LECTURE

ON

ARTIFICIAL FLIGHT

GIVEN BY REQUEST AT THE

ACADEMY OF NATURAL SCIENCES

AT

San Francisco, California, August 7th, 1876,

BY

WM. G. KRUEGER

WITH REFERENCE TO A MODEL OF HIS OWN INVENTION.

Editor Prof

Compliments of

Wm. L. [illegible]

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ERRATA.

Page 4, line 4, read "one from Kœnigsberg," for "Kœnigsberg."

Page 4, line 18, read "afterward," for "ago."

SAILING IN THE AIR.

I.—INTRODUCTION.

Gentlemen of the Academy :

The problem of artificial flight is of such great importance to civilization ; so interesting and fascinating, not only to the student, but to every one ; and it allows us to indulge in such a wide field for speculation as to the great changes which will be wrought by the practical solution of it in the social, political and commercial world, that I must beg of you to consider only my good intentions in appearing before you, and pardon my shortcomings as a lecturer. It is my first attempt, and is simply undertaken to bring the subject more understandingly before the public, that they may assist, morally, and pecuniarily, the several inventors who are wrestling with it more or less successfully—some rather less. If only one inventor in a hundred should meet with flattering results, the attention bestowed upon all will be repaid a thousand fold by that one's success.

The idea of sailing through the air in a flying machine is not new, nor such an absurd one as is generally supposed; and it is indeed important to investigate and lay it before the public more directly than has been done heretofore through the medium of great, musty and long-winded volumes. If found to seem practicable and feasible, it is for you, gentlemen, to see that the future great State of California shall also be ahead in this—one of the greatest and most important inventions of the age—as she is, and has been in many other things before.

The subject has really been taken hold of in a thorough and scientific manner only the last few years; but with such earnestness and scientific knowledge and intelligence, not only by the foremost and principal society for the advancement of the art—the Aeronautic Society of Great Britain—to whom, really, the most credit must fall—but in every civilized country; and so much has been done already to prove, not only the possibility but the absolute certainty of an early practical solution of the problem, that soon we will see the air traversed in all directions, by aspiring man. Many seeming impossibilities of the present, need only time and effort to become realities in the near future.

II.—HISTORY AND FABLE.

In turning our thoughts to History, reaching back even into the mazy and wonderful ages of fable, we find that from time immemorial the great science of ærostation has occupied the minds of philosophers and inventors. There can be little doubt that it was known and made use of in olden times in isolated cases, but was again lost, like many other important inventions.

We are furnished with many interesting proofs of this. Old Chinese, Arabian and Hindu fables give some beautiful descriptions of ærial chariots, in which wizards, princes and fairies sped over the fertile and populous plains of their native country, disbursing good or evil, according to their disposition, to the poor devils crawling in the dust beneath them. The Jews had their cherubim. The Assyrians have left us their winged bulls; the Greeks, their Sphinxes; while the Roman writers describe how that mythical personage, Daedalus, a famous Athenian artificer, and builder of the Cretan labyrinth, constructed wings with which he flew across the Ægian Sea, to escape the resentment of Minos. But his son, Icarus, undoubtedly of his strength giving out, fell into the water and was drowned. Their nation has bequeathed to us various bas-reliefs, illustrative of what appear well-proportioned wings.

Archytos, the great geometrician, made a wooden dove that flew like a natural one, and the famous German astronomer, John Mueller, who died suddenly in Rome, at the age of forty, in 1476, and whose memory was celebrated last month in Germany, constructed an artificial eagle, which flew out to greet the Emperor, Charles V, when he visited Nuremberg. This Mueller was more widely known by the assumed name of "Regiomontanus,"—the "Kingshiller"—that is, "Koenigsberg," a small village in the heart of Germany ; the custom of the times being for learned men to adopt the latin name of their birthplace. He invented the almanac, and prepared the first astronomical tables, by the aid of which mariners, who, up to that late day could only make coasting voyages, were enabled to trust themselves to the open sea, with some degree of assurance ; and Columbus was among the earliest to use these tables, twenty years afterwards, on his first discovery voyage to America.

Another German, a young watchmaker's apprentice, constructed a flying machine, with which he, when showing the same to his ignorant townspeople, flew away to escape mobbing. His bones and pieces of the machine were found some years ago in a wild and isolated part of the Black Forest. Towards the end of the fifteenth century Giovanni Battista Dantes, of Perugia, flew several times over the Thrasimenian Sea ; he certainly must have been at a considerable elevation, for he fell on a church steeple and broke a leg. Another account, particularly noticed in history, is that of a man who flew high in the air in the City of Rome, under the reign of Nero, but lost his life in the descent.

In "Astra Castra," we read that soon after Bacon's time, projects were instituted to train up children in the exercise of flying with artificial wings, and considerable progress was made ; by the combined effort of running and flying they were enabled to skim over the surface, as it were, with incredible speed. This same Roger Bacon, an eminent philosopher of the thirteenth century, and possessed of the very highest genius and ability, whose ideas and knowledge, like Franklin's, were many hundred years ahead of his age, descants, in one of his works, in glowing language, on the practicability of constructing engines that could navigate the air. He accomplished wonderful things in his day, and was accused of holding communion with the devil, who was quite an important personage in those times. His writings were interdicted, and himself locked up to prevent closer acquaintanceship of his readers with the aforesaid friend.

About the Confessor's time, a monk, Elmirus, in Spain, flew often, by means of a pair of wings, many miles from high elevations. Cuperus, in his treatise on "The Excellency of Man," contends that it is practicable for human beings to attain the faculty of flying. He asserts that Leonardo da Vinci, the great painter of the "Lord's Supper," and other highly prized works of art, practiced it successfully. The reasoning of the great John Wilkins, Lord Bishop of Chester, who died in 1672, embodies the sentiments and principles of all these on the subject even stronger. In his work on "Mechanical Motion," he treats expressly on artificial flight, and conceives, in the sixth chapter, the framing of such "volitant automata" very easy ; and says that the time will come when men will call for their wings when about to make a journey, as they do now for their boots and spurs.

Lastly, in the "Journal de Savans," of the 12th of September, 1678, an account is given of one Besnier, a locksmith of Sable, France, who succeeded in flying. But as his machine was extremely primitive—the wings consisting only of four rectangular surfaces, one at the end of each of two poles, which passed over the shoulder of the operator, and were worked alternately up and down—the inventor could only avail himself of their aid in progressively raising himself from one hight to another, until an elevated position was reached, when he could glide through the air a long distance.

Many more cases could be cited. Some ended disastrously; others, because of the apathy, distrust, ignorance, and superstition of the people, were lost sight of again; while some, perhaps the most practical ones and of which we find many indications in old writings, were never made known for selfish reasons. Such has been the fate of this—one of the most interesting problems—almost up to the present time. We were, perhaps, not prepared sufficiently, to receive the great boon. We had to have the printing press, steam, and electricity first, before we could attempt this next great step towards a higher civilization.

