The Fortnightly Review — The Future of Air-ships

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THE FUTURE OF AIR-SHIPS.

I.

SUPPOSE that I consider it quite possible to visit the North Pole in an air-ship? Suppose I predict that at no distant date aerial cruisers will threaten fleets, make war on submarine boats, and stampede army divisions?

Suppose I tell you that I hope, as early as the coming summer, to give something to the impetus remaining needful to the aerial effort that will bring such things to pass in Europe? That I fully expect, before the particular experiment be finished, to go cruising for a week at a time over Europe in an air-ship that will not need to touch earth each night because it will be in itself a floating house?

You might reply that such looking into the future is easy. But looking into the past is also a kind of looking into the future. When eight years ago I first proposed to attach an explosive petroleum motor beneath a balloon filled with inflammable gas, the world cried out against the project.

After I had proved the safety of the automobile motor in the air, I declared that I would build an air-ship capable of making steering-way against moderate winds. I was at once accused of being as ignorant of mechanics as of

aeronautics ; the elongated balloon would double on itself ; and the system would be carried off by the first breeze. To add to the discouragement, the balloon of my second air-ship did double on itself, and I was carried by the wind from the Jardin d'Acclimatation to the Plain of Bagatelle.

Years passed. I built other air-ships. I navigated over Paris; I made evolutions above the Champ de Mars ; I accomplished trips to points indicated in advance; I returned to my starting points. In a word, I enjoyed great pleasure in my air-ships, which I saw to be practical. Yet the accusation that I would be helpless in the wind pursued me ; and I heard it from so many authoritative lips that it is a wonder I did not come to fear it myself such is the world's power of suggestion over the individual.

Then I navigated the air between St. Cloud and the Eiffel Tower against a time limit believed to be prohibitory—not once but twice ; not twice, but three times. On October 19th, 1901. I made the eleven kilometres plus the turning of the Tower in 29 minutes 30 seconds. Was it done in a profound calm? No; the Central Meteorological Bureau reported, at the moment of starting, a south-east wind blowing six metres per second—twenty-one kilometres per hour—at the altitude of the Eiffel Tower.

At Monaco in the early part of 1902 I dealt so continually with the wind that I was never able to make a satisfactory estimate of my speed. Up and down the Mediterranean

coast I sped, sometimes accelerated, sometimes retarded by the wind ; and so I came to look on the entire wind-problem as simply one of plus and minus as to speed and of the toughness of superposed silk and varnish with respect to pressure ; and my strongest impression of those Mediterranean flights remains that I rejoiced, laughing to see how I outsped and left behind me the steam-chaloupes and petroleum launches that ought to have accompanied me to pick me up in case I fell!

Everything I have thus far accomplished has become common-place. It is known, it has been seen, it seems natural, not unusual. But let us not forget that the commonplaces of 1902 were the impossibilities of 1898.

I said this to myself. I had tired of straining for speed to gratify the curiosity of others; and so I permitted myself to take some aerial amusement. I built my little "No. 9," in which, day after day, I hopped over the trees of the Bois, kept appointments to lunch, attended a review, and guide-roped down the Avenue des Champs Elysées to my door at the corner of the Rue Washington.

That was one kind of air-ship. Had I at that moment predicted that, within two years, I would go on aerial pleasure-cruises of a week's length, accompanied by friends whom I would lodge, feed, and keep warm, while they should sleep between the constellations and the earth, and exult through golden afternoons spent gliding over Europe,

I should have heard all the old objections—and some new ones.

II.

Why is it that no balloon has ever been able to stay much longer than twenty-four hours in the air, and that the world's record, made in a recent sensational contest, is not quite thirty-six hours?

It is because ballooning has two great enemies—condensation and dilatation. Suppose that you are at equilibrium at five hundred metres. Suddenly a little cloud masks the sun. The gas in the balloon cools and condenses, and if you do not at once throw out enough ballast to correspond to the ascensional force lost by such condensation, you will begin descending to earth. If you throw out too much ballast, you will become too light again and shoot up too high.

Imagine you have thrown out just enough. All goes well for a time. Then the little cloud ceases to mask the sun. Your gas will heat up again, and by its dilatation will regain its old lifting power ; but, having less to lift by the amount of ballast just thrown out, it will dart higher into the air, where

the decreasing atmospheric pressure will permit it to go on dilating until a lot of gas escapes through the valve with which every balloon is furnished. Otherwise the balloon would burst !

