successfully crossed the Irish Sea by air.

With the greater size of balloon and the more satisfactory methods employed in filling the envelope, balloon voyaging became quite a popular sport, whilst many scientific men became so keenly interested in

the observations that could be carried out so successfully aloft that they too, became balloonists.

There is a whole list of successful balloon voyages, most of them having a happy and a successful ending, but others, such as Andrée's to the North Pole, terminating in disaster and total loss.

One of the most exciting of these aerial voyages, in which the wind took charge of the balloon and the occupants of the basket, was when the *Nassau* went aloft from Vauxhall Gardens in November, 1836. After proceeding through the night, and by day enveloped in fog, the airmen lost all count of distance travelled, and tried to conjecture where they were. In the momentary clearances of the fog they saw lights of towns below, and they knew also that they had crossed the sea. When at last they did descend they fully expected to find themselves marooned upon the steppes of Russia. Instead, they alighted at a village in the Duchy of Nassau, where they received a warm welcome instead of what they had imagined might be a singularly cold one.

We may well conclude that, as time went on and the balloon improved its records as regards distances flown, there would inevitably come that day when the crossing of the Atlantic would be seriously discussed.

In point of fact, an American newspaper dug out an earlier project, and decided to ask for volunteers to make the attempt.

John Wise, an American aeronaut of great experience, not only pronounced the scheme as feasible,

but went further, offering to build a balloon of suitable size, and then make the trip in it. It is perhaps as well that the attempt was never made owing to the balloon bursting on a preliminary inflation. This caused the abandonment of the scheme, which, after all, was not so wildy improbable of success as one might think. Already Wise, with a much smaller balloon, had covered half the distance in a non-stop flight; and as late as 1900 a balloonist succeeded in covering almost 2000 miles from Paris to Russia.

Greater distances might have been attempted still had it not been that the airship came to oust the big balloon from pride of place as the leader of the lighter-than-air craft.

The rapid evolution of the aeroplane and airship has rather placed the old-fashioned balloon in the category of things that have been and were good. But talk to an old balloonist, and he will tell you that the aircraft driven by machinery gives none of the charm experienced in the basket of a well-built balloon, particularly if its navigator knows his job. He will dwell on the lazy days when he drifted with the wind and had only one bogy—the sea. Abroad this was rather a remote bogy, but in Great Britain one could never be really far from the ocean.

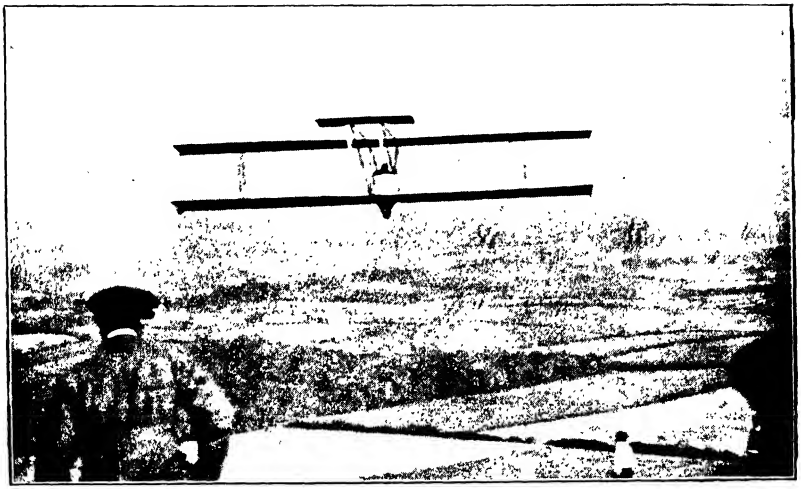
Although the balloon could not be steered, its travelling height could be determined, and kept low, which was a happy way of voyaging before the country was netted with telegraph and telephone poles, and worse still of late years, with electric cables, which might be death to touch let alone to get entangled with.

Flying low the balloonist kept in close touch with the sounds of the busy earth, sounds which are lost to the aeroplane and airship because of the noise of their engines.

Did fog or mist begin to shroud the pleasant scene, then a little ballast was thrown out; this took the balloon well above the veil, and left her in beautiful sunlight. It was always necessary to keep an eye on the ground below, though this could be done at intervals if needed. The reason will be appreciated when we think again of the proximity of the sea to any part of Britain.

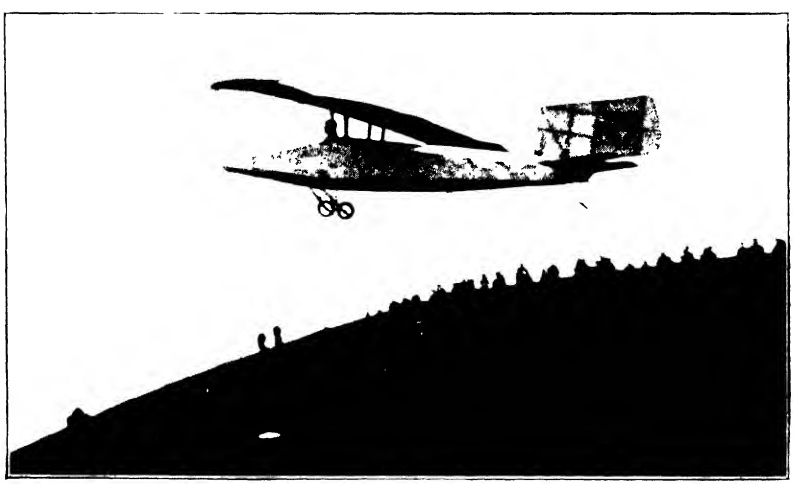
There is a story told of a balloonist who liked to make ascents in winter in order to escape the fog and cold patches of air which seem so frequently to embrace the earth. Getting right above the mist he would lie upon his ballast in his oilskins, happily basking in the brilliant sunshine, of which the world below knew nothing. One day he ascended in this fashion and was thoroughly enjoying himself, after having told his pupil to keep a look out and never to be out of sight of the earth below for more than half an hour. When they ascended the direction of the wind should have carried them inland. But what was that which broke upon the ear of both the balloonists? Clearly it was the sound of a steamer's siren! The elder man, who was an instructor, and therefore ready for all emergencies, got hold of the valve cord and alighted safely—almost on the North Sea!

That is a glimpse of the balloon as a pleasure craft, but there are occasions in which there is much strenuous work to be done aloft instead of idling, and this is



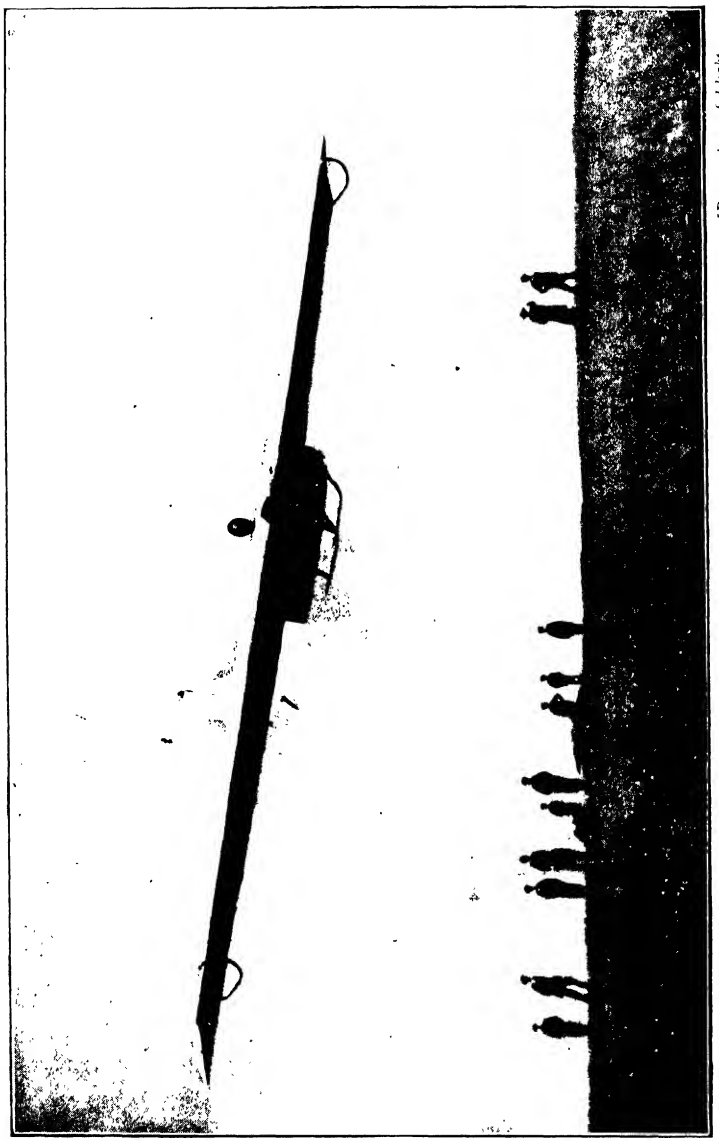
[*By courtesy of Flight.*

Herr Fokker on his Biplane Glider.