III.—DISCOVERY OF THE BALLOON.

Although it is well understood now by most scientific men, that the principles upon which ballooning rests, will scarcely form any part in the solution of the problem of ærial navigation; yet, when, in 1782, the brothers, Mongolfier, in France, made the first successful experiments with small paper balloons, filled with heated air, it was thought that the key to that wonderful art had been found; many applied themselves to its improvement; and the next year already saw gass balloons on a much larger scale.

The first passengers, who had the honor of being sent up into the realms of space, were a sheep, a cock and a duck; and as their safe descent proved highly satisfactory, the well-known French savan, Pilatre de Rozier, tried the same experiment shortly afterwards with great success, reaching a hight of nearly two miles. The glowing description of his experience raised the excitement of all classes to fever heat. Numerous day and night ascensions were made by diplomats, distinguished naturalists, professors of note, scientific women and gymnastic aspirants, and their journeys soon became more daring and extended to wider fields.

IV.—NOTED AIR VOYAGES.

Blanchard, the supposed inventor of the parachute, with the American, Dr. Jeffries, were the first to cross the channel from England to France. M. Charles, the inventor of the gas balloon, and one of the earliest and most enthusiastic advocates of ærostation, made extensive voyages. Madame Thible, of Lyons, was the first of her sex who trusted herself to the elastic element. Crosbie, who passed over the sea from Ireland to England, came near losing his life; for, the balloon, being struck with great force by an adverse current of air, and most of the gas escaping, tore over the raging waters at a fearful speed, until the courageous man was rescued, near the English coast, by a ship happening in his way. But the view which he had enjoyed, seeing both countries at once, was sublime beyond description, and compensated him for all the danger. He had been at such a hight that, although the July sun melted everything below, his ink was a lump of ice, and the quicksilver in the instruments had sunk almost out of sight.

The battle of Fleurus, in 1794, was won by the French over the Austrians principally through the aid of balloon reconnoitering; and similar service was occasionally performed by the balloon in our own war. The favorably known Italian, Count Zambeccari, who added many improvements to this art, and created great interest in the principal countries of Europe, made an ascension, in 1803, with two friends, at Bologna. The three alighted in the Adriatic sea and were picked up by fishermen, while the balloon, free from weight, rose again and was carried by the wind to the Turkish fort Vihacz, where the commander, believing it a present "sent from heaven," had it cut up in small pieces and divided amongst his friends as amulets. But quite a "reverse opinion" was generally entertained by most of the ignorant Christian country people, when the huge monster happened to fall amongst them for the first time; and their comparison of it to the "evil one" is excusable when we consider the peculiar smell of the escaping gas, after their attack upon it with pitch-forks and similar agricultural implements.

Among other remarkable ascensions is that of Guy Lussac, who reached the prodigious hight of nearly four and a half miles. This was exceeded, though, by another scientific æronaut, James Glaisher, in 1862, who, with a companion, mounted the great altitude of seven miles—over 36,000 feet; but as he was insensible for some minutes after reaching the elevation of 29,000 feet, the highest ever attained by human beings, their calculations could only be approximated. The mercury in the hygrometer—a delicate instrument for measuring the moisture in the atmosphere—had fallen below the scale, while they were rising more than 1000 feet per minute. There are instances of balloons that have shot upwards at the rate of fifty feet per second, or much over half a mile per minute; but, generally, even twenty feet per second is a rare occurrence. And here might be mentioned that, since the late serious loss of several French scientists by asphyxia, or cold on their unfortunate ascension, the problem of maintaining life in the highest regions of the atmosphere has been solved in France. With a certain apparatus, man could manage to live comfortably nearly ten miles above the level of the sea, while, ordinarily, two miles is the most.

As to horizontal speed, perhaps the fastest time on record was nade by Garnerin and Snowdon, from London to Colchester, some eighty miles, in one hour, or about 110 feet per second, almost swifter than an eagle flies; and another balloon went from Paris across the Alps, to the vicinity of Rome, in twenty-two hours, making over fifty miles per hour, considering its zig-zag travel. The reason for such great speed is, that the different air currents travel far faster in the upper regions than below, where the velocity of the wind is seldom over twenty miles per hour; and yet, were it not for the continually changing scenery, the æronaut would imagine himself stationary.

The shortest trip, perhaps, in the annals of this art, both as to hight and distance, was made, a few years ago, by a gymnast, at Woodward's Gardens, that most beautiful pleasure resort in this city. The little disobliging monster went lazily, and with great difficulty, over the fence and capsized promptly on the other side, leaving the trapeze-man hanging, by the seat of his unmentionables, on the top of it in an uncomfortable position, but no bones were broken.

V.—ABSENCE OF DANGER.

It is erroneous to suppose that ærial voyages are fraught with even ordinary danger ; on the contrary, travel by sea and land is far more so ; for, although thousands of assensions have been made, but very few persons have met with accidents, in fact, a less number by far comparatively, than by any other profession or mode of locomotion ; and, whenever such has happened, gross carelessness or ignorance was often the cause.

During the late Franco-German war, over sixty balloons, many but indifferently constructed, left Paris, during the siege, with some one hundred and eighty persons and nearly three millions of letters. All reached a point of safety.

Professor Wise, the most noted Amertcan æronaut, has made, during the last forty years, nearly five hundred voyages, and one in particular, in 1859, of nearly 1200 miles—perhaps the longest on record—with three companions, from St. Louis, Mo., to New York State. This trip was made partly in the midst of a tornado, while above Lake Erie, during which time some twenty sailing crafts succumbed to the effects of the storm, yet the intrepid æronauts alighted in safety. M, Green, who was the first to use coal gas, instead of pure hydrogen, and has also made hundreds of successful ascensions, was carried from London to Weilburg, in the central part of Germany, about seven hundred miles in eight hours, without the slightest mishap. Lastly, Arban, crossed the Alps from Marseilles to Turin, four hundred miles, in stormy weather during the night. Mont Blanc to the left, on a level with the top of which he was, resembled an immense block of crystal-sparkling with a thousand fires; while the moon occa. sionally seemed to have borrowed the light of the sun.

VI.—CHARM OF ÆRIAL TRAVEL.

Nothing can equal the beauty of an ærial voyage, that most wonderful, easy and luxurious mode of locomotion, with its entire absence of dizziness—this sensation being lost with the separation from earth, as soon as the last cord, which unites us with the world below, is cut.

In rising from the ground, the feelings are absorbed in the novelty and magnificence of the spectacle presented, while the ears are saluted with the buzz of distant sound until the clouds are reached, when all is still as death. The scene is sublime. Around and beneath, the clouds roll in magnificent grandeur. They form pyramids, castles, reefs, icebergs, ships and towers, and again dissolve into chaos. The half obscured sun shedding his mellow light upon the picture, gives it a rich and dazzling lustre. Reverence for the work of nature, the solemn stillness, an admiration indiscribable, all combined, seem to make a sound of praise.

