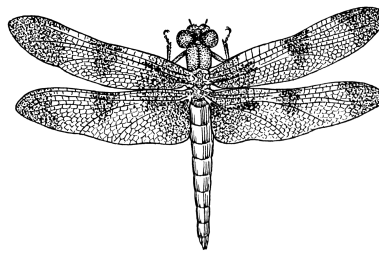
THE DRAGON-FLY,

OR

REACTIVE PASSIVE LOCOMOTION.

A VACUUM THEORY OF
AERIAL NAVIGATION,
BASED ON THE PRINCIPLE
OF
THE FAN-BLOWER.
TO WHICH IS APPENDED
SOME REMARKS ON
WATER AND ITS
NAVIGATION.



BY

A DISCIPLE OF BACON.

1882.

"The tales of Antiquity—the poetical productions—the religious tenets—and even the Histories of most nations show that to acquire the Art of Flying, or of imitating the birds, has been the earnest desire, and has exercised the genius of mankind in every age."—History and Practice of Aerostation, by Tiierim Cavallo, F.R.S. London, 1785.

—

Waste marks the imperfect works of man:
Economy the perfect works of God.

PREFACE AND AN APOLOGY.

MY apology for writing this book is contained in what follows:—

In the year 1857-58 I offered a reward of $1,000 to any inventor able to produce an actual flying machine. This offer was made through the columns of a leading scientific journal in America, and kept open for a year, but failed of its object. Some time after this, while living abroad in an old city of the Continent situated by the sea, famed for its ancient history and modern brandies, I set myself seriously to the task of carefully watching the motions of birds in the air, with the view of ascertaining by actual observation of their wing-movements in what the secret of flying consisted. These observations were kept up by me for many years— for fully ten or eleven —with little or no intermission, when they were suddenly discontinued. Why my work was recommenced, and why these pages have been written, I will now proceed to tell, though fully aware of the ridicule it must necessarily expose me to from that class of remarkable people in our world who understand the whole mechanism of material nature, and the spiritual or effluent laws of the universe so much better than their more ignorant and to-be-pitied fellow-creatures do.

During my residence in the old city by the sea, as I have said, I studied the birds carefully. Bats also interested me, and there were plenty of them there. Of insects, however, I took no notice, except as to butterflies, on account of their large and slow-moving wings, which could be easily watched; for what could creatures with comparatively no weight at all teach in respect to a problem the very gist of which relates wholly to weight! for the problem of aerial navigation is the problem of a flying man: a flying horse: a flying elephant: a flying mass: a ton, or tons of matter going through the air: and the largest birds we know of, or can imagine, the roc of fable, and the winged dragons of story, come nearest as exemplars of the kind of flying and flying creatures we need to consider in order to discover the wonderful secret of locomotion through the air. Evidently in such a field the insect world with its pith-like bodies has no standing. Of course I did not study insects.

But in the daily rambles I was accustomed to take around the ruined ramparts of the old historic city, one creature of the insect world singled me out for his attentions, and, in a sense, became my companion for years, following me from city to city, and from continent to continent, making itself known to me under circumstances and in ways so peculiar, that I was at length compelled to notice and consider it. I

observed the creature at first from something strange in the way it flew about me. I cannot say that at the time I actually thought it was trying to attract my attention, but it flew near me and around me in circles that were significant enough to make me look at it with a perception of some observable difference from its ordinary flying: and this took place usually at moments of deep thought. Walking as one does with his eyes wide open and looking at objects about him, the phenomenon never happened. The insect, indeed, might have been as much about me then as at other times; but if so, it was following its pursuits in its ordinary manner, and doing nothing to specially call my attention to it. Its peculiar movements, and those that forced me to look at it, invariably took place during certain conditions of my own mind and thought—the condition being one of intense and profound abstraction:—with the whole natural world shut out from view: such moments of existence as one lives in a speculative world; a world where "objective subjectives" are paramount. It was at these times, when the mind, strained to its utmost in the effort to extract from previously observed phenomena in nature their secret principles: to detect as it were the hair-spring of some spiritual mechanism coiled up within the world of things:—it was, I say, at such moments of abstraction that I would suddenly be brought back to the consciousness of a natural world and material things by the feeling of a material presence about me; and one object invariably, and always the one object, at such times met my abstracted gaze—

A Dragon-fly! What I thought or how I felt when this first happened I cannot now tell. One never notes particularly the first link in the chain: it is only when the separated and detached links fasten themselves together and become a chain that human observation is sufficiently arrested to note and draw conclusions. Naturally I looked at the creature—but only vaguely: I really couldn't have told at the moment why I looked at it: I didn't know myself: and when I did it was a—disappointing look, for the flash of its wings was like the lightnings at play in the clouds: I could see the flash, but with no chance to study it: and my desire was to understand the mechanical movements of wings! So if I did pause to look at the creature it was to only look away again and think no more of it: until a like occurrence again took place, when the same process of looking at, and looking away, and forgetting, would be gone through with as before; but with apparently no practical results of any moment whatever. These things occurred constantly during a period of years, but with no greater effect on my mind than to make me regard the coincidences as peculiar and curious. But when the same thing again took place on my return to America, and with the same regularity (though possibly not so frequently) as before, my attention became somewhat aroused:

particularly aster the following occurrences. Having seen in the photographic gallery of an artist friend in Washington, D.C., a picture of what he called a flying machine, and feeling curious to see it, I went out to the place where I was told I should find not only the machine but the inventor, an old Frenchman. Arrived at the grounds of "The Washington Observatory" (for this was the place I was told to go to) the first object that met my eyes as I entered the grounds was a dragon-fly! The poor little fellow was helpless and a prisoner; caught in the web of an enormous spider, and struggling vainly to escape. It is scarcely necessary for me to say that I lost no time in setting him free. I not only took him out, but released him from every filament in which he was entangled; and had the satisfaction of seeing the flash of his beautiful wings as he sailed gracefully away through the air. (The Frenchman and his machine I did not see.) But I could not help but be struck with the strangeness of this "coincidence." I, in pursuit of a flying machine and its inventor, confronted again by a dragon-fly! and the very first thing too, to be seen by me! Can anyone wonder that I should now begin to think of the possibility that something in the nature of a principle and a discovery might be lying somewhere behind a dragon-fly! But the "manifestations" did not stop here. What had thus far taken place, was as nothing to what I was yet to witness. And here I must pause for a moment to say that I shall have no word of condemnation for anyone (who does not personally know me,) who after reading what I am now about to relate, may say—"don't believe a word of it!"

When in the life of some one man occurrences foreign to the run of human experience take place, not only have mankind the right to challenge them, their verity, and the relator's sanity, but he himself, in the interest of his own common sense, is bound to do the fame; and this is exactly what I did and what I have always done through life. I think no one in the present case can fairly charge me with any very great haste to swallow the incredible, considering that the phenomenon spoken of was a constantly recurring one during a period of at least seven full years. A man who wouldn't or couldn't have his eyes opened to a fact during this length of time must be either a very "great" philosopher or a very old one; the latter, I should suppose, somewhere of the tertiary period, possibly earlier.

After having released the little dragon-fly from the spider's web in the grounds of the Washington Observatory, I had occasion to go almost immediately to Philadelphia, a distance by rail of 140 miles; and the day following my arrival was the Sabbath: a warm, sweet, bright summer's day. I had for years been in the habit of noting my observations of flying creatures under the head of "Thoughts on Flying," and this day

was busily occupied in doing the same. I was alone in the room sitting before an opened window, my whole attention occupied in writing, when the dragon-fly once more made his appearance, this time planting himself unceremoniously on the table alongside of my manuscript. I was both delighted and surprised, not to say a good deal struck. A large bell-shaped glass being near at hand, I placed it over the creature as quickly as possible, but I might seemingly have been as deliberate as I liked, for the fly showed not the slightest inclination to stir. Doubters will say, "Oh, the poor creature was still because it was tired. Very likely it had just flown from a long distance." Very likely, for it looked exactly like the little fellow released by me from the spider's web 140 miles away two days before! Yes, it was most likely "tired." But mind! I don't say it was the same fly! My readers may say or think anything they please; my business is to relate occurrences truthfully and state facts, and I will relate truthfully the occurrences that now took place. The fly, remember, is now under the bell-glass, and, addressing it as if speaking to an intelligent being, the following took place:—(To the fly) "My little friend, what has brought you here? Have you come to show me something about flying? Well, how is it done? What is the secret? Let me see you fly!" And the creature, until now quite still, at my bidding was up instantly in the air within the bell-glass, flitting about in all directions, and so continued until I said to it,

"There, that will do; you may stop!" And the fly again settled upon the table within the glass. I now looked at the creature as scrutinizingly as possible. In the motion of its wings while flying I had been unable to discover anything. I now felt curious to have a look, at them in repose, and were I to live a thousand years I could never forget my sensations, when, saying to it (but without really believing it would be done), "Now let me see your wings! SPREAD THEM OUT!" and instantly the four little gossamer wings ☞ trembled and spread themselves out on the table visibly before my eyes!! But still I could see nothing to give me a single hint in the direction of my thought. I still asked myself as vainly as before, what is the secret of flying? And, if possible, I felt more discouraged than ever, for here, with this flying creature before me, near to my very eyes where I could see it, obedient seemingly to my will, and offering the mechanism of its wings for my inspection, still I did not get the clue to a single thing. I again told it to fly, and it did precisely as before—flying while I wished it to, and ceasing to fly at my command, and yet all remained as dark to me as ever. The pursuit seeming fruitless, I put an end to the experiments by raising the bell-glass and saying to the obedient creature, "There, you may go now, my little fellow; I cannot really understand what it all means, but I won't keep you a prisoner any longer. Go!" And,

at the word, he darted out of the window. But although I felt discouraged at the time, and could see no meaning in the pertinacity with which the dragon-fly pursued me, I think I see it now.