You have overshot your equilibrium and lost too much gas —because the balloon is an impetuous thing, always exaggerating. Therefore you will find yourself descending —to condense your gas again as the atmospheric pressure increases—when more ballast must be sacrificed, and the balloon shoots up too high again, and the trouble recommences !

The skill of the spherical balloonist consists precisely in maintaining his desired altitude with the greatest economy of gas and ballast ; but, be he ever so exact, the time must come when repeated condensations have forced him to throw out his last gramme of ballast and repeated dilatations have lost him so much gas that the balloon sinks to earth— no longer spherical, but pearshaped, with its lower part hanging flaccid.

From the earliest ballooning times, men have sought to combat condensation by means of heat. Montgolfier's first balloon was filled with nothing but hot air, which is lighter than the cool air of the atmosphere ; and it has always been known than an adequate heating of one's gas would be equivalent to saving so much ballast.

Pilâtre de Rozier who, accompanied by the Marquis d'Arlandes, was the first in the world to make a free balloon ascent, finally lost his life in an attempt to cross the English Channel by means of such a contrivance in which heated air was to reinforce hydrogen gas.

Many methods have been since proposed, the latest and most logical being a plan which would allow steam to freely mingle with one's gas—the theory being that such steam will condense in drops on the inside surface of the balloon envelope, to be caught again without loss they fall into a proper receptacle below the open vent at the bottom of the spherical balloon.

Nothing could be more logical or beautiful than this plan in theory and the only reasons I have for refusing to adopt it in practice come from my own small experiments, which I do not claim to be conclusive. Only, so far as I have been able to experiment, the system would require me to take up too much water. The surface of the balloon is so great that the mass of the steam, instead of condensing and falling in drops as it ought to do, seems simply to disappear, to escape through the varnished silk, where gas itself cannot escape. At least this is what happened to me.

Yet such heating of one’s gas is too tempting an idea to be abandoned, especially in these days of perfected petroleum fuel. With one kilogramme of petroleum I am promised by the manufacturers of my boilers and condensers that I can

vaporise twenty kilogrammes of water. If I can devise a practical means for catching this water again as it ceases to be steam, the oft-studied problem will be solved. Imagine the balloon to be coming down—the result of gas condensation. Instead of lightening it by throwing out twenty kilogrammes of sand, I will have but to burn one kilogramme of petroleum! My twenty kilogrammes of water will become steam, itself lighter than the air, and whose heat will dilate my gas to such an extent as to produce *thirty* kilogrammes of new ascensional force !

At first I hoped that the thing could be accomplished by means of a small and very tight steam-bag sewed inside the balloon. I would lead my steam to it, there to condense and fall in drops which could be caught, by means of a tube. This steam-bag, expanding as it filled, would have at the same time served as an interior air-*ballonet* to aid in maintaining the balloon's form, Unfortunately no silk and varnish will resist steam, and after long experiments in which the steam reduced my steam-bags to a sticky mass, I hit upon my present condensers.

Why should I not lead from the boiler directly to a present-day aluminium condenser hung inside the balloon? It had never been done—but that is the distinguishing particular of all new things. Now I have done it. You can call it a condenser or a radiator ; in fact, it differs little from the radiator of an automobile in construction or function, though its object is to heat instead of to cool. It consists of

half a kilometre of very thin aluminium tubes disposed vertically in the form of a hollow cone, the whole being suspended inside the balloon from its top.

Now imagine the balloon to be in the air—and coming down as the result of gas condensation. I simply turn a faucet, and steam immediately generated by a remarkable little up-to-date boiler begins mounting to the condenser and rushing through its half a kilometre of tubes. This steam cannot possibly mingle with my gas, yet it heats it, re-dilates it, and gives new ascensional power to the balloon. Indeed, the radiation of the half a kilometre of tubes is so complete that the steam ceases to be steam before it has traversed their whole length. So it immediately drops out at the other end in the form of water again!

Now you see what happens. Interrupted at will by the play of the faucets, I keep my twenty kilogrammes of water in continuous circular movement of water, steam, water, steam, water. The twenty kilogrammes (or more) of water remains always a part of the original weighing of the balloon ; yet each time I send it round the circle, at the cost of one kilogramme of petroleum fuel, I gain temporarily thirty kilogrammes of ascensional force : and, thanks to the play of my faucets, I can graduate this force at will

I repeat, I gain thirty for one—thirty kilogrammes of ascensional force for one kilogramme of petroleum ballast. Therefore—it seems clear to me—if the ordinary spherical

balloonist can stay twenty-four hours in the air with a given quantity of sand-ballast, I shall be able to stay thirty days the air with the same quantity of petroleum ballast.