The earth, which is never lost sight of at any hight, except clouds interfere or night sets in, seems to be concave, like the inside of a flattish hollow globe, instead of the outside, as would naturally be supposed. The reason for this optical delusion is, that the horizon appears on a level with the aeronaut, while the distance downwards remains unaltered, making the surface below appear like a valley. The earth presents the panoramic view of an immense map, such as the enchanted Alladdin must have enjoyed. The coloring, designating the various products of the soil, is lively and exquisite. Variegated grass-plats, the golden tinge of waving grain fields, the more sombre foliage of the trees, the glossy surface of the water dazzling in the sunbeams, with occasional white specks for sailing craft; the innumerable villages, with tastefully decorated and tinny, toy-like houses, the numerous roads tortuously spreading over the surface and looking like chalk lines on a gaudy carpet, fairy-like carriages seemingly drawn by mice and guided by liliputian little things. Such is the beauty of this glorious earth. Yet, when mountains appear like ant hills, and Niagara a neat little cascade in a pleasure garden—instead of the raging grandeur, only a frothy bubble—man must be forcibly reminded that he is but the minutest animalcule, and not of so much importance as he presumes himself to be.

No less impressive is the scene at night. The sublime exhibition in the vast solitude and darkness of night creates the most stupendous effect upon the lonely æronaut.

The earth's surface, as far as the eye can reach; absolutely teems with the scattered fires of a watchful population, and exhibits a starry spectacle below, that rivals in brilliancy the lustre of the firmament above. A city looming up in the distant horizon gradually appears to blaze like a vast conflagration. On drawing near, every street is marked out by its particular line of fires; the forms and posititons of the theatres, squares and markets are indicated by the presence of larger and more irregular accumulations of light, and the faint murmurs of a busy population still actively engaged in the pursuits of pleasure or the avocation of gain; all together combined form a picture, which, for beauty and effect, can not be conceived.

Again, higher up, or when clouds intervene, the sky, at all times darker when viewed from an elevation, seems almost black with the intensity of night; while, by contrast, the stars redoubled in their lustre, shine like sparks of the whitest silver, scattered upon the jetty dome around. Nothing can exceed this density of night. Not a single object of terrestrial nature can anywhere be distinguished, and an unfathomable abyss of "darkness visible" encompasses one on every side. It seems like cleaving the way through an interminable mass of black marble, and a light lowered from these dizzy hights appears to absolutely melt its way down into the frozen bosom of the surrounding inkiness. The cold is here intense.

VII.—ÆRIAL VOYAGES HEALTH PROMOTING.

But while the charm of floating in the air is so fascinating these delightful ascensions will be even more beneficial in sanitary respects.

Atmospheric pressure, exerting nearly 30,000 pounds upon a human being of full growth, has much to do with the mechanical functions of life. At a moderate elevation, one-tenth of this weight can be relieved, and at greater hights, even one-third, as balloon experiments have sufficiently proven. This pressure, then, diminishing upon the muscular system, allows it to expand. The lungs at once become more voluminous and breathing purer air; the freedom with which all the circulating fluids of the system are allowed to act in the rare atmosphere, intensily quicken the animal and mental faculties; the novelty of the voyage, and the most sublime grandeur opening to the eye and mind of the invalid ; all assist to promote health, impart new life, inspire ideas and invigorate soul and body.

VIII.—PARACHUTES.

This simple contrivance often forms an adjunct to balloons. Its appearance is generally tnat of a huge family umbrella of revolutionary times. It is likewise concave underneath, because such form, above all others, condenses a column of atmosphere more rapidly and retards its velocity in the descent immensely. The ribs are generally of whale-bone or bamboo covered with strong domestic muslin, and a light wicker basket is fastened some twelve feet underneath for the aeronaut, who may cut himself loose from the balloon with perfect safety at any hight, and descend slowly to the ground, if the parachute is strongly made and perhaps fourteen feet across when open.

By giving it a slight inclination, it can be made to descend, sliding-like, a long distance from the vertical point; and some of the flying machines we read of have likely been only a modified form of the parachute. The nautilus on the ocean moves on the principle of it, the pollen of plants is carried from one place to another by this mode ; so the flying squirrel moves in parabolic curves from tree to tree and even crosses rivers when the nut crop fails ; as also the flying tree-frog slants down long distances from high trees. This animal has a considerable expansion of skin, connecting the toes only, and which looks as if on its four legs were fastened those short, broad and light snow-shoes, known as Webfeet, used in our northern Territories in winter. It is, therefore, called a "webfoot" frog, but from which must not be inferred that it is "an Oregonian," for it is encountered so far only in Borneo.

IX.—THE KITE.

Every one is undoubtedly acquainted with the exceedingly simple mechanism—invented when boys commenced to exist—for the enjoyment of one of the most pleasant pastimes—kite flying. It is indulged in mostly during the fall, and, perhaps, a trifle more so in the rural districts than in the cities, because of the greater freedom of room which stubble fields and meadows allow.

But attention has also been given to the employment of this kind of ærostation as a means of support and conveyance ; and kites have been made as much as thirty feet high, looking more like buoyant sails than boyish playthings, and exerting an immense power of waftage. Loaded wagons have been drawn over turnpikes; persons have frequently been carried up in the air by huge kites; and, in some parts of Europe, experiments have been made to signal and save ship-wrecked people on dangerous coasts, proving sufficiently that the kite can be made, even in its present primitive state, to be quite useful.

In this connection it may "not be amiss" to state that the first person known to have ascended—some eighty years ago, as the "History of Kite Carriage" informs us, "was a Miss"—a young lady of some one hundred and twenty-six pounds, avoirdupois. She was seated in a chair underneath the gigantic structure which weighed nearly thirty pounds, had a surface of about sixty square feet, and rose most majestically to a hight of six hundred feet—an incontrovertible instance of the superior courage of the gentler sex over man.

The kite is maintained in the air by two opposing forces: the impelling power of the wind—lifting it by striking against it at an angle, and the restraining powers of the string—motive-force and gravitation combined; so that in the kite, above all, we possess in a crude form, the three principles requisite for artificial flight: the plain, weight and propelling force. By improving upon the kite, therefore, we will arrive at the practical solution of the problem of artificial flight.

X.—BALLOONS IMPRACTICABLE.

It is not creditable to the present age that the problem of ærial navigation has not been solved. But one of the causes has undoubtedly been the discovery of the balloon, which has retarded this science for nearly a century by misleading men's minds, and causing them to look for a solution of the problem by the aid of a machine lighter than air, and which has no analogue in nature.

Weight is one of three essential factors in flight, for a light body cannot be propelled through a heavier one. Hence all attempts at driving and guiding the balloons have signally failed. This arises from the vast extent of surface which it necessarily presents, rendering it a fair conquest to every breeze that blows, and because the power which animates it is a mere lifting power, which acts in a vertical line. The balloon, consequently, rises through the air in opposition to the law of gravity, by which all flying creatures are governed, very much as a dead bird falls downward in accordance with it. Having no hold upon the air, this cannot be employed as a fulcrum for regulating its movements, and hence the cardinal difficulty of ballooning as an art of locomotion and its uncertainty, because the air-currents cannot be regulated. A balloon starting from San Francisco might be intended for New York, but, against the desire of the passengers, alight in China or the Canibal Islands, which would be rather disagreeable.