[*By courtesy of Flight.*

An A.D.C. Glider, 1922.



[By courtesy of Flight.

Raynham gliding at Ilford.

particularly true when the balloon has been entered for a race. As there is no means of propulsion, it is clear that the competitors cannot rely upon their engine being slightly better than that of the other entrants, and as all envelopes are of very similar design, there can be no question of finer lines helping one craft against the other. But that does not mean that there is nothing to be done to help in the contest for first place. Skilful handling, coupled with the greatest care, will often give a lead; more particularly the skipper—or perhaps we should call him pilot in this case—by studying carefully the instruments with which all balloons are fitted may accomplish a good deal. In one respect he can probably alter the result of a race; a quick eye will detect, by watching the statiscope, the first signs that the balloon is losing altitude, and this may be corrected.

The races for the Gordon-Bennett Cup have fostered balloon racing, and the conditions under which the cup was first presented, in 1906, allowed the contest committee to award it either for the distance covered, or for the duration of the flight, a very wise provision, since distance must largely depend upon the prevailing wind.

The winner of the first race was an American, F. S. Lahn, and the race started from Paris; in this case the winner reached a Yorkshire village after being aloft for just over 22 hours and covering 647 kilometres.

The next year saw the race take place in the United States, the trophy being then held in that country. Here a German, Erbsloh, accomplished over 1403

kilometres in 40 hours. In 1908 a Swiss was the winner —Col. Schaeck—after a voyage lasting 73 hours, and terminating in Norway from a start near Berlin, the distance covered was, however, considerably less than in the previous contest, when about half the time was occupied.

The 1909 contest had to begin in Switzerland, and it finished in Poland. Here the distance flown, though only slightly inferior to that of the previous year, was accomplished in less than half the time, which shows how largely the balloon is at the caprice of the wind. The winner was an American—E. W. Mix.

With the exception of the break caused by the War years, the contests proceeded until 1924, when Ernest Demuyter, Belgium, having won the trophy three years in succession, retained possession. For three years there was no competition, but a second cup was offered by the donor of the first, and, in 1927 and 1928 it remained in America. Apparently two years' win under the new conditions enabled the Americans to hold it permanently; in any case the third cup was offered in 1929, when it was won by Van Orman after a trip of 341 miles.

The cup has never been won by Britain.

The full record of these races, and others, in the air cannot be given here, but it may be mentioned that they will be found in *The Aviation Year Book*, which has been well described as "The Whitaker of the Air!"

Ballooning as a sport has naturally suffered from the competition of other pursuits less costly, and even

with those possessing the air mind, the light aeroplane, and more particularly in the last year or two, the glider, have taken first place. A balloon when all is said in its favour is rather an ungainly fellow, and ascents are not possible from any spot, largely because of the difficulty in obtaining gas.

The making of hydrogen in bulk has not made progress in this country, though abroad, where ballooning seems to have created a demand for the gas, it was possible to buy it fairly cheap. There were centres where balloons could be filled at a price per 1000 feet which would leave an Englishman aghast with the cheapness of the stuff. Even if plants could be laid down for making hydrogen for balloonists, say at airship stations, there would not be many who could afford to take it. If made at a price not now deemed feasible, but which might be if plant could be utilised in other directions, it would cost about £20 to fill an ordinary envelope. And we have to remember that in the descent, most, if not all, of the gas must be lost.

One enthusiastic balloonist has made the suggestion that the gas wasted from the airships could be sold to the balloonists at a cheap rate, and yet prove a good investment for the government when they have to empty the containers of the various airships. At present, owing to its loss of efficiency, the gas has to be emptied, to escape to the outer air, meaning a tremendous cost for renewal.

The cost of coal gas is equally prohibitive, and there is always the difficulty of connecting the gas works with the envelope. Unfortunately for the balloonist,

the modern gas plant is usually right amongst houses, though again a balloon does not need a long run like an aeroplane, its ascent being practically vertical.

The modern balloon is singularly well equipped for all emergencies, and with good reason its protagonists aver that it remains the safest of aircraft, being fool-proof to an extraordinary degree. To this might be added the proviso that the balloonist must know his job just as much as the pilot of an aeroplane or the skipper of an airship.

It is largely a question of careful organisation before the ascent which ensures its success and happy ending. The trail rope and grapnel, placed all ready outside the basket, must be so arranged that they can be released quickly; the instruments, particularly the altimeter and statiscope, must be placed in such a position that they can be consulted without difficulty. The watch for time and the compass for direction are often carried in the pilot's pocket. Maps must be handy, and it is very essential that a good knife shall be ready should it be necessary to cut away the trail rope if it becomes foul with anything on the ground. The correct amount of sand ballast must be placed within the basket with a few bags of sand on the outside to be taken off at the ascent. Food must be stored, of course, for a lengthy trip.

THE FIRST AIRSHIPS

THE difficulty with the balloon had always been the inability to steer it. A tremendous number of experiments were made, and although perhaps some slight success was attained, the results were never sufficient to make the balloon a dependable means of transport.

During the Franco-Prussian War many balloons were made in Paris, and something like seventy were despatched from the besieged city.

The full drawbacks of the balloon's lack of steering apparatus was clearly demonstrated in this connection; had these seventy balloons been able to have made for a particular spot and there descended, right away from the German lines, they could have been re-inflated and loaded with urgent provisions and ammunition for Paris. But where the wind willed there the balloons had to go, and, in some cases, they fell into the hands of the enemy, nor could they ever come back.

It was during the siege of the French capital that, the disability of the balloon being fully demonstrated, attempts at making dirigible airships were put in hand.

De Lôme was a naval architect who had been responsible for some outstanding vessels in the French Fleet; he was entrusted with a commission to design

what was then called a dirigible balloon. Unfortunately for this clever designer, he was placed most awkwardly owing to a lack of the necessary materials, and so great were the delays in carrying out his plan, coupled with a shortness of money, that the war had been over several months before De Lôme's airship was ready for her trial trip. The designer had planned to install a hot-air engine for driving his curious craft; this was never installed, and for propulsion the airship depended upon the exertions of eight men, who, concentrating their power on a crank, drove the propeller at a not very rapid speed. The inventor realised from the outset that he must get rid of the globular envelope, and he replaced it by a cigar-shaped air container; this was 119 feet long and had a capacity of 122,000 cubic feet.

The basket-work car was suspended some distance below the air container; it was quite a large car for its period, and provided accommodation for no fewer than fourteen men.

This pioneer French airship marked a great advance upon any previous type of lighter-than-air craft. Though regarded as a failure, De Lôme certainly hit upon details which were embodied in later airships.

It is perhaps necessary to add that there were several prior attempts at the production of airships—or possibly we should call them balloons capable of propulsion—before this period, but there is nothing which can be written down as really pointing to a successful outcome of these attempts.

Some of the attempts included steam engines as the propelling force, whilst Giffard, the French engineer, who invented the injector for feeding the boiler of the stationary and locomotive types of steam engines, came very near to success with this type of machinery. Later came renewed attempts at airship building with gas engines as the motive power. The gas engine of the 'seventies was rather a crude kind of machine, and it is not surprising that it was not successful, quite apart from the fact that a new element of danger was introduced into the make-up of the airship owing to the fact that gas was not only very inflammable, but that a good deal of heat was caused by the explosions in the cylinders of the engine. In the 'eighties came the electrically-driven airship of the Tissandier brothers—good in general design, but having such drawbacks that the craft cannot be added to those which marked substantial progress to the fine airship of to-day.

Two military men, Renard and Krebs, took the airship with the electric motor a step further, and here it is on record that not only was a steady speed obtained and maintained, but that the craft proved extremely susceptible to her rudder, a factor which had been too frequently absent in previous attempts.

A name which is inseparably linked with the development of the airship of the non-rigid type is that of Santos Dumont, who began with balloons, realised their full disadvantages, and then came to France—the Mecca of all the enthusiastic airmen in a period which saw the greatest advances made. He then went ahead with several ventures, including the building of

a series of airships, each one of which marked a step forward. Mishaps involving danger to him, and destruction to many of his ships, simply egged on this intrepid airman to greater efforts, and, with his No. 6, he managed to secure the Deutsch Prize of 100,000 francs offered for the first successful flight from St. Cloud to the Eiffel Tower and back within half an hour.