III.

The balloon envelope of this aérial yacht—as I may call it —is being sewed. Its car is already built. Its boiler and condenser are being constructed. Its motor is ordered. Its propellers exist. And very soon the aerial yacht will start on its first cruise. In appearance it will more resemble the preconceived idea of a twentieth century air-ship than anything heretofore produced.

Beneath an egg-shaped balloon, slightly less elongated than the balloon of my “No. 9," will be seen hanging what looks like a little house with a balcony window running half its length on each side. The balcony window will characterise the open, or observation, room of the floating house, or car ; and in it the motor will have its place. Behind it is the closed sleeping and reposing room ; while in front of it you will see an open platform holding the steam-producing boiler. From it steam can also be led, by means oft a pipe, to the open room for cooking and to the closed room for heating purposes when needed.

As the floating house is designed to remain for days at a time in the air, protection from the cold, even of moderate altitudes, may become important. Therefore the closed room can be made quite tight, to retain heat, it—like the whole of the car—being composed of a framework of pine, aluminium, and piano wire tightly covered with varnished balloon silk of many thicknesses. It will contain two cot beds. You may ask what will the guests do while the captain sleeps? The whole idea of the aerial yacht is contained in the answer.

My guests may remain at ease while I take my turn at sleeping. The aerial yacht is not designed for high speed. Therefore its balloon need not be cylindrical. I am even making it egg-shaped ; consequently the skilled labour and unremitting attention required for the maintenance of a cylindrical form by means of interworking ventilators and valves will not be needed. In this respect, indeed, the aerial yacht can, for hours at a time, be made to assemble very closely a spherical balloon, its motor being stopped, and the system being allowed to float gently through the night—or afternoon or morning—on a favourable air current. The labours of my guests will be limited to a common-sense opening and closing of a faucet as the balloon obviously falls or rises.

We shall do a great deal of such reposeful gliding on favourable currents, floating onward at no great height above the earth, but atterly free from the guide-roping

nuisance. For us there will be no darting up into the frigid solitudes above the clouds, no falling into dank mists—after the fashion of spherical balloonists. Nor will there be the strain for speed, or the pressure preoccupation incident to ordinary air-ship flights. A proper handling of the faucets will secure us the level altitude we desire ; and we shall float on, watching the great map of Europe unroll beneath us!

We shall dine. We shall watch the stars rise. We shall hang between the constellations and the earth.

We shall awake to the glory of the morning.

So day shall succeed to day. We shall pass frontiers. Now we are over Russia—it would be a pity to stop—let us make a loop and return by way of Hungary and Austria. Here is Vienna! Let us set the propeller working full speed to change our course. Perhaps we shall fall in with a current that will take us to Belgrade ?

And now that it is morning again, let us ride on this breeze as far as Constantinople ! We shall have time, and shall find means to return to Paris !

IV.

The obvious advantage of an egg-shaped, dirigible balloon under slight interior pressure, and furnished with my steam heating system is, of course, its ability to remain thirty days in the air where the ordinary spherical balloon can stay but one day.

Had André possessed it, he might have started off with serious hopes of crossing the Pole on an air current, and being carried to civilisation in the opposite hemisphere ; therefore I see no reason why such an aerial yacht, built for the purpose, should not reach the Pole and get back safely. An Aretic exploration steamship could carry it to the farthest possible point North ; and there, on the deck of the steamship, it could be inflated and sent off to make the few hundred kilometres remaining between it and the great goal.

I have always been attracted by the idea of reaching the Pole in an air-ship. When one considers the very few hundred kilometres remaining to be conquered, it seems annoyingly unpractical that an aerial machine, capable of racing against a time limit in the teeth of a wind blowing twenty-one kilometres per hour, should be baffled by them. To have recourse to speed would have been my fist idea, actually proposed by me in my book *Dans L'Air*:

“Some day explorers will guide-rope to the North Pole from their ice-locked steamship after it has reached its fartherst possible point north," I said. "Guide-roping over the ice-pack, they will make the few hundred kilometres to the Pole

at the rate of from fifty to sixty kilometres per hour. Even at the rate of forty kilometres per hour, the trip to the Pole and back to the ship might be accomplished between breakfast and supper!”