It is simply astonishing to hear of people trying, year after year, to propel elongated or cigar-shaped balloons with a car underneath, and a screw-propeller, of course —an experiment which was tried, unsuccessfully, forty years ago. But this is generally the first conceived project of an aspirant for fame who commences to think on the subject, and soon fancies himself the happy possessor of the secret; yet what a very small amount of science is necessary to show its fallacy. In fact, all kinds of propositions for the propulsion of balloons have been advanced and experimented upon, but scarcely any improvements have been made since the first five years after its invention; proving, perhaps, more conclusively than anything else, that the practical propulsion of balloons is an impossibility.

The most remarkable idea in this respect, was undoubtedly that of Teissol. He flattered himself to be able to train geese or other birds to pull a balloon by being hitched to it, while the conductor, in a car underneath, was to direct their movements by the aid of a long pole. Although the training of birds is not so ridiculous as it may seem, yet he found that geese, if not too tough, answer the purpose of a good roast much better. And another genius, still more unique, long before balloons were invented, conceived the idea that air, like water, must have a defined limit, and that it was possible to sail on its surface like ships on the ocean. He did not state how to get up there, but lost no time in inducing the King of Portugal to forbid everyone, under penalty of death, to use said invention. So far, no one has come in conflict with that law.

Yet, although the balloon is impracticable as a means of transportation, it should by no means be discarded, for it can be made very useful for scientific and other observations, to give pleasure to thousands of people by fanciful ascensions, and not the least, to serve, as stated before, sanitary purposes, when captive and well secured. But instead of lowering and elevating it continually, as is being done at present, and which occasions danger and great loss of time and money, a contrivance should be made by which persons could safely, and without interruption, be carried up and down underneath parachutes.

XI.—REASONS WHY THE PROBLEM HAS REMAINED UNSOLVED.

The slow progress made, and the unsatisfactory state of the question, notwithstanding the large and universal share of attention bestowed upon the subject from earliest times, must be attributed to a variety of causes, the most prominent of which are—

"The great difficulty of the problem.

"The incapacity on the one hand, or theoretical tendencies on the other, of those who have devoted themselves to its elucidation.

"The lack of means of inventors generally, and the difficulty of obtaining the same to experiment and carry out their ideas even after the completion of their invention. Hence so many failures amongst this class, while men of genius in the literary or most other fields require but little pecuniary outlay to succeed.

"The stolid indifference of an unthinking community, which so often proves the deathblow to the mind of the philosophical inquirer, and whose aim is condemned and pronounced as 'visionary,' absurd and incapable of realization, instead of receiving that support and encouragement which is so necessary to success."

Flight has therefore been unusually unfortunate in its votaries. It has been cultivated on the one hand by profound thinkers, especially mathematicians, who have worked out innumerable theorems, but have never submitted them to test of experiment; and on the other by either uneducated charletans who, despising the abstractions of science entirely, have made the most wild and ridiculous attempts at a practical solution of the problem; or inventors, who, desirous to triumph over some of the acknowledged difficulties of propulsion and navigation, but for want of organization or pecuniary support, or being unacquainted with preceding failures in the same direction, or ignorant of some one condition demanded by the peculiar nature of the experiment, but which is absolutely necessary to success, have also failed, thus causing still greater doubt in the public mind, and, consequently, less support to inventors in the same direction afterwards.

A common error prevails, that models are essential to help the inventor. The province of the model is to explain the invention to others after it has been made, and not to assist the inventor. Except in very restricted limits they have been found to be almost useless, and most of our valuable discoveries have been made and carried out without their aid. Watt's first condensing engine had a cylinder of eighteen inches diameter, or about the average size now in use. It is so with agricultural and other practical inventions and applies particularly to flying machines. Models often signally prove failures on a small scale, yet would be successful on a larger.

The problem is not an unphilosophical phantom, but a mathematically demonstrated truth, which needs only actual realization to revolutionize the world for the better. That the air is navigable can no longer be denied.

XII.—FUNDAMENTAL PRINCIPLES OF FLIGHT.

In contemplating the boundless atmosphere, we perceive it to be tenanted by a multitude of creatures of varied form and size, who move and direct themselves with marvellous ease and skill. These beings, so different in their nature, form and construction—from the proud eagle to the "blood-thirsty" mosquito—resemble one another in the possession of three important fundamental principles which constitute the power of flight. These are—weight or gravity, surface or resistance of the atmosphere against it, and force or power of projection.

The medium in which the phenomenon of flight is produced—the air—is an invisible, impalpable, comparatively imponderable fluid, and its density is nearly 800 times less than that of water. Hence a movement through it can be made far more rapidly than through its sister medium. Nevertheless, if agitated, it is capable of exerting great pressure, as the tempestuous storms, overturning fences, unroofing houses, uprooting trees, and carrying even large animals into the air, teach us. Hereon then, that is, the proper manipulation principally in creating artificial currents of air, hinges the secret of flight, because this phenomenon is reproduced in a manner identical, if a surface is moved against it, as we see in the wings of flying creatures.

XIII.—WEIGHT.

Weight is absolutely indispensible in flight, it adds momentum and assists the propelling power—with greater force comparatively in heavier bodies. A wooden cannon ball can fly only a fraction of the distance of an iron one; and an equal weight of musket balls, propelled by the same charge of powder, will not reach near so far as the cannon ball, because of its consolidation in one body; and a feather or little toy balloon can not only not be propelled, but will actually recoil if attempted. Hence, all flying animals are many hundred times heavier than air, and the heaviest are generally the best flyers, yet require the least amount of surface and force in proportion.

The sympathy existing between weight and power is very great. Weight acts in flight upon the oblique surfaces of the wings in conjunction with the power expended, and thereby husbanding the latter immensely. Thus only are the denizens of the air enabled to perform long journeys, while otherwise they could retain their position in the upper region but a very brief time, as their strenght is no greater than that of other animals and would soon give out. Weight acts on flying creatures in a similar manner as we see it in the clock, where weight is the moving power, and the pendulum merely regulates its movements.

Of course, the belief of many, that birds have large air cells in their interior, that those cavities contain heated air, and that this heated air in some mysterious manner contributes to, if it does not actually produce, flight, falls to the ground upon the least reflection. No argument could be more fallacious. The bird is a heavy, compact, by no means bulky body, and that trifle of heated air, or gas, if such were the case, but is not, which possibly might help elevation, would be but dust in the scale. A small balloon of two feet diameter—a larger body than any bird—can lift only about a quarter of a pound. But, besides, many admirable flyers, such as bats, have no air cells; while many animals, never intended to fly, are provided with them. It may, therefore, be reasonably concluded that flight is in no way connected with air cells, and the best proof that can be adduced is to be found in the fact that it can be performed to perfection in their absence.