After having done splendid work with airships, Santos Dumont seems to have come to the conclusion that the future lay rather with the aeroplane, and he carried out many successful flights with this then recently invented machine. He also designed and built some successful craft.

The effect of the experiments of the young Brazilian was seen all over Europe, and most of the leading experts of several countries attempted the construction of airships which were, at the beginning of the present century, thought to hold a greater opportunity for successful voyaging than the aeroplane. For a few years after its invention in 1903, the aeroplane showed signs of too many weaknesses to give encouragement to any but the most enthusiastic.

The Spencers in England produced several very good airships of the non-rigid type, and they were seen over London. Perhaps the best known was the Mellin which had a silk envelope seventy-five feet in length and a gas capacity of 20,000 feet.

Meanwhile the Army workshops at Farnborough were well to the fore with the construction there of several quite successful types of airships ; though weak

and small in comparison with modern craft, they demonstrated very clearly that for observation work, involving only a slow rate of speed, but great endurance, they were superior to the best heavier-than-air craft of their day.

Amongst them were the *Beta* and the *Nulli Secundus*, the former having quite a long and useful life, finishing her career with the Belgian Army in 1916. She was employed in spotting for the Belgian guns.

Perhaps the greatest interest was evinced in the Lebaudy airship, which gained a great reputation with the French army authorities, and it was said that our own army wanted to secure one built to the same plan. There was so much delay that one of our leading dailies organised a fund and presented an airship of this type to the Government.

In 1910 the Welman airship was built for an attempted voyage over the North Pole, and although she was driven back and many people thought the project hare-brained, it is worth recording here that the Pole has been twice crossed by airship since. This American airship was then prepared for a crossing of the Atlantic, and had made some progress in her attempt when she was compelled to give in, her crew being rescued by a passing ship. An outstanding feature of this voyage was the trailing of a kind of sea anchor, which it was hoped would ensure the safety of the airship. In all probability the retarding effect of a long chain of floating canisters was largely responsible for the failure of the trip.

Throughout the story of the airship one is struck

with the vast difficulties experienced by the men who had faith in this type of aircraft. Always there was a derisive element, especially amongst many of the protagonists of the heavier-than-air machines who saw in the other class a competitor. To these were added the ignorant fellow who knew nothing and was not disposed to lighten his own darkness by searching for the truth about the airship. Then there was the important, and almost insuperable difficulty: unless a thing shows either an immediate profit or one to be anticipated within a reasonable time, the business element is not attracted. It so happens that the airship is an expensive affair to build, even the smallest running into thousands of pounds, whilst one of the modern monsters will need at least half a million. To this was added that all history has shown that the airship is essentially a vulnerable type of craft.

To take a concrete case of what was involved in building the smaller class of airship, such as the *Nulli Secundus*. No less than 200,000 oxen contributed to the making of her envelope, their share being the small section from each animal to make the gold beaters' skin. These sections measured roughly 30 inches long by about 8 wide, and each section cost something like twopence. But as soon as the demand was felt, the price was raised immediately by quite 20 per cent.

As the envelope was about 110 feet in length and had a circumference of 90 feet, the number of skins required may be estimated. Yet, perhaps, this would be difficult, because there was considerable overlapping of material, and the total cost could not have been

less than £2000 for this purpose alone. There was the cost of construction of the framework and the motor—this latter ran to £500, and a single filling of gas took well over £200. These details were fairly well known, and it did conspire to make the airship appear as a very expensive kind of toy, quite beyond the means of the air enthusiast, and rather a waste of public money for the Government to undertake their building and running.

The late E. T. Willows was probably the most successful designer of airships before the war, and he accomplished some really fine trips in 1909-10.

He crossed the English Channel by night, voyaging from London to Paris, incidentally being the pilot of the first British-built airship to cross the Channel, and he gave many demonstration flights over Paris and various British towns.

Unfortunately, the Government could not be induced to give any real support to Mr. Willows and other pioneers of the airship, or quite easily aerial history might have been written very differently, and we as a nation much better prepared for the blow which descended in August, 1914, as if from the air itself.

Beyond a few small ships we had nothing to compare with those very efficient Zeppelins, whose presence over England, with all lights out, was suspected some months before the Great War began.

The experience gained by the crews of the pioneer Zeppelins was sufficient to ensure that no efforts were relaxed in the country of their birth to make the airship at least a very good second line of defence.

UNTIL Britain showed, by her building and successful navigation of the various airships included under the "R" denoting letter, that she could compete successfully with German builders, the Zeppelin was counted the highest point reached in lighter-than-air craft.

Germany may indeed be proud of having evolved so successful a type of airship, and in this evolution there is a good deal of romance mixed with solid endeavour.

Whenever the Germans settle down fairly to tackle a subject they are usually successful. In the first place it has been said that they are quick to learn; then that they are splendid copyists, bringing to their work the utmost application, and so ensuring a successful outcome.

Never has this been shown more clearly than in the Zeppelins.

And if it be true that some aircraft critics condemn them in common with all lighter-than-air types, their originators can at least point with pride to the many achievements of these splendid ships, not the least being those of the *Graf Zeppelin*, at the moment the pride of Germany's aerial mercantile fleet, even as the *Europa* and the *Bremen* are rightly acclaimed as the queens of the ocean.

Up to the production of the pioneer Zeppelin, with one or two notable exceptions, the airship had been of the non-rigid type—actually we might call it a balloon with an elongated envelope, but having power for propulsion. Indeed, it was the stage which marked the evolution of the balloon to the airship of to-day, though, of course, the balloon as a balloon, still maintains its original pear-shaped gas container and square basket beneath it.

Count Zeppelin had become interested in balloons and airships, and, with his growing interest, came an intensive study of the problem.

He was soon assured that the non-rigid type had very little future because of its manifest disabilities, not the least of which was its parlous position did a leak occur and the envelope become more than a trifle soft and flabby. If the leak proved a rapid one, then the earlier airship was *hors-de-combat*, and sometimes in positive danger. The drawback which the pioneer airships suffered was that experienced by the earlier ships of the ocean. That is to say the envelope was like the hull of the vessel which lacked water-tight compartments. In both cases a big leak meant inevitably the sinking of the ship. When, however, the hull of the ocean-going ship was divided into several water-tight compartments, any two or three of which might be flooded without endangering the ship, safety was greatly increased. So with the airship, and Zeppelin was one of the first to appreciate that the water-tight compartment idea must be applied to it. He did it by providing a cigar-shaped outer cover in which were

enclosed many gas-bags, or balloonets. One or more of these could leak and lose its gas without seriously affecting the speed or the safety of the Zeppelin. An Austrian, Schwarz, had already hit upon the general idea of what a successful rigid airship should be, and it was largely on his theories and facts that Zeppelin was able to make his first experiment.

The 'nineties were great years for Germany; her empire was growing, also her trade, and more particularly she was building fine liners, which compared very favourably with those which she had formerly ordered in Britain. Indeed, in 1897, one of the home products actually took the Atlantic Blue Ribbon from England, who had held it undisputed for many years.

In such circumstances it is not surprising that the people of the Fatherland were not only willing to listen to Zeppelin's ideas, but to subscribe the necessary funds to carry them into practice.

With that thoroughness so characteristic of the German race, Zeppelin began as he meant to go on. First, he selected the best possible site for airship building. This was at Friedrichshafen, on the shores of Lake Constance.

A very large shed was erected, and left open at one end, though a curtain could be pulled across it. Realising that the best taking-off space for the new airship would be over the water, the shed was actually built upon a series of pontoons. The shed—or dock, as it came to be called—was equipped with the necessary offices and quarters for the designers and constructors of the new vessel.

It was not until July, 1900, that the first Zeppelin was hauled out of dock for a trial trip over Lake Constance. Like our own R100 and R101, it was regarded purely as an experimental craft; by it should lessons be learnt which might revolutionise the whole future of travel.

It is well to note the date of the launch—more than three years before the Wright brothers solved the other method of flight by a motor-driven heavier-than-air machine. We are left to conjecture how the story of the air might have been written had the Wrights failed and others had followed closely in Zeppelin's steps, making the rigid type of airship the sole object of their hopes and achievement.