Until the dragon-fly made its appearance, my thoughts on flying were running in the old grooves in which the thoughts of all men had been running for centuries, and running with utterly barren results, viz., "beating the air as birds wings do!" sailing on "inclined planes," &c. &c.

And now comes along a creature visiting me so constantly, and in so many wide-apart places, as to compel me to think of insects, and give them attention; so that finally, after long years have passed, I get to understand that behind the dragon-fly is to be found the great law of VACUUM OR FORCE-FLOTATION, the condition precedent to all navigation of the air!

But although I felt greatly disappointed at the time with the results of my experiments with the dragon-fly in the bell-glass, I did not at once abandon my pursuit of the ideal secret. I continued to watch the birds, and sometimes insects, and record my "thoughts on flying" as regularly as ever; and by-and-by I got hold of a little thread, that became to me finally the scarlet clew out of the labyrinth I was in; and to test the correctness of my thought at the time, I made an experiment with an insect (the miller or moth spoken of in the treatise following). After this I made four large wings in perfect imitation of the dragon-fly, constructing them of reeds for the nervures, and calico for the membranous covering.[1]

There are some old boys now living who remember the advent of india-rubber balls, and their marvellous power of getting high up into the air, beating the old particoloured leather-covered fellows "all hollow;" and with the ideals of such india-rubber performances in a boy's brain, nothing was easier or more natural, when the announcement came that india-rubber shoes were in the market, than for him to fancy that, with a pair of these on his feet, leaping five-rail fences, or even ten, would be a trifling pastime. My father assured me I was mistaken, and would be disappointed; but I saw myself so plainly in the air, bouncing up on india-rubber shoes, that nothing but india-rubber shoes would pacify me, and they were bought. I could hardly restrain my childish impatience; but instead of finding myself ten feet high in the air, I found myself twenty feet deep in the slough of disappointment and chagrin: my india-rubber shoes wouldn't bounce me a bit! Ah, those (hoes! I shall never forget them. But who is there that has not had

---

[1] There is nothing so satisfactory or delightful to an inventor as ideal mechanical constructions; all the parts are so perfect, move with such precision and with no friction; and then, too, everything comes out exactly in accordance with your theory.

his india-rubber shoe experience? Alas for the visions of childhood! Alas for the ideals of youth!

The pest of an inventor's life is that his facts won't accommodate themselves to his theories. About the time I constructed my dragon-fly wings, I was seeing myself in the air, and flying about on them as lively as in earlier days I had seen myself bounced about on the india-rubber shoes, and my impatience to get out into the country to put them on and try them, was fully as great as in the case of the shoes. So I started for the country, and from London went down to Maidenhead, putting up at an old farmhouse on the downs. My brother-in-law, and the machinist who had made and arranged the mechanism for my wings, were with me. For obvious reasons, I thought it safest to not try the performance in open daylight: so about two o'clock in the morning we took up our positions on a hill near the house, for I concluded that for a first experiment it would be glory enough to do it by running down hill, leaving for a time the more ambitious and pretentious up-from-the-ground method to the bird. It took my machinist, oh! such a time to get those four great wings (nine feet long each) properly fixed on to my back and shoulders! (I can feel the weight of them now on my poor old back when I think of it.) But then there was glory before me, and what won't a man (or a woman) do for glory! The moments of wing-fixing seemed to be hours; and then, too, spectators came, and I wanted no spectators; they were, however, only horses: they came neighing up, arranging themselves in a great circle, each one standing in an attitude of trembling fear, and ready for a bolt at a moment's notice, but filled with so much curiosity as to compel them all the time to draw nearer and nearer. There was something marvellously impressive in that night scene. I never think of it without almost feeling the breath of those timid, curious, trembling horses—now approaching, now receding, coming close up, then galloping away, and then again returning: and the solemn mistiness of the dewy midnight air: the four great white wings! the low tones of the speakers: and the preparation! and what was to come of it! the expectations! the anticipations!

Alas! for the vanities of earth: alas! for human intellect! for human mechanism! Disappointment! and disappointment only. I tried to run down the hill: the machinist supported me on one side, my brother-in-law on the other: we all ran down together as well as we could, a sort of partnership and combination fly, the course downward rather zig-zaggy: and my poor legs! I cannot say which was most to be pitied, legs or back. I thought I had about seventeen hundred pounds of old iron on my shoulders: why my legs did not break in that run down hill I don't know; but the six-rail fence at the bottom of it was not sailed over by

me as I had seen myself sailing in imagination—nor the next field, nor the barn!

And I felt just as glad to get "them" wings off again as I had before felt impatient to feel them on. I didn't believe as much in flying after I tried it as I did before: and I haven't hankered much after it ever since.

There are, no doubt, a good many four-square sort of people in the world who will say that after such an experiment I should have turned my back on the dragonfly. I did not do it right off, but I did after a while; and I am afraid that the mortification of my failure when the horses witnessed my defeat may have had something to do with it; partly this, I think, and partly the conviction felt by me that others more favourably conditioned for the work than myself were sure to accomplish it; for the mind of the world had become greatly stirred up on the subject of "Aerial Navigation" since my thoughts had been first turned towards it.

From the hour when I gave up thinking about flying, I saw no more dragon-flies. From this hour, too, misfortunes began. The man known as "the lucky" became the most unlucky of mortals: matters proceeding from bad to worse, until I found myself reduced to the mental state of the afflicted Job, and the despairing condition of Jonah in the belly of the whale.

How it happened I cannot exactly say, nor would it matter if I could, that one day in conversation with a friend, a devout believer in the necessity and certainty of air-navigation, I was suddenly impressed to say to him, "Lyman! it just occurs to me that my past seven years of misfortune are judgments upon me for my neglect of duty! Jonah was sent to preach to the Ninevites, and he wouldn't go; and got paid up for it by getting into the whale's belly, where he had to stay till his common sense returned to him; but the minute his toes touched dry land he drew a bee-line for Nineveh! And this is what I mean to do! I had a 'mission,' and should have gone ahead on the flying problem: I dropped it, and neglected it, and look what has happened to me! From this moment I will imitate Jonah, and pull foot for Nineveh! I'll return to duty! I'll go to work again at the flying problem!" All which I began at once to do. A few nights after this I fell asleep with my last thought on flying, and before it was fairly light awoke the next morning with an ideal flying machine in the shape of a dragon-fly sharply defined in the airy vision of my brain. While I was considering it, a loud noise was suddenly heard in my room, the sound of wings, and powerful ones too, so powerful as to startle my wife, who exclaimed quickly, "What is that?" I listened for the sound again, and when it came I replied, "It is the dragon-fly! I have not seen him for years, but he knows now that I have returned to duty, and has come-again to encourage me!" In a short time the light of the morning became sufficient for me to

see, and going over to the corner of the room from whence the sound had seemed to proceed, there uprose at once before me the largest and most beautiful creature I had ever seen; so majestic and graceful and grand as without hyperbole to be worthy of the title KING OF THE DRAGON-FLIES! Addressing him, I said, "I know what you have come for! It's all right! Good-bye!" and drawing aside the lace curtain from the open window, my visitor darted out and disappeared.

And this is why I have written this book. I cannot suppose that I shall tell all that needs to be known to make the navigation of the air possible. No cause and no science is ever made by one man; in fact, men create nothing: we can only imitate Nature; and we know only what is given to us; our responsibilities are limited to what we can do; and though it be but little we are able to accomplish in the world's long history, it matters not where each one performs his Divinely allotted part. The general may get the glory of the battle, but the humblest soldier who has performed his duty in the field has always within his own breast the consciousness and the satisfaction of a duty done and commendation earned: and our great Milton says:—

"they also serve, who only stand and wait!"

T. H.

INTRODUCTION.

THE problem of flying is the problem of the ages:—towards its solution the hearts and hopes of men have steadily set through all the generations. Who has not dreamed of flying? That he flew? And the delight! And is it but a dream? Has this yearning of the human heart, coming down to us through all the centuries, through all history, all tradition: an instinct like that for immortality; a born prophecy within us; has it been given to us, never to be gratified—never to be fulfilled? The embryo foretells a birth, the petal's folded leaves a flower. The rootlet in the dark below the surface of the ground, turns from its course, obedient to an instinct that points it to the living water that it thirsts for. How could it turn were not the waters there? And will God mock the human soul? Shall all its prophecies prove false? Believe it not! He, who is faithful to even the tiny rootlet in the earth, will be also faithful to the creatures made by Him, with yearnings for a loftier, nobler, and happier existence.

When we consider that daily, for a period of nigh six thousand years or more, God, the Creator, has been demonstrating the possibility of aerial navigation, by the flying of creatures practically of the same specific gravity as men, it seems amazing that the secret of flying mould have remained so long a mystery: man's ignorance of it, more mysterious still! A mystery admitting but of one explanation: the will and providence of God.

No man can discover until it is given to him, until then the eyes of men are blinded. The building cannot be made until the foundation is laid. God prepares mankind for the events of His providence. The history of the world shows that great events are preceded invariably by others of equal significance as forerunners. Discoveries are like the links of a chain; like dependent parts of a machine. Invention is made up of discoveries precedent and discoveries consequent.