XIV.—SURFACE.

The next of the three properties necessary for flight, is the extension of the locomotive organs in winged beings—the planes. Although the wings in the different animals differ much in their form, texture, construction, number, and the matter which composes them, yet they resemble one another in the expansion and development of their surfaces, being stretched on each side of the body, and playing the part of a parachute. The animal, therefore, cannot fall like a stone, in obedience to the accelerated force of gravity, but it descends with a slow velocity; constant regular, and considerably abated.

This influence, then, exercised by the flat surface on the fall of masses, is seen in a sheet of paper of the same weight as a grain of lead, it will fall much more slowly. But if we make the paper a compact ball, and flatten the lead into a broad, thin sheet, the reverse result will be produced, and the paper reach the ground before the lead Therefore, bodies in the air are light or heavy in proportion to their surfaces, and the heaviest may become light by an alteration of form. For successful flight, then, a just proportion of surface and weight is necessary ; because, as stated, the air being elastic, its resistance is much more effectual with light bodies than heavy ones ; and this proportion is such that the extent of surface is always in an inverse ratio to the weight of the winged animal.

The principle in the fall of flat surfaces is strictly applicable to the bird. Its weight, tending downwards, and being situated below the plain of suspension, keeps it well balanced, so that it cannot fall head over heels, nor rapidly. If the wings are inclined at an angle with the horizon, the bird will not descend vertically, but glide along an inclined plane with much greater swiftness, because the vertical distance remains unaltered in the same space of time. Hence their immense horizontal velocity, without comparatively any effort. This is in obedience to two forces—gravity, or weight, and resistance of surface.

XI.—POWER.

But for actual flight a third force is required—the propelling power, the necessary amount of which has greatly been overrated by many mathematicians.

Borelli estimated the power of a three pound bird to be over one hundred and thirty horses relatively. But, Navier, more reasonably, calculated a force of five horses sufficient for the flight of a pigeon. Coulomb, again, offset this "great liberality" by demonstrating that the surface to support a man must be two miles long and two hundred feet wide, with the power of a "Corliss engine" to propel such a "fifty acre ranch."

Now, facts prove that man can, without danger, descend from an high elevation under a surface of much less than fifteen feet diameter; and the force to lift himself, as will be shown hereafter, is also comparatively small. He can walk up stairs, and likewise mount upon air, which, properly manipulated, becomes sufficiently solid.

It has been demonstrated beyond a doubt, that the heaviest flying animals require the smallest amount of surface and power in proportion. The surface is less, because the resistance of the atmosphere is much greater toward one unbroken body than all the parts thereof if detached. Hence a stork, weighing eight times as much as a pigeon, needs only five square feet of surface, while the eight pigeons, with nearly one square foot each, possess together over seven square feet; and the common fly, if magnified to the size of the crane, would show a surface sixty times as large.

The heaviest flyers require the least amount of power, because weight, as stated before, itself is power, which increases in a certain ratio. Hence we find the muscular force of the smaller beings, who possess little weight, to be enormous; this is particularly so with insects, who are the strongest in creation. A stag-beetle, of which two hundred weigh only one pound, can lift fourteen ounces; crickets leap eighty times their own length, and the "lively flea" can jump through space estimated at even two hundred times the length of its body—which accounts for the difficulty of catching it. If a mouse would simply reproduce the gait of a horse, its progress would be about twenty inches per minute only, and cats would soon find themselves out of employment.

Nature has wisely established a compensation to make amends for the diminutiveness of organs by rapidity of movement, and has, consequently, furnished the animal with the necessary power to produce this rapidity.

The force necessary for lifting in all winged beings is not near so great as is generally supposed. The fall of a body, continually accelerating, is seventeen feet per second, and a very great force would be necessary indeed to offset this gravitation, if that second were allowed to expire without a counter-movement; but when that body is provided with a parachute-like arrangement, there is no such rapid fall of seventeen feet per second; and when, besides, the force is applied constantly, thereby counteracting even a fraction of the fall, the power needed to accomplish this is but a trifle; it is the principle, to use a homely phrase, that "a stitch in time saves nine." What extra strength the animal possesses has to be used in pursuit or escape, from the powerful eagle to the minutest insect; they must be prepared to exert at a given moment all the strength that nature has given to them in store.

Their strength is no greater than that of fishes or quadrupeds; all possess surplus power greatly above the need of their average use, and the strength exhibited therefore by flying creatures shows only that but a small portion of it is used for lifting and propelling purposes.

Eagles have been known to carry off small deer, lambs, hares, and even young children. Many of the fishing birds, as pelicans and herons, can likewise carry considerable loads, while the smaller birds are capable of transporting comparatively large twigs for building purposes. A swallow can traverse 1000 miles at a single journey, and the swift, the fastest of all, is known to have made nearly 180 miles an hour. The albatross, despising compass and land-mark, trusts himself boldly for weeks together to the mercy or fury of the mighty ocean; and the huge condor of the

Andes, as Humboldt, Darwin, Orton, and others inform us, lifts himself to a hight where no sound is heard, and from an unseen point surveys, in solitary grandeur, the wide range of plain and mountain below. He has been seen flying over the Chimborazo, and attains, on occasions, an altitude of six miles.

FLYING CREATURES, THEIR PROPORTIONS, MOVEMENTS.

The great common characteristic of the different winged beings are the same throughout all the modifications of detail. These are, as stated, weight, extension of surface, and the mechanical application of the propelling force; so that the animal is a gliding plane, part of which is fixed and the other moveable, and the whole being maintained in stable equilibrium by the weight of the body, placed a little below the plane of suspension.

By comparing the different species it is found, by M. de Lucy and others, that the extent of surface is in inverse ratio to the weight, the determination of this ratio being based upon certain considerations. The proof of this is overwhelming. Supposing all flying creatures of the same weight, say one pound, it is found that the :

Gnat possesses	50
Common by	22
Bee	5
Beetle	4
Sparrow	3
Pigeon	$1\frac{2}{3}$
Stork nearly	1
Vulture	$\frac{3}{4}$
Crane nearly	$\frac{1}{2}$

Square feet of surface per pound.

Thus we find the gnat, of which 160,000 make one pound, and which weighs four hundred and sixty times less than the beetle, has thirteen times more surface, comparatively. The sparrow weighs about ten times less than the pigeon, and has twice as much surface in proportion. The Australian crane—one of the heaviest birds, it weighs over twenty pounds, or almost three million times as much as the gnat—possesses the least surface—not quite ten square feet, or one hundred and twenty times less than that insignificant but formidable animal. Yet its flight is, gliding softly on the air, without effort or fatigue, with but little exertion, the longest maintained, and it can, with few exceptions, elevate itself the highest.

In regard to the movements of the wings, there is a similar ratio; for, while the mosquito makes over two hundred wing strokes per second, the sparrow makes only thirteen, the buzzard three, and so on, continually decreasing with heavier bodies.