Unfortunately, there was a slight mishap with Zeppelin I, which, though it spurred the designer to greater efforts, rather discounted the success which he had undoubtedly obtained. It is so with all inventions, especially with those connected with transport. The early motor-car held up by the roadside from some undiscoverable but not really serious fault; the locomotive of Stephenson which often stopped and refused to budge, the early steamships, whose engineers had to draw the fire of their boilers and come home under canvas—all of them seemed to point only one lesson to the pessimist—that man could not succeed in mechanical transport. But to the optimist they told another story, a story which has had its reflex in every advance that the world had made—that first failure is the stepping stone to real success.

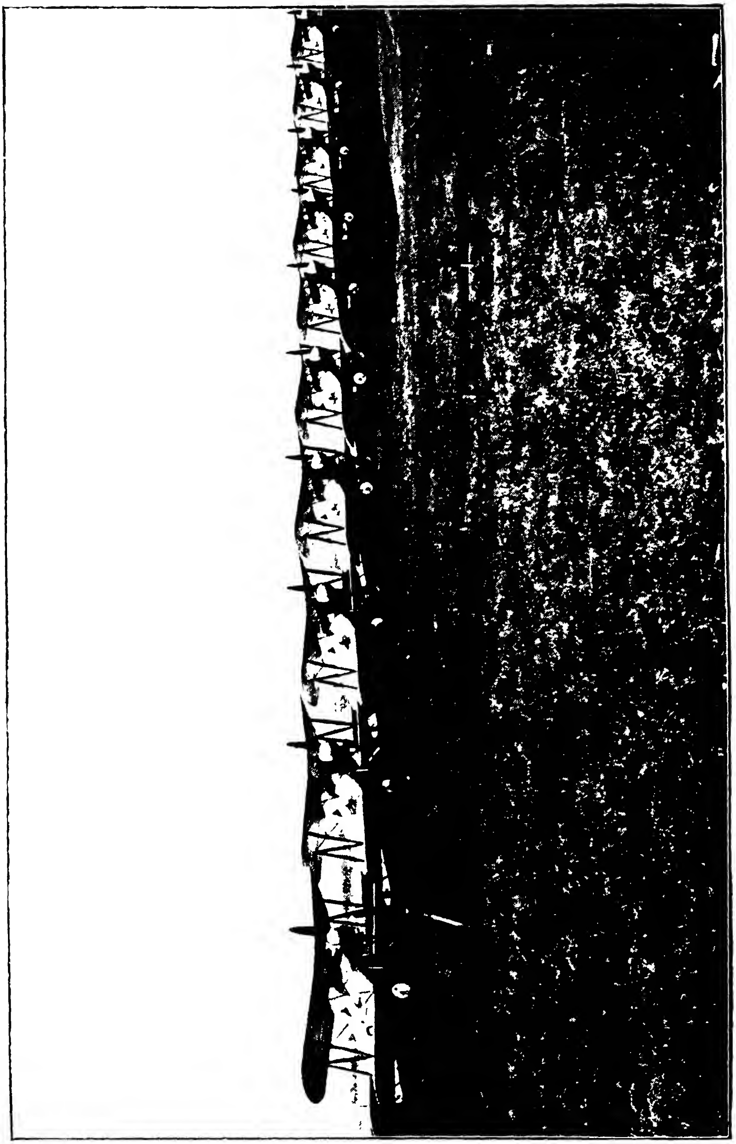
In this pioneer Zeppelin the designer had provided

no fewer than seventeen balloonets ; this was the first great essential, and one which has never been departed from save in their size and number.

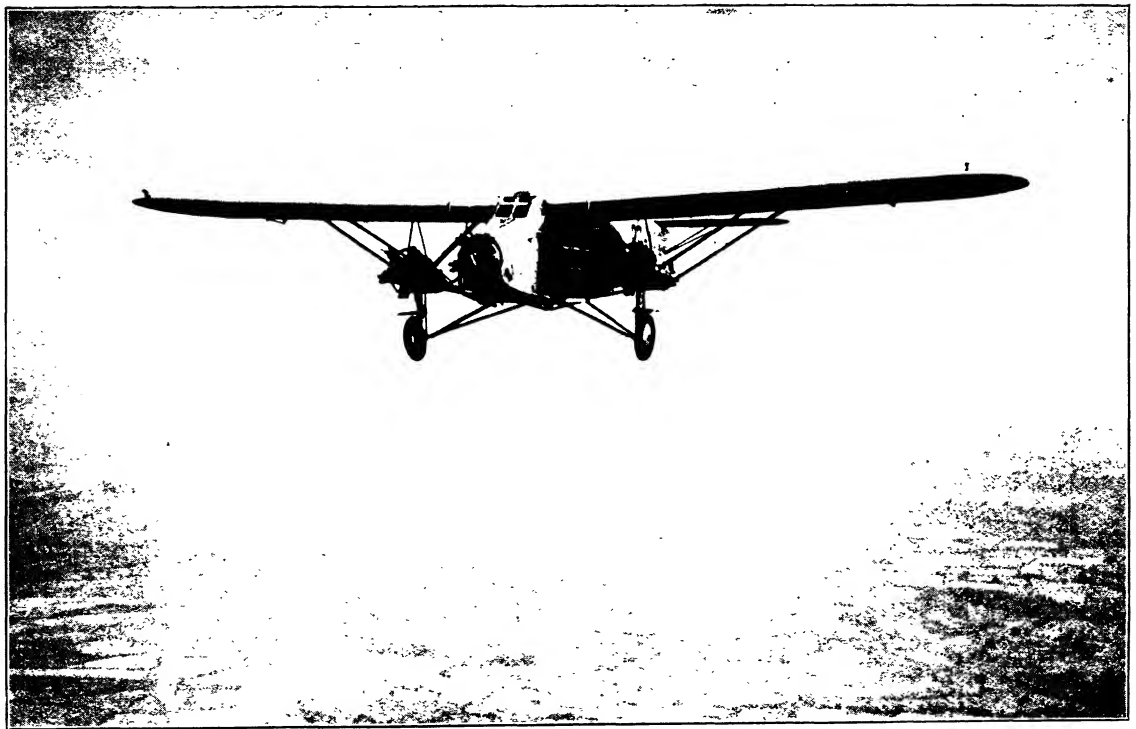
The balloonets were filled quite easily from floating containers, which brought the supply of hydrogen right alongside the airship. Four screws were employed to drive the ship and two gondolas were provided.

The performances of the pioneer Zeppelin were closely studied, and then number two was built, followed quickly by three and four. In each one some improvements were carried out, and, by the time the fourth ship was in service, the designer felt that he really had solved the question of successful flight. Then, as was to be the case so often in all types of aircraft, whilst every one in Germany was rejoicing in the success of the Zeppelin and her designer, the extreme vulnerability of the lighter-than-air craft was clearly demonstrated by a disaster which fairly upset the trend of German ambitions in the air—though only for a time. Fortunately, the disaster to the airship did not involve her crew. In the year 1908 Count Zeppelin decided that his No. 4 ship should make an exhibition flight so that his countrymen might see for themselves that the claims which had been made for the product of the big dock on Lake Constance were of real importance. No. 4 was therefore started upon a cruise, which followed on some highly successful voyages between Zurich and Lucerne. The commander was instructed to make a twenty-four-hour cruise, following as a guide the lovely winding Rhine. Reaching Mainz he started back, but was compelled

LATEST TYPES—I.



A batch of Fairey *Flycatchers*.



[*By courtesy of Flight.*

A Westland *Wessex.*

by a slight irregularity of the engines to come to a stop outside Stuttgart, where the ship was temporarily anchored down. Whilst anchored the wind changed to gale force, and, with a terrific wrench, the Zeppelin broke loose, soared upwards for some distance; then followed a loud explosion, and what had been a minute before a splendid ship of the air was so much debris—a tangled mass from which it was impossible to learn much of the cause of her going. It was not the gale, that is certain. One theory which was generally accepted was that lightning had caused a common explosion in which all the balloonets were involved.

This was a terrible blow to all concerned, but especially to the Count. Its effects were far-reaching at a time when the heavier-than-air was challenging its rivals. For Zeppelin and his enthusiastic supporters the disaster merely acted as spur to greater efforts, although they felt very keenly the loss of this splendid ship.

The German public opened up subscription lists, and such was their faith in the champion of the air-ship, that sufficient money was quickly subscribed, not only to replace the lost vessel, but to build others. Amongst them was the *Deutschland*, which, after a very brilliant opening to its career, ended it by breaking adrift in a storm; later being blown into a forest whose trees pierced the balloonets and brought the ship to the ground in a completely wrecked condition, thereby providing another peg upon which the dismal Jeremiahs hung a further wail or succession of wails.