Just now, God has made it for the interest of men to foster electricity—fortunes in electric lights!—the Stock Exchange gone mad! stimulus to invention hand in hand with stimulus to greed; but all in preparation for the greater thing to come, the aerial railway of the skies! the great highway of nations! the universal belt and bond to bind together in one common tie, all tribes, all castes, sects, creeds, communities, nationalities, and governments in one grand unity of universal brotherhood, the common family of man.

When Dr. Franklin and his confreres of the Academy of Sciences, just one hundred years ago, witnessed the ascent in a Montgolfier balloon of the

first human being who had ever thus penetrated to the region of the clouds, the world imagined the mystery solved and aerial navigation an accomplished fact. In his book, Cavallo speaks of it as "the art of travelling through the air .... at last discovered!" And yet the world to-day, with regard to flying, stands just where it stood then; not one single inch advanced. No regular balloon-steamers between London and Paris; no aerial clippers to or from New York, China, or Japan; no winged Nihilists, Socialists, or Red Republicans hatching conspiracies among the clouds and hurling dynamitic thunderbolts upon the devoted heads of unhappy Czars, Emperors, and Kings.

Livingstone, Speke, Stanley, and other African explorers have had to "do" the sources of the Nile, the mystic Niger, and the Mountains of the Moon, in the old foot-sore way. Travellers continue to be eaten up by cannibals; and the cold spit of the North Pole is still run through the vitals of unlucky Arctic explorers. In short, the bird continues to be "master of the situation," and man, the evolutionized ape, the laughing-stock of all the insect world and feathered tribes!

WHY?

CHAPTER I.

REACTIVE LOCOMOTION.

An Inventors Maxims.

I know nothing until I try. The way to discover is to doubt. The way to invent, do it the other way. Everything that ought to be done, can be done. Nothing is "good enough" that can be done better.

Winds or Force-density in the Atmosphere the source of

Aerial Locomotion.

"A moderate wind moves at the rate of seven miles an hour, a storm at thirty-six miles, a hurricane at eighty, whilst air rustling into vacuum at 32° Fahr. and barometer 30 inches, reaches the velocity of 884 miles per hour."

Lardners Philosophy.

AS far as we can glean anything from fable and history, the First and Original Theory upon which mankind proceeded in their attempts at locomotion in the air, was the Bird Theory.

The Second Theory, originated just one hundred years ago, and was the Balloon Theory. All attempts at air navigation based on these two theories have failed.

I now offer to the world a Third Theory. The number three is regarded by many as the "lucky number," so that we have the expression in common use, "the third time is always sure to win." I venture to hope that it may in this cafe prove true.

The wind that opposes the bird is also the power that floats it; and the problem of locomotion in the air for all the creatures that fly in it is one of flotation primarily, from whatsoever source or by whatsoever means the wind pressures may be induced.

The men of 1782 were quite right in regarding flotation as the pivot in the problem, wrong only in mistaking specific-gravity-flotation for the method of Nature. And those who before and those who since 1782 have theorized and experimented to solve the problem of aerial navigation have failed because their attention has been wholly fixed upon the machine or flying creature instead of the atmosphere. It is not the machine or the flying creature we need to change, but the air. The atmosphere is too light to buoy us up. We must change the specific gravity of the air.

The Montgolfiers and men of Franklin's day attempted to solve the problem by changing the specific gravity of the machine or flying creature, with not a single analogue in Nature to justify them, and

later experimenters have dealt with the question as one of projectiles.

Birds sail or glide through the air by employing their weight as projectile force. Birds are floated through the

air by the force of the winds. Birds with no wing movements are impelled through the air as weighted and balanced inclined planes operated upon by combined wind forces, the impulsion producing passive locomotion. Birds hover or stand still in the air under the combined operation of winds and wings. And birds mount into the air and urge themselves forward under the action of their wings in their dual capacity of fan-blowers and propellers. Bats and large-winged light-weight creatures are animated parachutes. But the Insect world, represented by the Dragon-Fly, have an aerial locomotion of their own, based on relatively small wings driven at high velocities on the principle of the fan-blower, their movements through the air not being the reactive direct locomotion that results from the play of wings when employed in their combined dual capacity of fan-blowers and propellers, but the reactive indirect or passive locomotion resulting from the employment of wings in their single capacity of fan-blowers. This species of insect locomotion is analogous to the passive locomotion I have mentioned where the bird is impelled by the action of combined wind-forces directed against the balanced body of the creature as a weighted inclined plane; the difference being that in the case of the insect the wind-force and pressures originate in the insect, but in the case of the bird the wind force and pressures originate not in the bird but in the vast magazines of external nature.

It seems presumptuous for any man to say, "I have discovered what mankind during thousands of years have sought for in vain!" And it is presumptuous. Therefore I will not say I have discovered. If any man could have discovered the secret of flying, Pettigrew, I think, is the man, for he comes nearer to it than any other; and yet, strange to say, he attempts to controvert the theory of Borelli, who wrote in 1680 on the action of the wings, and of Professor Marey, who wrote in 1869 advocating Borelli's theory because substantiated by his own experiments; both Borelli and Marey being quite right, and Pettigrew quite wrong. Nevertheless, Pettigrew, in his book "Animal Locomotion," has enunciated more sound philosophy on the subject of flying, and has shown a deeper insight into the true principles of bird performances, than any other writer whose views have fallen under my eye. Take for example the following:—

"The wing of a flying creature, as I have taken pains to show, is not rigid; neither does it always strike the air at a given angle. On the contrary, it is capable of moving in all its parts, and attacks the air at an

infinite variety of angles. Above all, the surface exposed by a natural wing, when compared with the great weight it is capable of elevating, is remarkably small. This is accounted for by the length and the great range of motion of natural wings, the latter enabling the wings to convert large tracts of air into supporting areas. It is also accounted for by the multiplicity of the movements of natural wings, these enabling the pinions to create and rise upon currents of their own formings and to avoid natural currents when not adapted for propelling or sustaining purposes. (See Pettigrew's "Animal Locomotion," pp. 218, 219.)

The words I have italicised, "to create and rise upon currents of their own forming," express really the gist of the problem to be solved, and yet Pettigrew himself evidently failed to perceive it, or he would not have elaborated so extensively his "figure of 8" theory, and neither would he have condemned Professor Marey and Borelli as he has done. Nothing is more common in invention than for a man to have a discovery in his hands and not know how to use it, and the difference between the machine that succeeds and the one that don't, is so exceedingly fine oftentimes that the unsuccessful inventor feels himself aggrieved by the success of the other whose machine he considers to be "exactly like" his own, and yet his own won't work and the other will. But the world judges by results.

The mistake of mankind has been in trying to fly. If the simple theory that I shall endeavour to set forth in the following pages should prove to be the correct one, then the world has been fooling itself for ages with wing movements—"wave" theories, "rowing motions of the wings," "heated air-cells," "hollow bones and quills," "inclined planes," "aero planes," "twisted planes or screws," "figure of eight" theories, "anterior and posterior margins" of the wings, &c. &c,—and numberless creatures, insects, and birds, have all been tortured and experimented on to no useful purpose whatever.

What man needs to know, and what he must know before the desert spaces of the air can possibly be traversed by any mechanism short of God's creating, is by what process, by what agency, by what contrivance, can human ingenuity and human skill succeed in charging the atmosphere with Force!—lifting force, floating force, impelling force.

The atmosphere charged thus with force would then become the active agent and propel the machine. Birds propel themselves. The dragon-fly, holding itself on an even keel, travels as well backwards as forwards, being under the influence of a wind-pressure external to but created by itself, a wind-pressure that the creature by its own will controls at pleasure, and can with the quickness of thought shift from one side to

the other—to front, to rear, to up, to down—to any and every point within the hollow concaves of the domed sphere of which it is at once the centre and the animating soul; a sphere that goes with it and that makes it independent of the external forces that roll and surge through all the regions of the air.

To navigate the air, the first thing in order is to be able to float in it. This can be done evidently in but one of two ways; either we must make ourselves lighter or the air heavier. Making ourselves lighter has been tried for a hundred years and failed every time. Nothing remains, therefore, for us to do but to make the air heavier, and as it is manifestly impossible to change the chemical constituents or specific gravity of the atmosphere, we must accomplish the same thing practically in another way.

Given, the power to create a wind blowing at the rate of 884 miles an hour—and what couldn't we lift and float! Hurricanes with a tenth of this power unroof houses and pick up ploughs and people from off the face of the ground and transport them long distances. Evidently we only need the power and machinery to create a wind-fulcrum in the air and control it to our liking, and we may travel where the condor soars, and the albatross sails, and the bald eagle nurtures its young in the clefts of the crags!

But the wind-force must be our own and independent of Nature. Aero-planes, and inclined planes, and twisted planes, are things for the winds of the firmament to disport themselves with, and hurl into fragments and ruin. Man may not be the plaything of the tempests. He must be the master of a tempest of his own,—that he can carry with him and about him, and, as it were, enwrap himself withal as with a vesture and a garment,—and, panoplied therewith, to meet the marshalled winds of heaven on their own battle-field and vanquish and defy them all!

This, would be true Flying!

This, would be the Navigation of the Air!

The winged storm-kings conquer by yielding; by compromise; by accommodation. This, man can never do, for without life in them there can be no wings. It is the life that is in the wing that makes it a wing. I mean to say it is life, and life only, that can give wing-function.

And mankind have been experimenting with dead planes.

Is it any wonder that they have failed?

Of what use the anatomizing of and the philosophizing on wings when it will remain for ever an impossibility for men to use wings? There are no wings for man! and never can be; and this is why "the figure of 8" theory and all other theories based on the idea of the possibility of employing wings as wings are a mistake.