A word about bats and flying fish. Although bats present no real resemblance whatever to birds or insects, but are much more like ourselves, they must be classed amongst the creatures of the air, because they are constantly moving in it, and governed by the same laws.

Their flight, being somewhat fluttering, but otherwise powerful, true and perfect, is undoubtedly caused, particularly in the early part of the night, when feeding, by their darting right and left after the almost invisible numerous insects, which they devour at once.

The wing of the bat is, like that of the bird, concavo-convex, and also more or less twisted upon itself, but it differs in so far that its arm is not covered with feathers, but a very delicate membrane, which forms the parachute-like wing.

Their nocturnal, and therefore disreputable habits, with our dislike for the blood-sucking propensity of a large specie, the vampire, has kept our interest in these otherwise harmless and clean creatures at rather freezing point. But they can be tamed easily, and are capable of giving considerable pleasure.

The flight of a shoal of flying-fish as they shoot forth from the dark green wave in a glittering throng, gleaming brightly in the sunshine, is a charming sight. But these fish can scarcely be classed with the creatures of the air, because true flight, that is the manipulation of the wings, is lacking. They are mentioned because they represent, like the kite, the first step toward that true flight which all other creatures in the air possess.

They are capable of moving through the air from 500 to 600 feet, and as much as 20 feet above the water. The fish first acquires initial velocity by a preliminary rush through the water, when it throws itself suddenly into the air, and, at the same moment, spreads out, kite-like, at a slight inclination upwards, its extraordinarily large pectoral fins. It keeps up the great speed until its momentum is exhausted, when the same performance is repeated.

The fact in favor of mechanical flight is certainly incontrovertible that less surface and less power is required and flight maintained the longest, in proportion to heavier bodies.

It must be convincing, therefore, that it is possible for man to apply the laws of flight to industrial purposes in the same manner as he has been able, in these days, to apply all the other grand physical laws that he has taken the trouble to study and fathom. The law of surface and force reigns in the most absolute and exact manner over all flying animals. It does not stop here. Nature, whose laws are general and universal, has not created this one only for the restricted compass of the winged animate beings. The law which sustains on the water the leaf and the straw is the same for the gigantic Great Eastern; and the mechanical law of the forces which drives the wheelbarrow also conducts on its iron line the locomotive and its endless train.

XVII.—MECHANICAL PRACTICABILITY OF ARTIFICIAL FLIGHT.

Living beings have been, in every age, compared to machines, but it is only in the present day that the bearing and justice of this comparison are fully comprehensible. Modern engineers have created machines which execute more difficult and various opperations than animate beings are capable of; yet it is always from nature first that man has to draw his inspirations.

Of the different functions of animal meahanism, that of locomotion is certainly one of the most important and interesting; and as we have brought this art on land and water, by successfully imitating the natural movements of walking and swimming, to quite a high state of perfection, the next great problem, equally possible, because flight is a natural movement, remains to be solved.

Of course, as different as the wheel of the locomotive is from the limb of the quadruped, and the screw of a steamship from the fin of a fish, so will the coming flying machine differ from the construction of bird, bat or insect.

Walking, swimming and flying are modifications of, and merging into, each other by insensible gradations; and the modifications, resulting therefrom, are necessitated by the amount of support afforded on, and in the different mediums — earth, water, air. Although flight is, indisputably, the finest of the different animal movements, yet it does not essentially differ from the other two, as the material and forces employed are literally the same as those in walking and swimming.

Flight is, therefore, a purely mechanical problem, and in compliance with the law of decrease, as stated before, the surface requisite to transport bodies in the air, is found to be about one-half, proportionately, to twelve times the weight.

Applying this observation to an apparatus of, say 200 lbs., we find that the surface of a bird of 18 lbs.—about one-twelfth of said 200 lbs.—to be 10 square feet; multiplying this by twelve, its weight, we have 120 square feet of surface, and of which one-half accordingly, 60 square feet, is enough for the support of 200 pounds. Such a machine, although possessing much less surface than parachutes generally do, is in the form of inclined planes of proper construction, fully sufficient for man to slide down safely through the air, without exertion, from an elevation at least ten times the vertical distance, that is, from the top of the Palace Hotel to the foot of Baldwin's.

As to the force required, although impossible to give datas, the law of decrease with greater weight reigns absolute here also. Man's muscular power for tolerably swift horizontal flight is far greater than necessary; and, with properly constructed contrivances, he will be able to travel, at an incline upwards of one in thirty, at least twenty miles an hour, by manual power alone. A carrier pigeon flies, for a short time, at the rate of one hundred miles an hour, and some birds much faster. But in employing any of the many excellent motive powers at command now, and with larger machines, we will be able to surpass the swiftest birds.

As for the objection, that the fury of the wind will hinder artificial flight, it is refuted by observing that even a hurricane, which, traveling over eighty miles an hour, occurs but rarely, does hardly prevent the flight of fast birds, and still less would that of a compact and solid flying machine, because of its greater weight and momentum. And even if an occasional storm should be dangerous, the machine, by its greater swiftness, could be turned above, below or sideways, out of the path of destruction, or it need not travel at such rare times. Besides, the effect of the storm upon a body within its own medium is insignificant to what it is when that body offers resistance by being attached to another medium, as ships on the water, or houses and fences on land.

XVIII.—FLYING MACHINES OF THE PRESENT, THEIR DEFECTS.

When it was found that no marked improvements could be made in balloons, the more advanced thinkers, turning their attention in an opposite direction, commenced to justly regard the winged being as the true model for flying machines; and experiments are now being made, in different parts of the world, of which all go to prove that "*flight is far more a question of mechanical adaptation, construction and manipulation, than of enormous power*," which, of course, in any experiment, must prove unavailable, if improperly applied. Some of the motive engines, lately exhibited in England, produced such remarkable power as certainly no bird possesses. One of four-horse power weighed 40 pounds, and occupied but a few cubic feet; another of 13 pounds exerted over one-horse power; and, at some experiments in France last year, a steam engine of two and a half horse power weighed 80℔s.; and, being applied to a machine with two vertical screw propellers of 12 ft. diameter each, it raised 120 ℔s. of the whole weight of 160 ℔s.

But, as far as known, these different motive powers have been employed so far only to elevate and propel machines by vertical fan-like contrivances—helicopterics or by æroplanes, pushed forward and upward by screw propellers; either quite as irrational as ballooning, because the rigid plane, wedged forward and upward at a given angle, in a straight line, or in a circle, does not embody the principles carried out in nature. Hence, the several advocates of the æroplane and helicopteric have met with but indifferent success.