I would now, nevertheless, prefer to rely on time rather than on speed, and trust the adventure to one of these aerial yachts, built for the special purpose.

Experience that will have to be gained by many cruises in my pleasure yacht would teach us how to build, equip, and handle a stronger and more powerful one adapted to Polar exploration. The size of the balloon would have to be calculated in proportion to the long duration of the cruise, the thickness of the envelope, the quantity of petroleum and stores, the capacity of the steam heating system, and the force of motor and propeller.

I have said that my aerial pleasure yacht will have no great speed. Probably it will not exceed fifteen kilometres per hour. What propeller speed ought to be given to the Polar yacht would be a question for calculation with many elements ; but I concede in advance that it might be carried away from its course.

It might be carried from its course ; but having, let us say, from thirty to forty days in the air at its disposal, it could always start due north again with its propeller the moment it had found a region of comparative calm. Note, it would

have no need to retrace its course after such a blowing aside —it would simply try to start due north again!

When it found a northerly air-current—either by accident or by hunting for it vertically—it would immediately stop its motor, in order to waste no fuel. Indeed, its propeller-force ought to be exerted only in two cases, for two great uses : (*a*) to push on straight to the Pole in every period of calm, and (*b*) to modify the air-ship's course when riding on a more or less favourable air-current.

Such are the two vital advantages of the aerial yacht not enjoyed by André in his balloon—its ability to re-direct its course due north, and time to wait for opportunities to so re-direct its course again and again and again. I will not dwell on the vital comforts of a heated cabin : but to me it is obvious that the closed room of the Polar yacht ought to be constructed very close, to hold all the heat its captain could give it. Its walls of many thicknesses of varnished silk enclosing both motor and boiler might save the expedition ; for, apart from the adventure of André, this would be the first time for men to affront the cold of the north without the resources of continual violent exercise. Indeed, I have often asked myself if André and his companion did not simply perish from cold !

Or another supposition—did it never occur to you that the tragedy of the André expedition might have been due to his balloon descending to earth in those far northern regions?

Who knows what practical effect of condensation the intense cold might have had on its gas? A single descent to earth might have occasioned the loss of a great deal of gas. To rise again might have cost André a dangerous loss of ballast: and he would have started off again crippled in both these vital means !

Should the aerial Polar yacht be obliged to descend to earth, its captain could accomplish the manœuvre by merely turning a faucet and allowing the intense cold to condense his gas. To rise again, he would simply re-heat his gas.

V.

When the secret history of the Russo-Japanese war comes to be known, the submarine-boat will probably be found to have played a decisive part in the destruction of the first Russian Navy.

It is astonishing how quickly we habituate ourselves to revolutionary inventions. Up to the moment they burst on us as successes, we condemn them; then we accept them nonchalantly, as something natural.

A few years ago the submarine-boat occupied the same category as the air-ship in our consciousness ; and it is only yesterday that a British submarine-boat drowned its entire crew while under cautious experiment in protected waters!

Yet there are few who doubt to-day that hostile submarine-boats rather than inexplicable carelessness with respect to their own mines destroyed the Russians' men-of-war and cruisers.

So it will be with the air-ship in war. The first successful one has but to appear, and the world will forget all its unfavourable judgments. And should the first one to appear be accidentally unsuccessful? I answer that, in such case, the world will probably have to wait a little longer for the surprise. There are inventions that have luck, others that have less : or is it simply that we are prone to overlook the small beginnings of the successful ones? The submarine-boat has, for the moment, distanced the air-ship-but in the end it is the air-ship that will be its master!

I have no doubt of it—the twentieth century air-ship is bound to become not only the unique enemy but the sensational master of the twentieth century submarine-boat —and this for a very curious reason, depending on certain optical laws not at all taken account of by the inventors of either!

It is now a well-observed fact that the occupants of balloons and air-ships floating over the surface of the water are able to perceive bodies moving beneath the surface of the waves, to a depth and with a distinctness that is marvellous.

In view of this one fact, imagine the case of a fleet threatened by submarine-boats. Without the aid of an aerial cruiser, it must remain as helpless as were the magnificent Russian war-ships in the harbour of Port Arthur. Protected by an aerial cruiser, observe how its chances change! The air-ship will be seen moving over the waves in long, parallel lines. Beneath the surface of the water moves the submarine-boat. Its speed is little in comparison with that of its adversary in the air. It cannot even perceive that the air-ship is threatening it without rising to the surface at great risk; and it can profit by the knowledge so obtained only by diving to depths in which its usefulness becomes nil.