The net result of these two disasters was to prove

to Zeppelin that his ships were under-engined. He profited by his lessons, and in all succeeding vessels the engines were of much greater capacity. How the Zeppelin would have progressed and become, quite possibly, purely a mercantile craft, we can only surmise. But, by the time the improvements had been carried out, and the size and power of the airship had been substantially increased, the war cloud, which had been gathering, finally broke and made enemies of friends.

It was only natural that the Germans, faced by a very great and growing series of enemies, should look to their Zeppelin fleet to help win the war. They knew too well, from the outset, that if they were to succeed the struggle must be sharp but short.

At first the Zeppelins appear to have been mainly regarded as auxiliary craft for observation duties, particularly with the fleet. Upon these duties they served well, and obtained much information, particularly of the movements of the British fleets.

In the spring of 1915 they took upon a new rôle, and became a sinister menace to Britain. Up to this point we had boasted of our right little, tight little island, with a navy which was so much stronger than all its rivals, that it could maintain that insularity which was so important a factor in the nation's welfare.

On a May night L.Z 38 stole out from a shed which had been erected near Brussels for her accommodation, and came swiftly over the Channel. Already the airship had crossed the North Sea and investigated the defences of the Thames estuary; these it found to be too strong for a direct approach via the river. It

therefore came about that the commander of the L.Z 38 crossed the coastline at Margate, and came, at a very great altitude, over London. More than 100 bombs were dropped on or near the city. Seven non-combatants were killed and thirty-five were injured, whilst a good deal of damage was accomplished. It was the moral effect for which the Germans were anxious; on the whole that effect was to steel our people to go on with the struggle with greater activity, and endeavour to put an end for all time to this type of warfare. The airship which had started out to accompany the L.Z 38 was turned back by gunfire, and within a week it was brought down in flames by gallant Warneford, who, alas, after earning the V.C. for his exploit, lost his life from the air only ten days later.

Altogether several airship raids were carried out over France and England, but they certainly demonstrated in no uncertain manner that this type of aircraft was exceedingly vulnerable. Quite a large proportion were lost or returned to their bases in such a crippled condition that they were out of service for long periods.

Not always was the crippling done by our airmen; there were many ways in which the Zeppelin could suffer. To give but a single instance, and we see why the Germans ceased to worry us with this type of aircraft. A fleet of Zeppelins was despatched to raid London with instructions to hover over the city with engines cut out. It had been found that on previous raids, the noise of the engines had enabled attacks

to be followed up on the Zeppelins by aircraft and by anti-aircraft guns. The commanders of the raiders found that the plan worked excellently until they came to start up the engines for their return—they were frozen up! There was nothing for it but to allow the ships to drift; they became balloons, in fact, and now was experienced to the full all the disadvantages of the craft which the airship had been designed to supplant. The Zeppelins were carried over France and few, if any of them, ever got back to their base.

Under the Peace terms the Germans were placed under certain limitations as regards the construction and operation of aircraft. But even with these limitations the work of perfecting the Zeppelin has gone on, and with the improved Maybach engine some remarkably efficient ships have been turned out from Friedrichshafen. Amongst them is the Z.R 3 which was built for the United States and made a highly successful trip out there. This ship now ranks as one of the most valued units of the United States aircraft defence arm.

Plans are well forward to build some much larger Zeppelins. There appears good reason to believe that they will mature and that the airship will take her rightful position in the commercial services for which she is so well fitted.

The *Graf Zeppelin's* successful circling of the world showed very clearly how steadily the airship has gained ground. Before the start a good deal of scepticism existed as to whether such a trip would be possible,

especially for an airship which had not been designed with that end in view. Herr Eckener was very anxious to demonstrate the capabilities of his craft under varying weather and climatic conditions, and it seemed to him that it could not be done better than in a voyage which would ensure a very considerable range of possible contrasts in these respects. Although not absolutely necessary to circle the globe to attain these ends, there was after all the spectacular appeal that such a cruise would afford, both to those who would make the trip and to those experts especially who had pinned their faith to the lighter-than-air craft.

Although the earth had already been circled by heavier-than-air craft the trip had been so prolonged, and the pauses so necessary and frequent that it was realised that the *Graf Zeppelin* could easily beat the existing record if she had any sort of luck. Her skipper knew at the outset that he would be able to make a very limited number of stops, because there were so few places where accommodation was available for such a huge craft. Even mooring masts were few and far between, whilst hangars, sufficiently large, were fewer still.

Commander Eckener finally decided that there could be only three stops en route if all went according to plan ; obviously to keep to the route planned needed careful navigation, wise forethought as to provisions and fuel supply, and a determination that the ship should face and surmount the weather conditions whatever they might prove.

Up to this circling of the world the prevalent

opinion was that the airship was a fair-weather craft and detractors of this type of aircraft could certainly point to the undoubted fact that, for days together, airships had been unable to leave their sheds on account of what seemed a mere capful of wind, or even when there was no wind, but an expectation of some.

It is true that the double crossing of the Atlantic by the *Graf Zeppelin* herself and the earlier British R 34 had shown that such craft were not quite the fair-weather ships which some experts thought them. In spite of all this the general opinion was still that an airship was too large and clumsy for very long distance voyages where weather conditions could not be sufficiently forecasted.

To the commander of the *Graf Zeppelin* it seemed the golden chance to take, plan the route, and follow it even as a liner would follow her route across the ocean, though in the case of the airship, land had to be added to ocean as regards route.

The first leg of the voyage was therefore scheduled from the base and birthplace of the Zeppelin at Friedrichshafen to Tokio. This promised to be not only the most difficult, involving the crossing of Russia and Siberia, but also the most interesting.

One of the first difficulties that Commander Eckener had to face was the fact that reliable charts of Siberia were unobtainable; this was distinctly unfortunate because the mountains of this partially explored country might easily prove to be the greatest obstacle to the successful crossing of this very desolate portion of Asia.

A forced landing in this part of the world would easily be the worst misfortune that could await them ; it might prove a fatal landing too.

The most direct route would have been via the southern belt of Siberia, but in the absence of the maps, coupled with the lack of knowledge of the altitude of the mountains which would have to be crossed, and the very strong probability that clouds, mist, and perhaps fog, would be experienced over these mountains, it was decided to take a more northerly route.

As it happened the commander of the *Graf Zeppelin* had to alter his chosen route, and actually the trip over Siberia was approximately equi-distant between the northern coast and the southern boundary, though as circumstances demanded the course was often varied.

Hundreds of miles of lonely swamp were flown, and where the forest began there appeared also some tremendous fires, covering huge areas of what would undoubtedly prove a rich timber area.

The marshland of Siberia is probably the most depressing in the world, even as it is the most extensive. A mishap to the Zeppelin over any of these series of giant swamps would have meant a complete blank for the world, since only from the air would any trace of the airship have been found. And it would have been like looking for a needle in the proverbial haystack. Nor could a search have been made by heavier-than-air craft, whilst Zeppelins, or indeed any other kind of airship, are notable because of their fewness.

Some idea of the length of the largest section of swamp may be gathered when it is recorded that it

took the giant ship fourteen hours of steady plugging to cover it. Even with this desolation passed they voyaged for hours over country which probably no human eye had seen before; certainly they saw not the slightest trace of habitation. Later came mountainous country to be crossed, which, if more interesting, was also more dangerous for navigation, because the air currents and storms were constant, and yet of uncertain onset in the case of the latter.

Had the weather not been singularly clear, it is doubtful if they would have passed successfully the highest peaks. Finally, the Pacific coast was crossed, and the *Graf Zeppelin* reached Tokio in rather less than 100 hours after leaving her base. The distance was 7500 miles, equal roughly to crossing the Atlantic three times without a stop!

The next stage meant the first non-stop run to be made over the Pacific, and this seemed a relatively easy task after that long voyage over Russia and Siberia. Only sixty-eight hours were needed for this stage of the flight, and then without undue delay the commander turned his ship to the east again to continue to Lakehust, the home of the Zeppelin *Los Angeles*, which Dr. Eckener had piloted over the Atlantic from Germany. Here the third stop was made, followed by the final leg of the long voyage to the base at Friedrichshafen, which was reached without incident. Thus was the world encircled by an airship.

Since then the *Graf Zeppelin* has made many trans-Atlantic crossings, carrying mails to and from South America.

THE AIRSHIP OF TO-DAY

THE protagonist of lighter-than-air craft finds it necessary always to stress that the airship is only at the real beginning of its development. This stressing is necessary because quite a number of voices and pens are at work denouncing this type of aircraft, whilst extolling its rivals of the heavier-than-air classes. Between the two classes there is no real rivalry, each has its special sphere of action, and yet, if worked in conjunction upon suitable services, it does seem apparent that commercial flying, at any rate, belongs to both.