What could come on dead wings, but "dead failures?"

It is not wings that we want—but wind-blasts, wind-power, wind-flotation; and wings as wings, as birds use them, man cannot get because all his imitations are dead— dead—dead! and to be dead is to be without function. Is a marble statue a man because made in the image of a man? Neither are the things called "wings," of man's make—wings.

Mankind must for-ever dismiss the thought of "wings," or they will never navigate the air.

Flying is therefore an impossibility.

But locomotion through the air is possible.

Many manufacturers in the United States are now turning fan-blowers to account by employing the suction-power of the machine to free their shops from the dust and debris incident to their work; shavings and sawdust as well as other dust rising up from the floors and benches like flying creatures, and directing their ways straight for the suction canopy and pipe, up through which they disappear. I was told by a friend that the suction of the fan-blower at his works was strong enough "to lift a man's hat right off his head:" and he mentioned the fact that one of his men in walking under the canopy had his hat lifted from his head and carried up the pipe. The incident to me has a peculiar significance from the connection it suggests between fan-blowers and infect locomotion in the air. The busy bee is a fan-blower, and the creatures, as is well known, ventilate their hives by the play of their wings: the bees assigned to this duty placing themselves in the passages and at the entrances to the hive, and by the play of their wings, as in flying, creating a perfect draught.

The moderate wind moving at the rate of seven miles an hour, and the storm moving at thirty-six miles an hour, and the hurricane moving at eighty miles an hour—are all rushing into vacuum, or trying to, just as really as the wind moving at the rate of 884 miles an hour.

But for the vacuum centre in the fan-blower the man's hat would not have floated: and but for the vacuum centres somewhere in the atmosphere, we should have no winds and no bird-flying: and but for the vacuum centres produced by the wings of insects of the dragon-fly type, no insect locomotion in the air. Air-locomotion relates to vacuums, and wind-pressures the result of vacuums; and whether these vacuums arise from solar heats at the equator or ice at the poles, or both, producing winds, wind-pressures, and bird-flying; or from the magazines of heat and force within the bodies of the insects themselves, producing winds, wind-pressures, and Reactive Passive locomotion —the law is still the same,— vacuum-originated-force the fulcrum and foundation of air-locomotion, for every living creature of the air,

from the lady-bird that floats on a breath to the eagle that floats on a blast.

The bird-world holds a monopoly of the vacuum forces of the firmament; the insect-world (typified in the dragon-fly) rely upon the forces created by themselves. It remains for man to imitate the insect, regarded as an animated fan-blower; but by no such clumsy imitations as those with which he has attempted to imitate wings. The mechanical fan-blowers contrived by man are not to be compared with the mechanical fan-blowers contrived by man's Creator. The material to be dealt with is air; 800 times lighter than water, and 6,400 times lighter than iron. Other things being equal, the resistance of a fluid to the surface that opposes it is proportioned to the relationship between the specific gravities of the two, for just as many times heavier as is the opposing body or surface than the fluid to which it is opposed, to this extent will it cut into instead of being resisted by the fluid. I am aware that it may be replied to this, that when air is driven at the high velocity employed in fan-blowers the fluid becomes practically so dense as to admit of being dealt with the same as water. Very true as far as it goes. But why use up the power required to bring it to this density? Why not employ less power, and deal with the fluid as it is naturally? This is what the dragon-fly and insects typified by the dragon-fly do.

The wings of insects are perfect gossamer, stronger and finer than the finest and lightest of fabrics that man can weave or make. From under the horny coat of mail which the beetle opens, see what a marvellously transparent tissue is unfolded to the breeze. From its crumpled condition one wouldn't imagine it wings. And the wings of the birds, what miracles of strength and lightness! But why the body heavy and wings light? The body is to cleave the air, the wings to oppose it.

But man makes the wings of his fan-blower of metal—thin metal, it is true, but metal, nevertheless—in specific gravity 6,400 times heavier than air! The contrivance is naturally like a rotary pump, and works centrifugally within a box: the construction producing friction, waste of power, and cost.

Now turn from this picture and look at the little live blowers made by the Creator. As I have already said, bees ventilate their hives by the action of their wings, a number of bees being for this work stationed in the passages and at the entrances to the hives: those at the doorways holding fast by their feet, to prevent being blown away by the wind-blasts of their own wings.

Now here we have before our eyes the example of natural fan-blowers, without boxing, not working centrifugally, producing perfect blasts of wind in the open air, to which they can give any direction they

choose! What machine of this sort has man ever constructed comparable to this? The most remarkable thing that happened in the course of my observations, was when I discovered that wings flapped at right angles to the body of the creature produced an air-blast, the whole of which was directed backwards! This mechanical puzzle I one day had the opportunity of finding out for myself. A large moth or miller, about the size of a bumble bee, finding itself in my room, and unable to get out, naturally took to where the light was strongest—the window; but the window was closed; and my attention was attracted by the frantic efforts made by the creature in its attempts to force a passage by butting its head violently against the pane.

Hearing a great flutter of wings, and perceiving the cause, I ran for a lighted candle, which I held first at the sides, at about three inches distance, when no flicker of the flame took place; neither did it at any point as I steadily moved the candle towards the rear of the creature, until I had it directly in line with its body exactly behind it, when the flame, with no premonition whatever, was puffed so suddenly out as to amaze me. I repeated this experiment several times over, and became then satisfied of what I had before surmised as to the action of the wings of flying creatures—viz., that as a first effect of wing-action, where the motion of the wings is at right angles to the body, a current of air is produced in the line of the long axis of the body; this floats it: the after effect, by a continuance of the wing movements, being propulsion, the wings then getting a fulcrum upon air of practically increased density. Later on I became convinced of the theory I have herein endeavoured to set forth., viz., that all the insects typified in the dragon-fly move through the air by indirect, in place of direct, action: in other words, they employ their wings purely in their capacity of fanblowers and not propellers, the only kind of air-locomotion possible to man: my reason for this opinion being, that a flotation and impulsion (not pro-pulsion) resulting purely and simply from wind-blasts, admits of the application of the rotary principle of mechanical power; so that all we have to do is to contrive an improved fan

blower, and, on the supposition that we are shortly to have a light motor, the air may be as safely navigated as water. I have myself contrived a Fanning-wheel that, to say the least, gives good promise. This wheel is simply a hub furnished with wings made after the pattern wings of the dragon-fly; the revolution of the wheel in open air producing a powerful wind-blast backwards. Now it seems to me that a number of such wheels, attached to a proper vessel, would in some degree resemble what is to be found in the insect world as represented by the dragon-fly.

In what follows I desire to have it understood that by the term Bird-flying is meant reactive, direct

locomotion; the kind practised by all flying creatures except the class typically represented in the dragon-fly: while by the term Insect-flying is meant reactive, indirect, or passive locomotion; the kind practised by all flying creatures typified in the dragon-fly. Humming-birds being more than half insect, and their mode of flight being wholly so, are to be regarded as included under this head.

I do not offer this as speculation. I offer it as theory deduced from observation. Let him who doubts it go with me to Nature herself—come with me into the cloverfields—thick with round-tufted heads, the sweetest of white and the juiciest of pink, and honey bees over them all; the air golden and still: not a breath; pulsing with its own quietude. Can there be anything more delightful than to lie down here and watch the movements of the bees? We may look at them as long as we like, they won't quit work because it is "half-holiday." Bees are workers in the strictest sense, and all their "combinations" are against idleness, not against work, not against society. Men can't do better than study them, especially "trades-union" gentlemen. Bees don't combine to turn out poor work, and discourage the production of good.

But never mind human workers, here are better ones; let us look at them: watch this little fellow in yellow plum breeches, and see how daintily he lets himself down from the air upon the clover-head that hardly bends beneath his weight. He can't run over it quick enough, and it don't take him the millionth part of a second to find out just where the sweet is, and especially where it is not, and then he is up and off. Did you see him jump? You couldn't, for he didn't jump at all. The sparrow jumps, and the pigeon jumps, and the butterfly jumps;[1] but the bee floats itself from the clover-tops as softly as the mist-wreaths of the dewy morning float away from the hill-side. No soap-bubble, brilliant with swimming colours stolen from the rainbow, ever floated off from the bowl of a pipe with more charming gentleness and grace. And in these soft murmurs of the busy bee, as you watch him settling, and rising, and floating, and settling again—in these delicate flotations and undulations, and in the low, soft, murmuring tones you hear, like elfin music from under mossy stones—in all this, I say, lies hidden and concealed the marvellous secret of the air; the secret for which man has so vainly searched, so vainly toiled, so vainly prayed for during all the life of man on earth!

1 I was very much astonished one day while holding a butterfly on my finger to distinctly feel the pressure of its tiny little feet as it jumped off" into the air. Pettigrew fays he could never detect it, but I did unmistakably.

But who would have thought to find it amid the clover and the bees? is it any wonder that mankind

have not found it before? They never thought of looking for it here! Nor would I, but for the dragon-fly.

Men are heavy, heavier by far than birds, and if we knew of any flying creatures still heavier we should naturally pass by the birds. Naturally, in our attempts to solve the problem of lifting and floating heavy weights in the air, we should make the heaviest flying creatures our study. This would be reasonable, and "reason." But to go to the insect to find the solution of such a problem is not reasonable, nor "reason;" it is something less or—something more!