Perhaps the best representative model of a flying machine on the principles of inclined planes, was that of Mr. Stringfellow, exhibited in London, in 1868, and which occasionally could rise. It had three æroplanes, superimposed as advocated by Wenham, the frames of which were made of light wood, with cloth drawn over it tightly, like rigid kites, fixed parallel one above the other, with a tail attached to the middle one. It had a small box underneath for the motive power, and a light screw propeller behind for pushing it forward. By giving the machine an upward angle, the planes strike continually upon new layers of air, and so cause a rise, like a kite pushed from behind. The whole structure had about thirty-six square feet of surface, and weighed, including the steam engine, which exerted nearly one-half horse power, under 12 pounds. It proved conclusively that, while the inclined plane, in a practical and different form, is necessary for æorastation, the secret of solving the problem lays far more in the mechanical application of certain laws governing the art of flight, than in enormous power.

These kite-form machines did not succeed, in spite of their great motive power and lightness, because the supporting planes were not active and flexible, but presented passive or dead surfaces, without power to accommodate themselves to altered circumstances. These planes were made to strike the air at a given angle, instead of continually changing to suit the elastic medium, and in which respect the ordinary kite is a better flying machine. If not driven with great velocity, such a machine can not support itself in the atmosphere ; besides, on account of its great surface exposed, a strong wind can easily capsize it ; while natural wings, on the contrary, present small flying surfaces, and their great speed converts the space through which they are driven, into a solid basis for support. This arrangement enables wings to seize and utilize the air, and renders them superior to the adverse currents, not of their forming. In this respect they entirely differ from balloons, and all forms of fixed æroplanes.

The different small helicopteric models, relying entirely on the aid of the screw, made from time to time, were also lacking, as stated before, in some of the true principles of flight; although some of these models could not only rise, but also carry a certain amount of freight, as was shown by the delicately constructed clockwork models of M. Nadar, a prominent French scientist, and others. One remarkable model, exhibited some years ago, was that of M. Phillips. It was made entirely of metal, weighed two pounds, had four two-bladed fans inclined to the horizon at an angle of twenty degrees, and made to revolve in opposite directions with immense energy. The motive power employed was obtained from the combustion of charcoal, nitre and gypsum, the products of combustion mixing with water in the boiler and forming gas-charged steam, which was delivered at a high pressure from the extremities of the arms of the fans, on the principle discovered by Hero, of Alexandria.

The production of flight by artificial wings is the most ancient method proposed, and will, undoubtedly, in a greatly modified form, and in combination with other contrivances, solve the problem; but to exactly imitate natural wings will be found as impossible as the production by the other different methods proposed so far.

Of the more recent attempts at the solution of the problem by means of artificial wings, worked by steam power, the perhaps most determined was that of Mr. Kauffman, of Glasgow. The machine had superimposed æroplanes, similar to those used by Stringfellow. The two wings were of great length, narrow, pointed towards the end, and were made to flap up and down somewhat like the wings of a bird. The model exhibited weighed, complete, 42 lbs., but the dimensions for a large machine were to be: length, about 30 ft.; hight, 5 ft.; width, 6 ft.; length of each wing, 60 ft.; surface of each, 400 ft.; total weight of machine, 8000 lbs.; nominal power, 120 horses; intended speed, 60 miles per hour; with water supply for five hours and oil as fuel for ten hours. Besides, a pendule, weighing 85 lbs., and 40 ft. in length, was attached, which could, telescope-like, be drawn up when necessary. The model was made exactly, to show the inventor's theory, and to ascertain if the connection to the wings could be made strong enough to withstand the violent twisting and bending strains to which they were exposed. When steam at a pressure of over 150 lbs. was turned on, the wings made a short series of furious flaps and broke. The experiment failed, because, to exactly imitate the movements of the long and delicate wings of fast-flying birds on a large scale, is impossible; the leverage to flap up and down 60 ft. long wings being simply enormous beyond computation, and no material can be found strong enough to withstand it.

Another machine, the propulsion of which was also to be effected by means of artificial wings, was exhibited some years ago in England. It differed entirely from the other in this respect, that it was very light, weighing scarcely 30 lbs., and was intended for a man to fly by his own muscular power. It had about 70 square feet of surface, two short wings, and the ribs were made of paragon wire, such as is used in umbrellas, and covered with silk. By a preliminary quick run, the inventor could take short, jump-like flights of more than 100 feet; but this machine was also in a very crude state of perfection.

These different practical experiments, although more or less unsuccessful, and others similar, but of which many models were far more ingenious than practical, have at least established the certain prospect and certainty of an early solution of the problem. And were it not that but very few, comparatively, of the great number of theories, which have been proposed from time to time for the accomplishment of this great object, have been submitted to anything resembling even the remotest approach to practical tests, and that the lack of means is generally the insurmountable barrier in experimenting, ærial navigation would to-day be an established fact.

XIX.—THE PRACTICAL FLYING SHIP OF THE NEAR FUTURE.

Possessing then, all the datas possible on the subject, it is, perhaps, not so very difficult as is generally supposed, to arrive at a satisfactory result; and, like other great inventions before, the coming air ship will also be a rather simple affair. While it will not likely possess such prodigious weight as 8000 to 10,000 pounds, with a hundred and twenty horse-power steam engine —sufficient almost for a man of war, it will neither be as light as a feather, comparatively, but hold the golden middle.

The inclined planes, in a greatly modified form, will by no means be discarded, as in fact no flying machine could be built otherwise. But, as stated before, this is only one principle long recognized, the A B C, so to speak, towards the solution of the problem. These planes, in wedging forward, for certain reasons, should be *elastic*, in some manner, and which has not been attempted by any inventor yet. The frames and covering of all models, built so far, have been rigid and immoveable, and yet, even with these great defects, partial success has been obtained already.

The fan or screw never will be used as the *only* means in propelling, but will be very effective in doing service as a part of the whole, with other contrivances in driving and guiding. But their form and style must be considerably different from anything known at present.

A modified and peculiar form and style of wings, as mentioned here before, must also be employed in combination with the planes and fans, to serve the double purpose of driving and lifting. By the manipulation of these wings the accumulating and compressed air is thrown underneath the machine, thereby urging the same in a forward and upward direction, and by which the planes in front are made to continually rise upon new layers of the elastic medium, like a kite when the boy runs forward.

The planes must be fixed in such a manner that they can be set at different angles with the horizon, in order that the machine may rise sooner when the angle is greatest, because of the greater resistance of the air against a larger surface exposed ; and to glide through the atmosphere swifter, after elevation has been attained, when the angle of the planes is most acute, thereby offering the least amount of surface to the horrizontally opposing air. No flying creature rises in the air vertically, but ascends at an incline.

A swallow, one of the very best flyers, lifts itself with difficulty from the ground. An eagle, particularly after eating, has to run some distance flapping its wings vigorously before it can rise. An insect, possessing considerable spring-power in its limbs, always takes a good jump at the moment its wings are spread out for elevation, at an upward angle forward. With similar contrivances for the purpose must a practical flying machine be provided. It should, in combination with a certain amount of spring power, to enable it to rise with greater ease at the final moment, and also to reduce the shock in alighting to a minimum, have wheels to run over the ground, until sufficient force and momentum has been attained to launch it into the boundless realms of space.