The ideal is probably the long distance service which could be operated by much larger airships than any yet launched, with mooring masts at stated intervals. These would be the exchange points for traffic for which the aeroplane would act as feeder.

Several long distance services at once suggest themselves in which mail carrying would be the chief feature, with passengers next, and then express goods traffic. We put passengers second instead of first, because it is realised that the number of people who are in a great hurry are really negligible, and that, on the whole, the higher fares which will be necessary via the air will not be worth while save to the man or

woman to whom time is vital indeed. Mails, however, can and would provide a great deal of revenue, as witness the constantly growing receipts from the Indian service. Express goods of the lighter kind would also provide good revenue, and in any case the space required for both these items is far less than would be necessary for a dozen passengers who were travelling the whole way. Even in the biggest airships of the future it is difficult to imagine there being adequate accommodation for more than 200 passengers, nor is it likely that a greater number of berths than this would be filled.

Some possible services, with aeroplane branch lines working out from them, are outlined below, and it is extremely likely that some at least will be instituted before very long.

(1) England to Australia via Egypt, India, Burma, Straits Settlements with branch lines working to the airship from Eastern Europe and Spain. Branch lines also working from Egypt to various parts of Africa, including, of course, the Cape.

(2) England to Australia (Western) via Egypt and the Cape; branch services working to India from Cairo.

These two services should be given at least weekly, and it would follow that both Africa, India and Australia would really get a bi-weekly service by means of the branch air lines.

(3) England to Canada and Japan, with branch lines to the United States, and also Hong Kong from Japan.

(4) England via Spain to South America, and thence across to Australia and New Zealand. Several South American republics could be linked with Europe and Oceana by this means.

Practically the whole of the world would have its air link—and a regular one at that. Possibly the critics would say that such services would never pay. The same thing was said in turn about the canals, railways, steamships, and particularly about the existing air lines. Regularity and safety are the great features in demand, and it is contended that the airship, working with the aeroplane and seaplane, could supply these needs.

We have only to think of the far-flung confines of the British Empire to realise that the giant airship provides the quickest and most reliable link—not yet perhaps, but certainly in the near future.

The close of the War showed that the position as regards aircraft had altered completely. The aeroplane and seaplane had been proved to be exceptionally trustworthy, whilst the airship, so far as it has been built, had also proved its usefulness from a military point of view. The Zeppelins represented the high-water mark then reached by the rigid type of airship, whilst the non-rigid, smaller classes had done excellent work both on the land and sea fronts.

The lesson learned with both types of airship was not lost upon the British Government, and with their R24, R33, R34, R38 and a few others the prestige of the lighter-than-air craft seemed very high and practically secured. Unfortunately, a wave of economy

swept the country, and with it went the closing down of the airship section of the Royal Air Force.

Such a step seemed inevitable at the time when every department was being combed to secure the reduction in expenditure that the experts considered so necessary if we were to pay our way. Naturally, the protagonists of the airship were wroth, and they prophesied that a return to building would surely come about as part of a defence scheme, if not as a commercial undertaking.

They pointed with pride to the performances of the relatively small number of modern British airships. Of how the R34 had carried out a long reconnaissance over the Baltic and the North Sea, of how R33 had been torn from her mooring mast by a terrific hurricane and having been blown over the North Sea, was still able, damaged as she was, to fight her way back home in the teeth of a gale, and come safely to her shed. Also of the marvellous trip to America and back by the airship R34, which flew 6400 miles in 183 hours without any real trouble.

Other good performances were recorded by similar craft, and yet finis seemed to be written to their career, and some were actually scrapped whilst comparatively new.

Amongst those who believed strongly in the airship—and especially in the big and improved type—was Commander Dennistoun Burney.

No man worked so much for what seemed a lost cause as did this enthusiast, and it is certain that the proposals which he laid before the Government in

1922 had much to do with the recent revival of the airship.

Commander Burney realised, at the outset, that some sort of competition was necessary to produce the best type of airship; for this reason he suggested that two large experimental ships should be built, and that to secure the utmost competition in design, leading to a high state of efficiency, the nation's builders should be pitted against private enterprise. In other words that whilst one ship should be built by the Government from the design of their experts, the other should be produced by a company at their own works. Thus it came about that the R100 was laid down at Howden, under the direction of Commander Burney, whilst the other ship, R101, was built at Cardington. It must not be imagined that the fight was fought and won as easily as the above might suggest. In point of fact it was not until 1924 that the first Labour Government, during its short term of office, agreed to the step proposed a full two years before.

In the full scheme there were other important features embodied, such as the erection of sheds and mooring masts on the route to India—at Ismailia and Karachi. More particularly was it stressed that the two new airships were to be regarded as purely experimental, even though they might be equipped for passenger-carrying, and, indeed, might be employed on an air route.

The main point was that the lesson learned with these experimental craft should be applied, at the

discretion of whatever Government was in power, to the furtherance or otherwise of this branch of air transport.

The arrangement made for the construction of R100 was noteworthy. First, the price agreed upon was no less than £300,000, with another sixth added for the provision of a shed to house the monster ship.

Whilst the sum quoted, especially when compared with the cost of the biggest aeroplane or flying-boat seems huge, it was quickly realised that it was not enough. There was a careful check kept on what was spent upon the Government-built ship. Without the engines, which were subsequently fitted (that is, the heavy-oil machinery), the R101 cost something like £475,000, and when the new engines have been taken into consideration, together with other improvements, this big airship involved an expenditure of something like £530,000 at least.

Some of the stipulations laid down in connection with the building of the R100 are worth noting as showing exactly what is involved in building these craft; it will be seen why they must necessarily prove expensive. The ship must carry at least 100 passengers, providing them with sleeping and living quarters, the latter to include kitchens for cooking all food required aboard. A speed of not less than seventy miles an hour at an altitude of 5000 feet must be attained on trial flights. Then the total fixed weights were not to exceed ninety tons, and the gas capacity was to be at least equal to five million cubic feet The ship must

be built in such a way that, at any stage, she must pass the standard laid down by the Air Ministry experts.

A rather curious clause was inserted—viz., that the builders shall have the right to re-purchase the airship for £150,000 for employment on a British transport service should such a course be deemed advisible.

It has often been said that the two airships were sisters; this is not true, except, perhaps, from the point of view of size. Here, indeed, they had something in common, inasmuch as they were easily the largest built up to 1930, and quite double the size of any so far built in Britain. Then again they have been called big Zeppelins, but their method of framing was quite different to that of the girder type employed in the German ships.

In the case of the R100 an experiment was tried in her construction which should have very far-reaching effects should further vessels of this class be built. Every part which could be standardised was made so. Including the planes and passenger coach, the hull has about fifty standardised parts, which shows a tremendous reduction on previous attempts. It means, of course, that ships could be built very quickly by employing mass production methods.

Although the two ships differ considerably in actual design, the brief description given below of R100 may be taken to include the essential features of both. There is a difference in planning, but the same air conditions are met in both, and these have been made

deliberately as stringent as possible since the aim is to produce a really serviceable all-weather craft.

Under usual conditions the R100 has an estimated lift of 156 tons. The length is 709 feet, maximum diameter 133 feet, overall height 135 feet. Approximately the length to diameter ratio works out at $5\frac{1}{2}$ to 1.

For the average person the passenger accommodation will be the attraction in the R100. The builders call the cabin "the passenger coach," and it is slung inside the vast hull of the airship. Actually, the coach consists of a three-decker erection, the bottom one forming the quarters of the crew. The coach is separated from the gas-bags by a double wall of fabric through which circulates continually a current of air.

The kitchen is a wonderful compartment, and all its cookers are worked electrically, making both for safety and cleanliness. The dining saloon is situated upon the lower of the two decks devoted to the passengers. It provides seating accommodation for fifty-six persons, the idea being to have meals in two sittings. It has an area of 864 square feet, and appears quite an imposing room when viewed from the staircase that permits entry to it from the deck above.

The upper passenger deck has two balcony decks, from which splendid views are obtained of the country passed over, whilst the lounge deck is really a gallery running round the dining saloon, but this has an area of 540 square feet. There are no less than thirty-two cabins, most of them having four berths, totalling, in all, 100 bunks.

The control car projects beyond the outer cover, but it is attached to the main structure just below the quarters of the crew. Next to the passenger accommodation the power cars—three in number—focus the attention of the visitor. Each of these cars contains two 660 horse-power Rolls-Royce Condor IIIB petrol engines, driving two air screws, which are placed tandem fashion. The screws can be reversed, and as the power cars are well behind the passenger accommodation, little noise disturbs the voyagers.