The movements of the dragon-fly display majesty and power, those of the bee gentleness and grace. Let us now consider a more humble member of the same family: the fly that can stand still in the air! House-flies almost do it, but this little creature does it to perfection. It is a species of fly to be seen in the country about farms, not larger than the common house-fly, but having longer wings; the colour of its body golden-green. A bevy of these little creatures when flying seem like a play of golden balls or little gilded peas floating in the air; their wings vibrate with such swiftness as to be perceptible only as a blurr about them, 300 beats in a second, 18,000 beats a minute! The fan-blower is considered to revolve rapidly at 3,000 a minute, a much easier mode, too, of fanning the air. If we wait a moment we mall see one of them standing still. Ah! here he is, standing as still as possible. You can't see a movement, and. yet there must be some sort of imperceptible vibrations reaching your eye from it, for it makes you feel as you look steadily at it as though in a dream. How in the world does the creature stand so still? A dead fly glued to the wall couldn't be more fixed. Perhaps he has found an air-stratum of exactly the specific gravity of his own little body. No, for now he suddenly darts to a place higher up, and fixes himself there again; and again to another spot, fixing himself just where he likes. Does Mr. Pettigrew's "figure of 8" theory explain this? or the theories of "pawing the air," or "compressing the air under the wings?" or "attacking the air at an infinite variety of angles?" Or is it to be explained by "the great range of motion of the wings, enabling them to convert large tracts of air into supporting areas?" Or has Mr. Pettigrew explained it where he speaks of the multiplicity of the movements of natural wings, thus enabling the pinions "to create and rise upon currents of their own forming?" Very nearly, Mr. Pettigrew, very nearly, but not quite! In the children's play of "hide and seek," even "burning" is not always "finding."

No bird-principle of locomotion in the air can explain the wonderful movements of the dragon-fly. Where the density of the fluid is such as to furnish the creature with a fulcrum almost or quite complete in itself, as in the case of water and the darting through it

of speckled trout, locomotion resulting from direct action can be understood and admitted; but where, as the preliminary to a locomotion that depends upon a constant and continuous creation of force-density, flying creatures exhibit the darting movements of the dragon-fly and the floating movements of the bee, and over and above all the standing-still-in-the-air performance of the fly, nothing short of the indirect locomotion resulting from superinduced wind-pressures seems to be sufficient to account for them. All the flying machines ever made by man have failed, and these have all been direct action or propelling machines. Why not now try the opposite (do it the other way), and see what can be accomplished by confining the whole of the power and all the fanning action of the machine to the work of communicating force to the air? When this machine fails, should such be the case, we shall have then, I fear, exhausted the mechanical methods of getting through the air, and will be compelled to await further developments in electrical science. Nearly forty years ago a gentleman remarked in my hearing that it was his belief that the flotation of birds in the air was due to an electrical aura, generated by the bird at will, producing a repulsion between the floating bird and the earth. And Professor Page, a distinguished American electrician and inventor, of Washington, D.C. (now deceased), once described to me the floating of a large bar of iron, weighing several hundred pounds, within the helix of his great battery, the professor laughingly remarking that it was like Mahomet's coffin, suspended between heaven and earth.[2] But I do not believe we shall be driven to this. My faith in the dragon-fly is strong. The locomotion of every flying creature is, I am persuaded, purely mechanical; and the man who first constructs a dragon-fly navigator of the air will bestow upon mankind the long-coveted "sesame"— the magic key to all the treasure-caverns of the sky! and, I was about adding, will be blessed by all mankind. But when I think of earth's benefactors, and what has happened to them all, or nearly all, I forbear. I forbear also as I think of what may happen to us when this amazing faculty shall become the property and possession of human devils! Think of floating devils in the air! Floating here and floating there; always floating; everywhere! filling mortals with despair! Crawling devils on the ground can do mischief enough, and are hard enough to be trampled out, but in the air, one shudders to think of it! Still, God rules, and the air can't be navigated until He permits it; and whenever this time shall come we may be certain that all the contingencies attending it will be provided for by His wisdom and goodness.

---

[2] Query? May not cyclones or whirlwinds be electrical helices, capable of being rendered harmless by means analogous to Franklin's method of taming the lightnings?

The suction-pipe that pulled the workman's hat off his head, led straight to the vortex or vacuum centre of the fan-blower. But the bee and the fly by the reciprocating action of their wings do better work in the open air. To use up in their operations as much power proportionately as man's fan-blower contrivance, would be a greater drain upon Nature's forces than she ever permits. The moving creatures of the deep, and the moving creatures of the air, have power given to them in proportion to their needs, and each one an apparatus so perfectly adapted to its power, that while nothing is wanting there is nothing to be thrown away. Waste marks the imperfect works of man: Economy the perfect work of God!

CHAPTER II.

BIRD-FLYING.

AS I have already observed, the speculations and experiments of both ancient and modern times have all had reference to birds, and if insects have received any attention, it has been because no difference was perceived between their mode of air-locomotion and the flying of birds.

Cavallo, in his discursive way, tells us of what fable and story mention—u the winged horses of the sun," "Juno's peacocks," "Medea's dragons," "the pigeon of Archytas," &c, and that Roger Bacon, who lived in the thirteenth century, speaks in his writings of "artificial wings that may beat the air like a bird flying;" also that the invention, said to have been made by John Muller of Nuremberg, commonly called Regiomontanus, and who died in 1436, is described as a flying "eagle." It is also evident that Bishop Wilkins, who wrote on flying in the fifteenth century, refers to birds in all that he says in his "discourses on flying;" and "the alleged invention of the Portuguese friar, Bartholomew Laurence de Gusman, made in 1709, was a vessel somewhat in the shape of a bird"

But though all the attempts at flying recorded in history, or which we know anything about of later times and recent years, have been utter failures, the bird continues to be the ideal flying model of mankind; and "kites" and "inclined planes" are spoken of by inventors in all lands as confidently to-day as though the experiment had not been a demonstrated failure through all the ages.

With the exception of some few ardent balloonists who still appear determined to be original beyond Nature, the world in general have agreed that travelling through the air in balloons can never rank with ordinary locomotion on the land and water, and is therefore practically of no account to mankind as a mode of travel.

The next error to be got rid of is the notion of flying; of course I mean bird-flying; for the essence of bird-flying is projectile force and live wings, two elements or conditions utterly impossible for man; conditions that directly relate to the tremendous atmospheric forces of Nature, to meet which the bird is specially organized, and with which it is able to cope; energies and forces in the midst of which, floated and wafted upon dead planes only, men would be as helpless and hopeless as a lost wretch in the rapids that lead to Niagara's thunders of waters.

As bird-flying relates to natural winds or the forces of the atmosphere, let us for a moment, before going any further, consider the nature and properties of the air.

"If we suppose the atmosphere, (remarks Dr. Lardner,) which extends from the surface of the earth upwards to a height more or less considerable, to consist of a series of layers or strata, placed one above the other, it is evident that each successive stratum, in ascending, will sustain a weight less than those below it. The first stratum of atmosphere, which is in immediate contact with the surface of the earth, is compressed by the entire weight of the atmosphere above it; that is to say, by the weight of the whole atmosphere, except the first stratum; the next stratum is compressed by the weight of the whole atmosphere except that of the first two strata; the third stratum is compressed by the weight of the whole atmosphere, except the first three strata; and so on. Now, it has been already shown that the density of air is always proportional to the force which compresses it; and it follows, therefore, that the density of the first, or lowest stratum, is greater than the density of the second; and the

density of the second greater than the density of the third; and so on; the air becoming gradually less dense as it ascends to a greater height." * * * * * * The weight of mercury is $13\frac{1}{2}$ times greater than that of water, and the weight of water is about 800 times that of air, at the mean density of the latter; consequently, the weight of mercury is, bulk for bulk, 10,800 times greater than the weight of air: therefore a column of air of uniform density equal in weight to the barometric column, would be 10,800 times higher: Now taking the average height of the barometric column at $2\frac{1}{2}$ feet, a column of air of equal weight, and having a uniform density equal to that of air at the surface of the earth, would give a height of 27,000 feet; and, since the barometric column is subject to irregular variations, which range within a twelfth of its entire height, the corresponding column of air would be subject to like variations, ranging within a like proportion of its entire height, Which according to this calculation would amount to 2,250 feet. If, therefore, the atmosphere were, like the ocean, of uniform density, the height of the waves, which would be incidental to its surface agitated by the disturbances to which it is exposed would be nearly half a mile.—But as the atmosphere is not of uniform density, but diminishes in density in a rapid proportion, as the height increases, its altitude is much greater than 27,000 feet; and the change incidental to its superficial level indicated by the variations of the barometer must therefore be proportionately greater. The waves of the sea, therefore, even in the most violent storms, are absolutely insignificant compared with the waves which prevail in the upper surface of the ocean of atmosphere under which we live!!" See "Lardner's Philosophy," book v., chap. 3. The italics and exclamation points are my own.

It is very easy to perceive from the above how vastly different are the conditions of bird-flying in our air-ocean from that of fish flying or swimming in the ocean of the waters; currents in the sea are not comparable in force to currents in the air. Imagine human beings organized to breathe water like fishes living on the mountain slopes and in the valleys upon which the water-sphere rests, as upon us rests the vapour-sphere that invests our globe. All the living moving creatures we see about us at the bottom of our air-ocean, reproduced under the waters, and living upon the land there just as we live here; for the land upon which the ocean rests is just as diversified and real as the land upon which air rests; once, indeed, above the waters and in the air, as we now are; and destined again to be, when our hill-slopes, plains, and mountains become again submerged and form the bottom of the sea. And the same Almighty Power that has fashioned men and women and living creatures on the land above water to breathe the mixture of fluid nitrogen and fluid oxygen we call air, could have equally fashioned men and women and living creatures for breathing the mixture of fluid hydrogen and fluid oxygen we call water.