To be thoroughly practical, the machine must be under perfect control, and be made to descend upon any spot desired with absolute safety and ease. This can be accomplished by the combined effort of the propellors and wings. By exerting the power of these contrivances in opposite directions the disturbed atmosphere is thrown in volumes underneath the machine, which, on account of its similarity to a parachute, although of a greatly different form, can be made to descend vertically and very slow.

The doubt expressed by many, that the guidance of an air-ship is possible, is easily refuted. All bodies, possessing the propelling force within them, can guide themselves in an elastic medium. Of this we have millions of examples before us in all flying creatures.

Finally, a practical shape and proper size and weight will form one of the most essential elements in a successful flying machine, and which has been disregarded more or less so far. Of course, it is impossible to calculate already, before an actual machine has been built and datas can be fixed, the limits of these factors in the average ærial structure. My impressions are, that the weight of a single carriage will be from 400 to 500 lbs., inclusive; a motive force of 3 to 5 horse power. It will have a total length of from forty to fifty feet, by about the same in width, from tip to tip; and a surface of from 500 to 600 square feet will be more than sufficient to sustain a total weight of 1000 lbs.; for such a machine will be capable to carry from three to four persons, or its equivalent weight of express matter, letters, newspapers, and other light freight. Of course, free mail facilities for our wise solons will, perhaps, unfortunately have to be barred out.

When the novelty and excitement of this style of travel will have subsided, we may take the next step in ærostation by carrying a much greater number of passengers and heavier freight; not in a single machine, but by making two or more to support inclined planes of certain construction between them. These planes, in swift horizontal flight, could be made to carry, in suitable cars underneath, much more than their own weight, because the power of support which the air affords to inclined planes at a great speed is simply enormous, amounting to 50 lbs. per square ft. in a pressure of 100 miles per hour. For this purpose, the manner of placing these æroplanes one above the other, as proposed by Mr. Wenham many years ago, would be practical to some extent.

The great swiftness with which these machines are expected to travel, seems at first to rouse fear in us to trust our more or less valuable lives into such a wonderful structure; and it possibly staggers our belief that such great speed can be performed with any degree of safety to brittle bone and breathing valve. But all these objections are easily refuted. The ærial traveler sits securely inside the strong machine, in no danger of catching a cold from the strong air-current rushing by, very much like the passenger in a railroad car; and if of an inquisitive turn of mind for the beauty of the surrounding panorama, he has suitable windows for observation. If the air passenger suffers from gout, rheumatism, or is susceptible to sea-sickness, he will experience no inconvenience, because there is no jogging, no rumbling over cobble-stones or broken rails, or riding on a heavy sea ; he will feel no motion at whatever hight he may be, but will glide voluptuously—without perception almost—like a summer cloud through the vast ocean of the ærial fluid.

The machine being under perfect control, can be made to travel very slow when towards the point of destination, and may be stopped at any hight to remain stationary or leisurely descend. And lastly, speed appears greatly diminished when the object is viewed from a distance, as we can observe on a railroad train. A telegraph pole standing near the track will flit by like a flash of lightning, so to speak; but if any considerable distance off, it disappears very slow. But when an object is followed by the eye from a considerable elevation, this fact is still more striking. The eye can command at a glance almost hundreds of miles of country, and a city can be seen at a distance of at least fifty miles in advance, giving the æronaut ample time for preparing a descent, if so desired. Of course, he must be well acquainted with landmarks, to know what part of country he is in; but this knowledge will be acquired much easier than water navigation.

Such about will be the coming flying-machine of the near future. The natural elements, so far from presenting barriers and obstacles, as they do to a great extent on land and ocean navigation, seem to be peculiarly inviting to ærostation.

Previous to nearly every great discovery, difficulties have been thought to exist which its completion dissolved. In the days of stage-coaching, the expectations held out by those interested in steam transport were considered, even by most competent and intelligent men, as wholly chimerical; yet the locomotive far surpasses the race-horse in speed and endurance. When practice proved and datas could be fixed, that smooth tires met all the requirements on railroads—in place of cogwheels to gear into racks—how easy all calculations on adhesive force and friction then became. So with flight.

XX.—WHAT THE CHANGES FOR THE BETTER WILL BE.

It is impossible to overestimate the benefits which will accrue to mankind from such a creation, Flying will become a studied art, an amusement, an accomplishment, and inconvenience from sultry heat, or freezing cold, or deadly epidemics will no longer be suffered. Flying will become a business, a trade, and the advan tages derived from it for industrial purposes will be wonderfully great. New channels of employment will be opened to thousands, yes, millions of starving fellow-beings. A new era will be inaugurated in history; and great as has been the destiny of our race, it will be quite outlustred by the grandeur and magnitude of coming events.

Traveling at a speed of over one hundred miles an hour, distance will become comparatively anihilated. Cutting through the air from San Francisco to New York, for instance, in twenty-four hours, at one-sixth in cost and time; far safer, because of no irr egulations nor obstructions of road, no snow-blockades or unnecessary delays; far cheaper, because of no great expense for outfit or maintenance, the ærial carriage will soon become the great means of travel throughout the world.

The vast uninhabited but productive regions of this globe will be populated from overcrowded and impoverished communities, because of the extraordinary cheap, safe, and rapid travel by flying machines. New life will again be imparted to enterprise, speculation and labor; and lands will be cultivated and great cities be built in regions where the foot of human being has not trod for ages.

The Andes and Rocky Mountains will become as familiar to us as the hills of our own city; and mining and other discoveries will follow each other with wonderful rapidity. The vexing and expensive explorations in the interiors of Africa and Australia, and towards the North Pole, will soon be brought to a speedy and satisfactory conclusion; and some of the wildest dreams of men be realized.

XXI.—CONCLUDING REMARKS.

The accomplishment of ærial navigation, then, is within reach; its practicability can no longer be denied. It will be one of the most glorious and fruitful conquests, and of the highest value and importance to civilized nations. But all inventions, and particularly an undertaking of such gigantic nature, require pecuniary assistance. This should not, in our age of progress, be lacking for a single moment; because, if for no other reason, the first promoters of it will reap such great financial benefits therefrom as must be beyond their calculation. Singer, Howe, Colt, McCormick, and hundreds of others, all, with thousands of friends so immensely wealthy, bear out this assertion. Let not this enlightened age look upon a great invention as was done in Robert Fulton's time, when he proposed the steamship to Napoleon in 1801. The plan was laid before a scientific commission, and these learned men reported it as "visionary" and impracticable. Such was the reception which steam navigation, that has achieved such immense results, first received at the hands of philosophy and capital; but France lost thereby, indirectly, the control of Europe, and Napoleon his crown; while another nation—America—more wise, ten years later commenced to reap the benefits emanating from Fulton's genius.

Means, then, being necessary for the accomplishment of this great object, let them be forthcoming at once, that California may enjoy the honor and the first fruits of this great invention.

In conclusion, let me thank you for the kind attention you have bestowed upon a weak exponent of a great subject.