As on the liner of the sea, auxiliary engines are needed to produce electric current for lighting, cooking, heating and wireless. The two six-cylinder engines for these purposes are contained in separate wing cars.

The hull is built entirely of duralumin, that wonderful compound metal which appears to have all the virtues of aluminium with the strength of steel. There are sixteen main transverse frames joined by longitudinal girders.

The airship needs 15 gas-bags, and as these could not be manufactured in Britain, only the Royal Airship Works having the necessary plant, they were manufactured abroad. The Government works were fully occupied in making the gas-bags for R101.

On the gas-bags much depends, and therefore the art of making them is rather a close preserve. They are fashioned from cotton, lined inside with two layers of the famous goldbeaters' skin. Inside and out the bags are varnished with a special preparation, and are then sprayed with aluminium dust to guard against changes of temperature. The largest of the fifteen gas-

bags weighs something like 1600 lbs., and has a capacity of 550,000 cubic feet.

No less than ten tons of water are carried on the airship in the emergency bags, which can be discharged rapidly, whilst another sixteen tons are contained in the slow discharge bags.

The modern airship has many opponents, indeed some of the antagonists of lighter-than-air craft cannot find a single good word to say on its behalf. These critics forget one very important fact; it is that the airship is still at the threshold of life, and the two largest and latest British vessels—the R100 and R101—were claimed as nothing more than experiments in big airships by which much may be learned. If again we consider the relatively small number of airships built as compared with their rivals the heavier-than-air machines, we shall have to admit also that the same progress could not be expected.

To build a monster like the R100 is similar to putting in service a *Majestic*, the biggest of our liners, as against the building of a motor launch, which is both cheap and of equal speed, but which could be duplicated *ad lib* and a thousand built for the cost of the *Majestic*.

The magnificent round-the-world voyage of the *Graf Zeppelin* in eighteen days without any real trouble, and with considerable comfort for her passengers and crew, shows how vastly the modern airship has been improved since the Armistice, though we must never overlook the fine trip of the Zeppelin during the war, which went out to Africa and back without mishap,

and at a time when conditions were such that she had little hope of succour had she had to come to ground.

The R101 had also weathered an eighty mile an hour gale whilst at the mooring mast, a feat deemed impossible not so very long ago. In addition this fine ship and her sister had made voyages in the teeth of strong gales, and come through with only the slightest and easily repairable damage.

The mooring mast is often criticised by the opponents of airships as a weak link in the chain of operations. Though not difficult to get a ship moored to the mast there is undoubtedly some little risk in performing the task if weather conditions are unfavourable. At present there seems no alternative to the mooring mast save the shed, and it is really more difficult to get an airship in and out of her shed than to attach her nose to the top of the mast. But this is a difficulty that can, and will, be solved in the near future.

The airship is much in the same position when coming to land, or to the mast, as the big liner at Southampton. The *Majestic*, for example, would not think of trying to come into dock under her own power; nor would she be allowed to leave the quay without assistance.

Here we find a splendid brotherhood of handy little tugs, who give the best example possible of team work. The whole business of berthing to getting a liner away is done quickly and with the utmost precision. May we suggest that in the very near future either there will be aerial tugs or landing machinery

operated electrically for the monster airship? At present man power is relied upon, and the difficulty, naturally enough, is to have sufficient available whenever the airship needs to land. There lies the rub. At such places as Cardington there are usually sufficient men on duty, but until the airship can make a landing where she will there will be found a drawback, which, in the majority of cases, the aeroplane does not suffer. But it is worth noting that the larger aeroplane liners must have a well-selected spot for a forced landing, so that the heavier-than-air type of aircraft is not immune from the troubles which beset the airship.

It needs to be added that whereas the aeroplane must descend when engine trouble is too great, the airship can usually go on until she can reach the appointed landing place. Providing these are not too far apart the lighter-than-air craft is in a fairly strong position.

Whilst the R100 was under construction at Howden in Yorkshire, a mooring and docking raft was devised, and Commander Sir C. D. Burney, who has pinned his faith to the future of the airship, and has had very much to do with the successful construction and flights of R100, has great hopes that the device at Howden can be improved upon still further. If his hopes are justified the greatest disadvantage from which the airship suffers will be overcome.

The arrangement is certainly ingenious, consisting of a mooring mast of a special type, and arranged upon the telescopic principle. To this the ship is attached when she arrives. Next there is the raft, which is perhaps

best described as a huge pair of pincers, having many claws.

These surround the centre of the airship and hold her firmly. The raft, ship and mooring mast (the latter telescopic to bring down the ship) will then run upon rails leading into the shed. The improved raft will probably be built on a kind of rotating table, so that in whatever way the ship is moored the claws can do their work. This plan will certainly help the airship, but it is desirable to add that special landing grounds will still be necessary.

The next step may be to effect all landings of lighter-than-air craft upon water, which certainly offers great possibilities.

The great airship success of 1930, so far as Britain was concerned, was the crossing of the R100 from Cardington mooring mast to Canada, the distance covered to Montreal being 3364 nautical miles, run at an average speed of 58·8 miles an hour. Unfortunately, the ship damaged a fin, and this considerably slowed her rate of travel during the last stages of the flight. The damage was apparently attributable to the cyclonic storms experienced over the St. Lawrence after the actual crossing of the Atlantic. One of the crew stated that she took a sudden list of forty-five degrees, and then was shot up about 2500 feet within a few seconds, thereby placing an enormous strain upon the fin. Even so, the crossing is a record one by airship, especially if that time is deducted which had to be lost in the darkness before attempting to pick up the cable attached to the new mooring mast at

St. Hubert. This mooring mast was built specially in anticipation of the coming of the giant airship, and has all the improvements suggested by the experience of those already brought into use.

Although experts are not yet altogether satisfied with the mooring mast and its functioning, there can be no doubt whatever about its extreme utility; indeed, it is difficult to visualise the crossing to Canada of the R100 had the mast at St. Hubert not been available. By it fuel, water and stores were brought to the airship, and by it came the leading men of Canada to board their visitor.

A very successful return voyage followed, made in good time.

Against the success of the R100 must be set the terrible disaster which overtook the R101 when upon her maiden long distance trip in October, 1930. The story of her loss is too fresh in all minds to need re-telling.

The worst feature of her going was the loss of 48 out of a complement of 54 men, including the Minister for Air. This loss, serious as it was, does not mean the end of airship enterprise, though undoubtedly there will be a pause for a time.

Subsequently, R100 was sold for breaking up, and the airship establishment at Cardington virtually closed down.

It must be reiterated that we are as yet merely at the threshold of air conquest, and the future is not without promise for the airship.

FIRST ATTEMPTS AT GLIDING

THE earlier attempts at flight which had been made in the Middle Ages with various machines, most of them apparently depending upon the action of wings fashioned something like those of a bird, had clearly shown that man could not fly like a bird. If he were to mount the air it seemed that he must do it by some mechanical method, which might be described as pushing the air beneath him.

By the opening of the nineteenth century experiments had definitely shown that man, if he could progress at all in the air, would do it by means of gliding. For this it was necessary that he should make his start from some eminence, which could not be very high, until he had mastered more of the details of gliding flight than had so far been achieved.

One of the greatest pioneers with gliders, and to whom the present-day airmen owe a very great deal, was Sir George Caley. Fortunately, he has left behind him the mechanical calculations upon which he arrived at his formula. He worked for some considerable time upon these calculations before he decided that he was in a position to have constructed a glider by which he might hope to prove his theories were really possible in fact.

Caley's glider had about 300 square feet of surface, and it possessed several of the features which are now common in the maintenance of stability, whilst some of the details which he appears to have fitted remind one strangely of present-day practice.

In Nicholson's *Journal*, dated 1809, there appears some of Caley's experiences in connection with gliders, particularly the one already mentioned. The main point which Caley makes in his papers, is that any person could run forward with his glider at full speed and, " by taking advantage of a gentle breeze in front, it would bear him up so strongly as scarcely to allow him to touch the ground, and would frequently lift him up and carry him several yards together."

It was unfortunate that Caley did not go further with his experiments, because he was clearly on the right track, but, like so many of the earlier enthusiasts for flight, he had come to the conclusion that it was useless proceeding further with a machine of the description he had designed and built. Caley has left it on record that it was impracticable to proceed further without some definite motive power, and so he appears to have given up his experiments. If only this brave pioneer could see the wonderful flights accomplished with engineless gliders to-day, he would be as much gratified as amazed.