And now if we imagine such a living world as this existing underneath the superincumbent water-sphere; a living, active, busy world; tribes, communities, and peoples: villages, towns, and cities: and if then to this picture we add to the water-sphere the distinguishing characteristic that marks our own—its fickleness, its variability, its cyclones of terrific force—water-winds of all degrees: water-winds at seven miles an hour; water-storms at thirty-six miles an hour: water-hurricanes at eighty miles an hour;—what a precarious world for the water people and creatures to live in! Howling water forces raging through the deep of waters as the wild forces of the air hold high carnival beneath our skies! Under a condition of things like this, no living creature possessed of any specific gravity known to man could exist. A small fish would require to be the weight of an elephant: it could float

only by mechanical flotation; and the foundations of the mightiest islands and continents of our globe would be in perpetual danger of being undermined and shattered to fragments. Imagine what would have to be the specific gravity of the water-breathing creatures there, the men and the women. To be able to move about and cleave the waters with the same facility that our bodies move and cut through the air, would require a specific gravity eight hundred times heavier than water, as our bodies in our atmosphere are eight hundred times heavier than air. Under the pressure of our atmosphere it is a very light individual that weighs only 100 lbs: but multiplied by eight hundred it becomes 80,000, or forty tons! and a lady of 200 lbs. weight in London above the water, would be a lady of eighty tons weight in the subaqueous London at the bottom of the sea!

Let not this be considered a mere piece of extravagant imagination. The atmospheric ocean in which flying creatures float, and through which not only flying but all other creatures move, demands, because of its forceful character, specific gravities in the creatures of a character analogous to what I have supposed would be the required weight and specific gravity of water-breathing creatures inhabiting a water-sphere penetrated with the tremendous forces that are stored up and discharged continually through all the spaces underneath our skies.

The difficulties of air-locomotion do not inhere in the non-force character of the air in its eight hundred times less density than water, and the specific gravity of the bodies of the creatures that live in it; but in the force-atmosphere that surrounds them.

It is not, therefore, practically speaking, the air that is eight hundred times lighter than man's weight and birds' weight (I admit something less for birds) that we have to deal with in the problem of bird-flying, but the Force-Atmosphere enclosed, so to speak, within the atmosphere we breathe.

This force-atmosphere is the bird-atmosphere, for which the creature is made and adapted, with reference to which his marvellous wings are made light , and his body made heavy; a body to sink it, and wings to raise it; two opposing agents giving rise to two opposing forces: the one a counteracting agent to the other, and yet conspiring to a common end; a mechanism and a combination of forces to meet and battle with, and overcome, and make subservient the forces of the air, only to be conceived of in the prevision of an Infinite Mind, and only possible to the supervising and all-governing intelligence of a Great First Cause. Surely if an undevout astronomer is mad, he is still madder, who, with God's marvellous creations all around him can fail to see, or seeing, can deny the Existence and the Personality of God!

In this force-atmosphere velocity is equivalent to density, and stands for it. It is the force of the air-current, whether caused by the wings of the flying creature, or existing naturally in the force-atmosphere, that gives the resistance of flotation and the resistance of locomotion.

On land the resistance, which is support, is at the same time, the fulcrum of locomotion; both functions in solids being a co-existing unit.

But in fluids, where the support or flotation results from displacement, the resistance which constitutes flotation precedes, in sequential order, the resistance which constitutes the fulcrum of locomotion. The fulcrums are, therefore, two: a fulcrum of support or flotation, and a fulcrum of propulsion or locomotion.

But for the forces of the atmosphere, hydrogen ships might float and be propelled in it equally as well as ships are on the ocean. A balloon made in the shape of a fish should float perfectly in still air, and admit of propulsion in such an

atmosphere as ships do in water. Whales are the balloons of the seas; lighter than the waters of the ocean, on the surface of which they float, to navigate it were as impossible to them as are the stretches of the air to vessels floated by hydrogen were the deep charged with water-forces of analogous character to those that fill our atmosphere.

The problem of air-locomotion is, therefore, one of FORCE; and bird-flying can only become possible to man when men are changed to birds.

If we regard the wings of birds in their primary capacity of fan-blowers for creating air-currents to fly in, then the longer the wing the stronger the current of air, and the greater the volume of it when produced by the wings. For example, let us suppose the wings when describing a complete circle to set an air-current in motion of a diameter equal to the stretch of the wings from tip to tip. Wings then measuring two feet from tip to tip should create an air-column four times as great as wings measuring but one foot from tip to tip; and wings measuring three feet from tip to tip should create an air-current or column nine times as great as wings measuring but one foot from tip to tip; and wings measuring four feet from tip to tip should create an air-current or column sixteen times as great as wings measuring but one foot from tip to tip; and so on by squares. The long axis of the bird being practically the axis of the air-column created by the wings.

So that when large and heavy birds are seen, as Captain Hutton describes the albatross, whose wings measure fourteen feet from tip to tip, "sailing and wheeling about in all directions for more than an hour without the slightest movement of the wings," we are to conclude that the strength or force-density existing in the winds that float the bird is equal to what the wings of the bird indicate to be its ability to create did necessity require it.

In illustration of the power of wings in rapid vibration to produce flotation, let us for a moment consider the law of atmospheric resistance to moving bodies. I quote again from Lardner:—

"Resistance of the air to the motion of falling bodies.—It has been shown that a body obedient to the action of gravity would descend in a vertical line with a uniformly accelerated motion. Its velocity would increase in proportion to the time of its fall, so that in ten seconds it would acquire ten times the velocity which it acquired in one second; but these conclusions have been obtained on the supposition that no mechanical agent acts upon the body, save gravity itself. If, however, the body fall through the atmosphere, which in practice it must always do, it encounters a resistance which augments with the square of the velocity. Now, as the accelerating force of gravity does not increase, while the resistance continually increases, this resistance, if the motion be continued, must at length become equal to the gravitation of the falling body; and, when it does, the velocity of the falling body will cease to increase. It follows, therefore, that when a body falls through the atmosphere, its rate of acceleration is continually diminished; and there is a limit beyond which the velocity of its fall cannot increase; this limit being determined by that velocity at which the resisting force of the air will become equivalent to the gravity of the body.

"As the resisting force of the air, other things being the same, increases with the magnitude of the surface presented in the direction of the motion, it is evidently possible so to adapt the shape of the falling body, that any required limit may be impressed upon the velocity of its descent. It is upon this principle that parachutes have been constructed.

"When a body attached to a parachute is disengaged from a balloon, its descent is at first accelerated, but very

soon becomes uniform, and as it approaches the earth, the air becoming more and more dense, the resistance on that account increases, and the fall becomes still more retarded."—LARDNER'S Natural Philosophy, book iii. chap. 9.

It is manifest, without argument, that an ascensional current of air established underneath the parachute, with a force equivalent to the fall of the body, would have the same retarding effect as the descent of the parachute through the air: also that an increase of the ascensional force beyond this point would support the parachute in opposition to the force of gravitation, and establish a fulcrum of locomotion.

The wings of a bird are its parachutes; and the movements of its wings the fall of the parachute, but lifted as fast as they fall; and as the resistance occasioned by the fall (wing motions) augments with the square of the velocity, the wings have this in their favour.

And although the heaviest bird that flies is, for its protection and safety, gifted like the insect with the power of rising in still or forceless air from the surface of the ground, or from the face of the waters, its home, nevertheless, is in the air, where its nest is among mountain peaks, or inaccessible hill-sides, or on the tops of trees, in the spires of churches; or under the eaves of houses, from whence the creatures launch themselves, and on their parachute wings sail and skim through the air by a projectile-force flotation due to their weight employed as force.

Pettigrew speaking to this, says: "The flying animal receives support from the air by increasing the size of its travelling surfaces. * * * When an insect, a bat, or a bird is launched in space, its weight (from the tendency of all bodies to fall vertically downwards) presses upon the inclined planes or kites formed by the wings, in such a manner as to become converted directly into a propelling, and indirectly into a buoying, or supporting power." (See Pettigrew's "Animal Locomotion.") If, instead of insect, Pettigrew had said butterfly, he would have been more correct.

Any one who watches birds, especially large ones, will discover that their flying consists mainly of sailing. The weight of the bird's body that impels it down the inclined plane of the sky sends it up again by the momentum thus acquired, aided generally by a few vigorous strokes of its wings; and the rush of the wing-surface of the bird over the air-spaces it traverses, amounts practically to the same thing as a wind or air-current rushing under the bird. Swallows are splendid examples of projectile-force flying; the momentum acquired in their flight enabling them oftentimes to rise perpendicularly for several feet; the shape of the bird, and its wings, being for this mode of flight marvellously adapted. Its power too, to increase or lessen the tendency of its body to fall, by the opening and closing of its wings and tail is wonderful; its movements in doing this are like flashes of lightning. What the swallow is able to perform in still air, by the celerity of its movements on small wings, the albatross, the condor, and the eagle accomplish amid powerful wind-forces with their greater weight and spread of wings by slow and easily sustained movements and at almost no expenditure of their motive-power.

No better illustration than the following can be given of the use made by birds of the force-density of the atmosphere, and of its necessity to them under certain conditions.