In a word, the submarine boat can do no harm to the air-ship ; while the latter can discover the submarine's presence, indicate its position to warships, and hurl down on it long arrows filled with explosives, and capable of penetrating the waves to depths inpossible to gunnery from the decks of men of war or cruisers.

In that day the nation that has submarine boats and no air-ships will find itself in a ludicrous position. Instead of being able to protect its fleet of warships with its submarine boats, it will be obliged to protect its submarine boats with its fleet!

Can you not see small air-ships used as scouts over both land and sea? You reply that they will be shot at by the enemy. Certainly they will be shot at—and now and then be

brought down to earth : such is the fortune and the cost of war, which sees costly artillery abandoned, stores deliberately destroyed—and war-ships sunk ! But other air-ship scouts will obtain information that may decide a campaign.

There will be air-ships and air-ships, small and large, for different uses. In my imagination I see one of the great aerial cruisers of the future ; and lucky will be the army or navy that is first privileged to use it as an auxiliary !

Being constructed with the resources of a nation, and designed for momentous uses, it will be enormously stronger and more powerful than my " No. 7," whose sharp elongated form it will nevertheless adopt for the sake of speed. I will suppose it to have a gas capacity of 77,000 cubic metres, to give it a lifting power of ninety-three tons. This is no fanciful picture. I have long and carefully calculated these specifications, and they are in due proportion to each other.

For example, there must be an intimate connection between the capacity, shape, and strength of its balloon, the speed at which it is to be driven by its motor, and the weight of the crew, fuel, munitions, and permanent furniture it is to carry.

The balloon ought to be two hundred metres long and twenty-eight metres in its greatest diameter. It would be propelled through the air by thirty propellers, each worked

by a separate petroleum motor of one hundred horse power. This would give a total of three thousand horse power, sufficient to impart to the air-ship a steady high speed of as much as one hundred kilometres per hour. To withstand the exterior and interior pressure corresponding to such speed, the balloon envelope ought to be composed of twenty-six thicknesses of Lyons silk properly superposed and varnished.

With a balloon of such lifting power, enough fuel could be curtied to make one thousand kilometres at full speed, or from three to four thousand kilometres at reduced speed, and there would remain enough lifting power to carry a crew of twenty men and a supply of explosives to be hurled at the enemy by means of one or two cannons *genre lance-torpille à l'air comprimée*.

Such an aerial cruiser would have nothing to fear from the wind. With its high speed of one hundred kilometres per hour it could make its way tranquilly in the stiffest breeze ; and when not in use it could be held close to the ground, practically out of the wind's reach, by a hundred cables.

Doubtless in future wars on land and sea the great aerial cruisers, with their crews, will be brought down like simple little air-ship scouts. It will happen less frequently because of their speed, the vigilance of their numerous crew, and their terrible offensive power. But are not whole sea fleets destroyed in war? Did the Russians give up the sea because

of the destruction of their warships in the harbour of Port Arthur?

I concede that air-ships may be shot at and hit ; yet if it will not follow because they are hit that they must fall like a stone ; “ full speed ahead" commanded after the fatal puncture will take the wounded aerial craft far from the scene of its wounding. I concede that they may be shot at, hit, and even be brought down ; yet the French and English officers who watched the Boers shoot day after day at the captive balloon that rose above Ladysmith have ideas of their own about the practical difficulties of thus bringing down a bag of silk filled with gas.

I concede that air-ships may be destroyed in war ; but, at the worst, remember that the crew of a great aerial cruiser will not contain a tenth of the crew of a war-ship ; that its construction will cost far less than a tenth in both money and time. Yes, air-ships will be destroyed in war ; but reflect also how quickly a 20,000,000 francs war-ship may be sent to the bottom of the sea by dropping a moderate quantity of dynamite on the middle of its deck !

VI.

How soon are we to enter on the Air-ship Age? Probably the great change will come rapidly : once let an air-ship

reach the Pole, once let an aerial cruiser make some action *d'éctat* in war—and within an astonishingly short time you will see hundreds of air-ships gliding overhead. The great change will have begun !