Caley published his work in 1810, and it is one of the misfortunes of aviation that for a long time, too long a period in fact, the work of this pioneer was neglected, yet when that work is examined to-day it is clear that either Caley lived half a century too

soon, or that some other genius should have taken up immediately the thread which he had so unfortunately dropped.

When so many claims are made abroad for the enterprise shown by their aviators and designers, it is singularly refreshing to find that an Englishman had solved already many of the problems which they claimed to have solved so many years afterwards.

The idea that men might have wings and fly like birds was by no means killed by the experiments of Caley and others with gliders.

After all there was something to be said for the fact that very large birds could lift themselves quite easily from the ground and progress at a reasonable speed. If a bird like the albatross, and even larger birds could fly, it seemed only reasonable that man, with his brains, should be able at least to equal if not improve upon their wings.

There is a capital story told of one of the last attempts to secure flight by means of wings. A Captain Le Bris, a French naval man, had made a special study of the flight of the albatross, and he announced that he was convinced that there was nothing to prevent an artificial bird being made upon the plan of the albatross. To prove his theories he designed a pair of wings, which were arched, and measured something like fifty feet across; they were then joined in an ingenious fashion to a body which was something like a boat. The weight of this artificial bird was considerable, amounting to close upon 100 lbs.; it had a wing area of 215 square feet.

The story is told of how Le Bris mounted this curious machine upon the top of a cart. He then caused the vehicle to be driven forward smartly, and at the crucial moment he slipped his mooring rope, the idea being that he would get a start from the slight elevation afforded by the cart. The curious part of the story of Le Bris's experiment was that when the rope was released it became entangled with the body of the carter, and instead of the inventor going aloft he had the privilege of seeing his assistant something like 200 feet above him. There are accounts extant which would seem to prove that Le Bris had considerable success with his experiments before his artificial bird crashed badly and became a total wreck.

The most useful data obtained from these experiments was that gliding flight was possible, always supposing the wind was strong enough, and that there was some means of towing the machine against such a wind.

Le Bris drops out of the picture, and Louis Mouillard seems to have taken his place. Unfortunately, Mouillard, who was a farmer spending a good deal of his life abroad, kept to himself very largely the data which he had been able to amass from his very keen observation of many birds. Unfortunately, too, when at last his work was published in 1881, it did not secure the attention which it so richly deserved.

Like Le Bris, Mouillard decided that man could fly by means of wings. He appears to have constructed several machines which began purely as a pair of wings, and finally developed into rather a crude type

of glider. Copying an earlier pioneer, he seems to have used his feet in connection with the wings. Mouillard was not able to progress very far with his wings, and when on one occasion he was bowled over by a gust of wind, suffering some slight damage himself, he gave up further attempts at flight, at least upon the lines he was following.

One thing did emerge from his experiments; it was that Mouillard, though he had failed himself, was convinced that very soon men would fly, and the main objective of his book was to encourage others to proceed farther along the path which he himself had been compelled to forsake.

Like so many pioneers he believed that he could do more with his pen than if he proceeded with his many heartbreaking experiments. Possibly he realised that others could attempt better the work which he probably knew he was not fitted, by temperament, to achieve.

So far very little had been done in practice, but much had been set down from a theoretical point of view. Time was now ripe for further experiments towards a reliable glider.

There are several names which must always be linked with this next phase in man's conquest of the air; assuredly that of Otto Lilienthal, a German engineer, must secure a very high place. With his brother, Gustave, he spent his youth in studying the question of flight, and in practising it so far as they might by the construction of numerous models.

Otto Lilienthal very soon determined that no real

progress in the matter of flight was possible, unless someone demonstrated very clearly that a glider could be navigated through the air. Who should this someone be? Clearly the answer to that question of Lilienthal's was that it should be himself. Soon he was at work building a glider from willow wood, which he covered with waxed sheeting. It was an altogether different machine from that of Le Bris, also it was very much smaller, weighing less than half, and having a wing spread of roughly 100 square feet.

In these days of beautifully designed gliders, Lilienthal's first attempt seems very crude indeed; there was a cross-bar placed in the front of it, and from it was laid a couple of padded tubes; these were to encase the forearms of the aviator, and they constituted the only method by which Lilienthal was attached to his glider.

His first experiments were made by jumping from a springboard, but this was found quite unsatisfactory. Later on he tried running down a hill against the wind, and when he felt that he was practically air-borne he jumped from the ground and actually entered upon a glide.

Through the help of some friends, Lilienthal was able, in 1892, to get a small conical hill erected in the midst of some quite flat country in the neighbourhood of Berlin; from the cone of this hill Lilienthal demonstrated to hundreds the clear fact that he could glide a distance of more than 100 yards from the point he took off.

Lilienthal appears to have commenced his glides by

starting to run down the hill and then taking the air when he felt that there was sufficient pressure under his wings. It will be seen, therefore, that Lilienthal had realised that great factor in aircraft, that there must be some motive power, but not necessarily mechanical. In his case he used gravity, and then allowed the air currents to do their work and carry him along. Another factor which he determined was that it required merely practice to attain the art of balancing; little by little he achieved this art simply by moving his weight where he would upon the machine.

It would appear that this experimenter began with a monoplane glider; certainly his final experiments were carried out by one of the biplane type. Whether it was a good plan to depart from the monoplane to the biplane glider we cannot say, but there are some experts who believe that this departure from the earlier type was the cause of the accident which put an end to the experiments, and, unfortunately, to the life of this clever pioneer. He fell from a height of 25 feet after having lost his balance; the injuries which he received were severe, and Lilienthal died within a few hours. One observer states that the accident was definitely caused by changing the type of rudder which he had so far relied upon.

The death of Lilienthal was a severe blow to the growth of experimental aviation. In this case there was, for a time, a decided set-back, and the usual Jeremiahs had their way, but not for long. The very fact that this brave German engineer had achieved so much in an apparently small period of time, set others

to work. They profited by his mistakes, and they learned thoroughly the conclusions to which he had been driven.

Amongst other data which Lilienthal left behind him were three useful maxims for gliding flight; these were (1) A suitable wind. (2) A correct shape of wing. (3) The necessity for having the wing in the proper position.

It was in 1896 that Lilienthal paid the great penalty of his temerity in the air. It was about this time that the petrol motor, already ten years old, was being brought to such a state of perfection that some far-sighted prophets were suggesting that here lay the next step towards successful flight.

Pilcher, a lecturer at the University of Glasgow, and also a clever engineer, might almost be described as the understudy of Lilienthal. He had heard of the German experiments, and he was so impressed by them that, in 1895, Pilcher actually built a glider from his own design. On general lines it followed the machines for which Lilienthal was responsible; it is quite clear, however, that Pilcher relied far more upon his own theories than the information, much of it incorrect, which he had been able to obtain of Lilienthal experiments.

In order to gain a closer knowledge of his subject, Pilcher made a visit to Germany and managed to obtain an introduction to Lilienthal, whose enthusiasm secured the Britisher several trips in the German glider. On his return from Germany, Pilcher built several gliders, some of which were unsuccessful,

others in which he was able to accomplish flights which could only be recorded in mere seconds.

In 1896 Pilcher ordered the fourth and most successful of his gliders; he gave it the name of the Hawk when it was finished building in a Kentish village. Without doubt it was easily the best of the machines for which he was responsible. Pilcher anticipated the modern aeroplane by adding landing wheels, which were useful, not only in moving the glider, but also in taking up the first impact when landing. The machine in flight resembled very much a bat, but, as the earlier gliders had been called by this name, Pilcher decided that Hawk would be better.

The inventor anticipated the modern glider as regards the method of launching, which was effected by means of a tow line passing over a pulley; the latter was situated on the crest of an eminence opposite to the top of the hill from which the airman was to make his glide.

Constant practice made Pilcher wonderfully expert in handling his glider, balancing was effected by the movement of the aviator's body, and it is recorded that, until the unfortunate day when Pilcher took his plunge to death, he had no accident worthy of the name. He was experimenting in 1899 near Rugby, and was just completing a really good flight, when the tail of his machine was seen to collapse; the immediate result was a crash, and poor Pilcher was killed.

The work that he did is too often overlooked nowadays, but, apart from the high honour which is his of being the first British airman to lose his life with a

heavier-than-air machine, he left behind him some extremely valuable data.

Both Pilcher and Lilienthal had demonstrated very clearly that gliding was possible. Up to their period the whole question had been largely one of theory, and although their lives were forfeited in translating theory into practice, their work lived on, and made the next steps to mechanical flight quite definite, though perhaps no man saw clearly or exactly the direction to be taken when the old century ended.

If the conquest of the air is considered for a moment as a wonderful building, it is certain that Lilienthal and Pilcher laid securely the foundation of that building.