When a flock of geese, feeding on the commons (a customary thing in New England, U.S.A.) feel an inclination to fly, they prefer to wait for the rising of a good stiff breeze; the weight of the creatures being uncomfortably great in comparison to their motive-power. When the breeze is at its best, the geese set up a tremendous quacking, stretch out their great wings to the utmost, elevate their heads, and

bring their wing-planes well up towards the perpendicular; they then rush against the wind as hard as they can, at the same instant beating the air violently with their wings. The effect is quite magical:

The whole flock in a second are off their legs, afloat, and away on the air.

But, as a rule, birds are sufficiently light, and have spring enough in their legs, to leap into the air and find immediate flotation. A crow, as it hops along the ground, seems to almost float as it hops; and the delicate and gentle manner in which it lowers itself upon a slender bough at the top of a tall tree when settling itself for the night is delicious to behold. The amount of motive-power stored up in the tissues of the creature's great wings must be immense.

One is strongly impressed with the infinitude of Nature's resources when considering the great variety of method and movement with which the creatures of the air are gifted. One set of creatures, with weight as an element of their organization, are constructed with wings of variable lengths and proportionate breadths with reference to their habits and modes of existence, and with instincts that lead them to select for their habitations situations that, in their first efforts to fly, precipitate them into space, thus calling into immediate requisition the weight-function of their organisms, the result being projectile-force locomotion. Again, we have the creature entirely supported on the winds. Then we find a combination of wind-support and projectile-force flotation. Under another modification, the bird, by a sort of rudder-principle, sails with and upon the wind, being carried along and floated by its force. By another mode, the bird, floated in the force-atmosphere, as a vessel is floated on water, propels itself in substantially the same manner as fishes propel themselves; or the bird combines projectile-force flotation with wing-propulsion; or the bird submits itself meekly to the wind-forces of the air, and setting up a passive resistance (as individuals and governments sometimes do), conquers the forces of Nature, and compels the winds to move it forward upon a pathway selected by itself and upon which it desires to travel! a miracle of locomotion in the air possible only to a bird. To this we may add the flying of bats and butterflies, or animated parachutes, and, to crown all, the Dragon-fly, or Reactive-Passive Locomotion!

Under such circumstances, is it to be wondered at that the secret of aerial locomotion has for so long a time eluded the grasp of man?

There was a time when inventors, or some of them at least, thought it necessary to exactly imitate Nature in order to follow her, and with this view condemned wheels and argued for legs and feet instead, not perceiving that the spokes of the wheel are the legs, and the periphery the feet: the difference between the methods being that in one the fulcrum of support and locomotion is intermittent and in the other continuous.

In the same way, mankind have imitated Nature and constructed wings—wings "to beat the air as a bird when flying." And, where they have attempted something different, it has been a device possessing no wing-function whatever, a "helice" or screw; the effect of which, I admit, is bird-flying, but of the projectile locomotion kind, far better, certainly, and more sensible, than "aero-planes" or any flat planes, and nearer to dragon-fly locomotion, for it introduces small surfaces and high velocities in place of extended surfaces with relatively flow movements. In this view it is an approach in the right direction, and the results obtained by Nadar and Landelle at one time seemed quite encouraging. In my opinion they would actually have succeeded had they

been fortunate in the possession of a true theory, for they would then have made a fanning-wheel instead of a helice.

With regard to the helice or screw, I shall have something to say in the Appendix. In this place I content myself with merely remarking that in my view the screw is a mistake, whether in water or air.

I come now to what, for want of some better way of expressing it, I have ventured to call passive locomotion. And to this I ask the reader's special attention. It is the passive locomotion of birds in the air, the most interesting sight, and, in the absence of a clear perception of what flying actually consists in, the most extraordinary possible to conceive of, so very extraordinary that even Professor Marey only admits it as a fact because of the testimony of the many who have witnessed it. My motive for asking the reader's special attention to this is because of the use I intend to make of it in illustration of the position I have assumed with respect to the reactive indirect or passive locomotion of the dragon-fly and creatures of its class.

The Atlantic voyager who cares more to watch the birds than his segar as he walks the deck of his steamer, will observe, as he approaches the British, coast, immense numbers of sea-gulls, of apparently all ages and sizes, following in the wake of the ship: some wheeling upwards, some diving downwards; at one moment miles ahead; and at another moment, miles behind: a bevy of them always hovering near the stern of the vessel, on the look-out for any stray bits from the ship's larder or stores that may be thrown overboard. At such times nothing can exceed the dexterity of the creatures: the suddenness with which they precipitate themselves upon the waters; the celerity with which they evade the billows; the accuracy with which they aim at the coveted morsel floating upon the dancing wave; and the graceful ease with which in circling flight they mount again into the air. And this,—not for an hour —not for hours—but all day long—a sight calculated to interest any lover of Nature, but of especial interest to one who at five years of age began his experiments in aerial locomotion, by attempts to walk upon the air. I felt quite sure I could do it: nor was my faith weakened in the slightest degree by the constant failure that attended my efforts: nor has it ever weakened since:—what ought to be done can be done. And now, as I look back over a waste of more than threescore years—that childish effort, in the light of my dragon-fly experience, and in the light of the great present— the steady advancement of the human mind—the marvels of science—the onward march of men towards mighty goals —the Alpine peaks of man's ascent towards God already climbed:—in the light, I say, and in view of all this—as I look back upon that infantile faith and effort, I cannot help regarding it in the light of a prophecy and an inspiration! The scene is all before me now, I can see it today, as it took place sixty-two years ago. The deserted school, scholars all gone home—(my father's school)—a little child alone: alone with his own thoughts: and "the thoughts of a child, are long, long thoughts."—Yes, I felt sure I could do it: and mounting one of the long benches, and walking quickly, I stepped from the end rapidly off into the air!—Nothing daunted or discouraged by the failure or the fall, I repeated the experiment with, "I will do it!" Again and again going over the same ground only to fail, and to fall as before, but with each succeeding failure only the more determined that I would do it; and only abandoning the efforts when the exhausted muscles and quivering nerves themselves gave out. But Will and Faith are a mighty team: they scale mountains; carve out destinies; subdue deserts; establish highways of civilization and commerce through wildernesses before untrodden by the foot of man; and, armed with the torch of science, scatter

from the face of Nature the gathered darkness of ages and generations.[3] "Impossible" has no place in the vocabulary of Will and Faith. The present and the future, alike of the world that now is and of the world "that is to come," belong to Will and Faith. The Past—and Death— and Corruption —and Oblivion, belong to the faint-hearted and the faithless.

The locomotion of a bird in the air, which does nothing but hold itself with engineering skill amid the forces of the winds, and in performing this feat travels pari passu with a vessel steaming at the rate of fifteen knots an hour, is something worth seeing. I have seen it more than once.

The bird travels in face of the wind: the winds blowing strong. The bird drawing in its wings and holding them partially closed establishes itself in the air in a position where it leans slightly forward of a true perpendicular line: the wings and body together make a practically flat surface or inclined plane so set in the midst of the wind-forces as to split them, so to speak, exactly on the line of cleavage, where the forces in front of the bird not only support it against its tendency to fall, but at the same time uphold it as against the pressure of the wind-forces at its back; the wind-pressure against the back of the bird constituting an impelling force to produce locomotion—and the wind-pressure against the front of the bird maintaining it in position to be driven forward—the path which it travels under these conditions being perfectly horizontal.

Like the wing-movements of the swallow, the wings of the gull may be seen to have a sort of nervous twitching, as the creature, ever watchful of the strength of the air-currents, increases or diminishes its wing-surface to increase or diminish the wind-force in relation to its falling weight. This feat of the gull, is, I think, the sort of thing for imitation, that men ambitious of "flying" should first undertake to do. It will be a static performance sure to immortalize the man who does it.

[3] Stanley in Africa.

CHAPTER III.

INSECT OR REACTIVE-PASSIVE LOCOMOTION.

IN his work on "Animal Locomotion," alluding to the speed attained by insects, Pettigrew observes as follows:—"Everyone when riding on a warm summer day must have been struck with the cloud of flies which buzz about his horse's ears, even when the animal is urged to its fastest paces: and it is no uncommon thing to see a bee or a wasp endeavouring to get in at the window of a railway-car in full motion. * * * If a small insect like a fly can outstrip a race-horse, an insect as large as a horse would travel very much faster than a cannon-ball?

He also remarks that Leuwenhoeck "relates a most exciting chase which he once beheld in a menagerie between a swallow and a dragon-fly (Mordella). The insect flew with incredible speed, and wheeled with such address that the swallow, notwithstanding its utmost efforts, completely failed to overtake and capture it."

In the above extracts Pettigrew has borne unconscious testimony to the importance of the insect world in their relation to aerial navigation, and in a manner prophesied of its accomplishment through their agency.

To the superficial gaze of man, Nature frequently seems inconsistent; but harmony reigns through all the works of God. Seeing that the portion of the atmosphere nearest the earth has the greatest density, being the lowest of the air strata, we should naturally suppose it best fitted for the heaviest of the flying creatures. Instead of this, we find the heaviest birds nearest the clouds, and insects and the lightest of flying creatures nearest the ground. But the reader who has followed me thus far will be under no loss to account for this. Force, though visiting the surface of the ground, and holding constant revels in the stratum nearest the earth, dwells in the skies, despite the fabled Æolus, with caves on earth. And the birds, as we have seen, find instinctively the forces where they are.