Hundreds of engineers and mechanicians will begin competing with each other in the improvement of aerial craft, copying from each other, improving on each other, racing with each other, exhibiting side by side in Air-Ship Salons. Factories will be devoted to air-ship construction, and the models of each succccding year will be more practical—by reason of the experience gained by a thousand experts in every-day competitive experiment.

At the beginning it will be as it was with automobiles when they bore no numbers, when no *chauffeurs'* certificates were issued, and when the amateur going out for a spin was tolerated as an exception in one sense, and as a pioneer of French industry in another.

Month after month more air-ships will be seen manœuvring over Paris ; but as they will not frighten horses, will not run over pedestrians, will not congest traffic, will not pollute the air of Paris with their odours, there will be less crying against them than you might imagine.

Oh, yes, there will be certain complaints against them. Now and again an air-ship, either by design or accident, will come down in the street—by preference in a wide avenue.

Crowds will collect around it. Now and again—not often—one of them will fall with painful, but not necessarily fatal, results.

There will be discussions. A portion of the population and Press will take sides against the aerial movement. Others will defend it, if only in the interest of French industry and of Paris as the world's centre of novelties : for Parisians will be once again ready as they have always been ready—to make greater concessions than other cities to maintain the reputation of their brilliant capital as the " Ville Lumière," the enlightened pleasure-city of the world, the capital of new sights and sensations !

Little by little these very accidents and interruptions of street traffic will force certain topographical changes on Paris.

The air-ship people will demand landing spaces.

They will say : We ask nothing of the street. We do not benefit by your expensively maintained avenues. If you will accord us landing spaces, we will keep to them ; and you will have no further trouble from us.

Thus the first landing spaces will be conceded—wide open spaces like parade grounds, free from trees, buildings, poles or fences, to which the air-ship captain may steer his craft in case of accident or desire to alight.

At the beginning they will probably be parts of already existing public squares ; but the topographical change will have begun. Little by little the landing spaces will have to be made in every part of Paris ; and when they begin to be constructed on the tops of houses, the second part of the topographical change will have begun.

Whether or not we who read these lines will ever mount in lifts to spacious platforms in the air to wait for the aerial craft to come and take us, will depend, I fancy, on how much the aeroplane principle will be found able to serve us. Dirigible elongated balloons, even when neither heavier nor lighter than the air, are accommodating craft, perfectly capable of mounting from landing spaces on the ground. Aeroplane air-ships, on the other hand, may find vital advantage in coming to, and especially in starting from, heights.

I have no objection to aeroplanes furnished with motors ; and there are even certain forms *plus lourds que l'air,* which I regard as eventually possible, if not probable. Indeed, were I, Santos-Dumont, to find myself at the head of a great experimental air-ship station with unlimited material and workmen at command, I would be immediately found constructing, side by side, a dozen different types of aerial craft, being convinced—as I have ever been convinced—that practical experiment must be our only true guide in the air. If, in my own modest experiments, I have thus far held to the elongated balloon, it has been uniquely from my

desire to navigate the air at once, without delay, for my own pleasure !

There may be aeroplane air-ships with great fixed wings, which will permit powerful motors to propel them, skimming through the atmosphere. The proportion between motive force and surface may be satisfactorily arrived at ; the natural laws of the sizes of such aeroplanes, either simple or combined with balloons, may be discovered. And so quickly do we become habituated to new things, the day when aerial omnibuses begin carrying tourists and business men from Paris to St. Petersburg, you and I will take our places in them as naturally as our grandfathers took the first railway trains.

Then, in addition to the surface landing spaces and the elevated landing stages of the smaller aerial craft, new and highly-organised aerial line stations will complete the topographical change.

They will resemble the termini of railways only in so far as they must have waiting-rooms, restaurants, bars and cab-ranks on one side, and traffic halls, machine shops, gas plants, and a lot of parallel railway tracks on the other. The railway tracks will be for the accommodation of small trucks and locomotives used in the manœuvring of waiting air-ships—for an air-ship on the ground is as clumsy as an eagle !

As clumsy as an eagle ! The other day I stood looking at an eagle flopping on his branch in his cage at the Jardin des Plantes. And as his clumsiness grew more and more apparent, I congratulated his Designer and Constructor that He had no mathematicians in frock coats and high hats at His elbow when He began His first experiments with the flying lizards. Their clumsiness and weight would have condenmed them in advance as their clumsiness and lightness has condemned the first dirigible balloons !

SANTOS-DUMONT.

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