But the insect world of dragon-fly type are quite independent of the birds and bird methods of navigating the air: they are the possessors of an independent sphere of their own. The winds of the firmament they neither court nor shun. Their locomotion goes on as well within the stifling atmosphere of a chamber of "dead air" as in the open, where the breezes stir the flowers. No mosquito ever had one bite the less because of the deadness of the air he was getting his repast in: no bee ever missed the sip of a flower because the winds were not blowing: and no wasp ever gathered less clay for his nest, or stopped a minute's work for want of winds to fly on. Wind or

no wind in the atmosphere, the wings of the little busy bee, and wasp, and fly make neither one beat less nor more; for the locomotion of all is due to the impulsion of the air-pressures created by the fan-blowing action of their wings.

Let us now consider the philosophy of the fly that stood still in the air. The little sea-gull that I have described as travelling with our steamer by a sort of passive locomotion—it should be observed—invariably kept its position just above the ship, not moving one inch forward or backward. With respect to the ship, it stood as perfectly still in the air as the little golden-green fly stood in the barn-yard.

Now then, here we have two facts. Let this be noted. In the case of the bird, the standing-still performance is clearly traceable to the force of the atmospheric winds in the firmament, winds having their origin outside of, and independent of, the bird. In the case of the fly (when I saw it), there were no winds in the atmosphere.

Now if we assume atmospheric conditions substantially alike in both cases, and admit—as admit we must—that the wind-pressures supporting the fly in space are due to the play of its wings—the conclusion is irresistible that the fly, when standing still, is as really sustained by a balance of forces as the bird:—and its locomotion or darting movements are equally the result of wind-pressures that cause a passive locomotion substantially the same with that of the bird.

But although the principle according to which the bird performs its feat in the air is the same with that of the fly, the modes vary. The art of the bird consists in accommodating itself to wind-pressures over which it has otherwise no control; but the insect is master both of itself and the wind-forces it creates. The upright position of the bird and the folding of its wings do not necessarily exist in the performance of the insect—though I may remark in pasting that the house-fly, when standing nearly still in the air, holds its body in a manner approaching that of the gull, but not so upright.

The flapping of a bird's wings, at right angles to its body, produces, as I have said, an air-current in volume and strength proportioned to the stretch of the creature's wings and the rapidity of their movements: this air-current flowing from front to rear because the flexible portions of the wings or fans look to the rear.

That a bird has the power to a considerable extent to change the position of the farts so as to make them fan the air somewhat differently, cannot be doubted. We see this when a pigeon, coming down in a hurry upon the ground, and wishing to break the fall, throws its head well up to the perpendicular, gets his body as plumb as possible, and with his wings stretched forwards and upwards and flapping them

vigorously, produces a powerful down-blast of air, with the effect of creating a sort of air-cushion to alight on. Anyone who will take the trouble to look at a pigeon may see this; the out-flying in all directions of the debris and dust upon the face of the ground bearing ample testimony to the character of the wind-blast.

But the dragon-fly and all other insects of its class are organized with special reference to the sort of locomotion I have described as belonging peculiarly to them, viz.:—passive locomotion. To this end, they must be able to not only fan the air in any and all directions, but practically, at the same instant of time. Upon no other theory can I account for the standing-still-in-the-air performance of the fly in an atmosphere unruffled by the slightest breeze—for the floating movements of the bee, or the backward and forward floating of the dragon-fly.

If then we assume for these insects the possession of such a power, our reasoning in attempting to explain the mode by which the fly stands still in the air will be this: When, for example, the dragon-fly fans the air only backward, it moves forward; when it fans the air only forward, it moves backward; let both operations be performed simultaneously (and it has two pairs of wings), and it will stand perfectly still, providing it so manages the pressures as to produce forces that at the same time antagonize all tendency to upward and downward movement.

Now, whether the fly in question is fortunate, like the dragon-fly, in the possession of two pairs of wings, I can't say. If it performs the feat with only one pair, it is so much the smarter, and we must assume for it the wonderful power of being able, with its one pair of wings, turning in every direction (like the flaming sword of the Cherubim in Eden), to produce practically a hollow sphere or vacuum centre in the air, the spherical wall of which is composed of the wind-pressures produced by the fanning action of the wings in their universal play, this vacuum centre having practically the effect of the electric aura some have imagined, and floating the creature as effectually as though enclosed within a sphere of hydrogen or other gas capable of creating a specific gravity of like density with the surrounding atmosphere.

Upon this view of the case, it is easy to see that the dart-like locomotion of the barn-yard fly, like that of the dragon-fly, results from an unbalancing of forces; the forces weakened at any point in the spherical wall producing a pressure at the opposite point of corresponding force.

If it be objected to this theory of aerial locomotion for man on the ground that it is contrary to Nature—seeing that bird-flying is the method of Nature for all creatures having substantial weight, and that the passive locomotion I have described has been confined

by Nature to creatures possessed of practically no weight—I would call the attention of the objector to the fact that Nature, in organizing living creatures for our planet, has provided, not for locomotion alone, but for all the needs of the creature, its mode of locomotion has therefore reference to conditions that do not fall within the scope of our inquiries. The objection consequently cannot properly be urged.

But my purpose is to neither anticipate objections nor answer them. Neither am I careful as to results. The object of this book is to introduce to the notice of my fellow-men a theory that may possibly lead to the result the world has wished and waited for so long. At one time, and not very long ago either, I had hoped to do something more than write-out theories. I had even gone so far as to construct the fanning-wheel I have spoken of. But the field is too great for any one man. Aerial navigation demands earnest work from many heads and many hands, and the best inventive talent of mankind will all be needed for its accomplishment.

Should the theory I have attempted to unfold in these pages aid in any manner towards the accomplishment of the great purpose, I shall feel amply repaid, and without other reward rest contented in the satisfaction of a

DUTY PERFORMED.

NOTE.

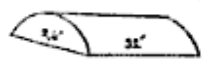
I HAD not yet recovered from long-continued illness at the time the following letter was written, and could therefore give no personal attention to the experiments alluded to. The letter relates to the fanning-wheel I have spoken of. The writer, Mr. A. P. Brown, of New York City, U.S.A., an ingenious mechanic, was employed by me to construct and experiment with the wheel: and among other things, I had directed him to observe the lifting effect of the wind-blast upon a canopy or sail: this is what he alludes to in one part of his letter. I quote the letter, as it may possibly interest some of those whose attention, like my own, has been directed to this subject:—

"New York, January 20th, 1882.

"FRIEND H------,

* * * * "The wheel is of 3 fans—each 9½ inches by nearly 3 inches in the widest part. It is pulled by a cord wound on a crank-wheel, and gets 80 turns at once winding up. It got 90 with the smallest cord here enclosed "(about like shoemaker's thread)," but the cord broke. To get 80 turns of the 'fly,' 22 turns of the crank-wheel are required. Time consumed is 10 seconds. So the velocity of the fly is 480 per minute." (This don't amount to much in comparison with the 18,000 of the real "fly!") "At and during 9 to 10 of the first turns the air draws towards the wheel from front and rear also. This means that the wheel rarefies the air in its immediate neighbourhood, passing it off radially to itself." (The little miller did far better than this.) "By the end of this time sufficient velocity is attained to set the sails askew, and a backward current gets itself established, and continues with reasonable and increasing uniformity to the close of the experiment." (This settles the question of ROTARY wings, and proves my theory of automatic adjustment of the wing-fans by air-pressure; and equally proves the applicability of the wheel, when constructed with properly organized pressure-blades, to water as a propeller in lieu of the wasteful and imperfect "screw" now in use.)

"The wheel only makes 1 to 2 revolutions at the utmost, after the cord is all wound off. There is a tendency in the air-current to shift it from side to side a little; perhaps the operator's arm or shoulder or head may cause it. There is also a noticeable side inclination to the current next to the wheel from left to right, and vice versa, according to the direction in which the wheel is revolved (easily accounted for). The canopy, a dead flat, gave indifferent results at any angle and in all positions. A hood or bonnet 32" long x 24" wide gave better results and a maximum of effect when 1/3 of the 32" was forward of the plane of revolution, and 2/3 to the rear. I also measured the angle carefully, having Fred" (the assistant) "get an independent verification thereof, and found it to be inclined above the horizon 340 (angle of screen to the shaft 340), and the back end of screen 4" below centre of shaft. At the 10th turn of the crank the screen will rise 4" to 5" (at back end), and remain there steadily during the run.



"All the lifting power we have yet been able to attain is 2½ to 3 oz.: current acting on this large curved screen. As to the power, I send samples of the cords; the smallest of the three held well until somewhat worn.

"A. P. BROWN."

P.S.—My friend Willis Gaylord, Esq. (of Brooklyn, U.S.A.) has charged himself with the duty of "materializing"

some of the ideas set forth in the pages of this book—patents being one of the "conditions."

So far as Water navigation is concerned, I am reconciled to this; but not as to the Air. If the theory of "Passive locomotion" herein set forth be the basis needed by inventors, in order that mankind may realize their long-cherished dreams, that basis should be free to all: more especially in view of the unusual incidents attending its promulgation to the world. Under these circumstances I desire to have it understood by all inventors, that, so far as regards the new principle of aerial navigation set forth in these pages—and the "fanning-wheel" described herein as a "reduction to practice" of the new principle—they are to be regarded as the common property, and as being hereby dedicated to the service of all mankind.

T. H.

APPENDIX.

WATER AND WATER NAVIGATION.

I HAVE not crossed the ocean as many times as Captain Lott, but I have been over it often enough to appreciate its majesty and its beauty, its grandeur and the terror of its perils; and by a long and often repeated experience of it in all its moods, to realize by sympathy the feelings of those who perish amid the seething of its raging billows. And I remember the ill-fated "President," the day that me sailed from New York, on the nth March, 1841. We sailed out together. I in the "Charlemagne," bound for New Orleans. And a pang of disappointment passed through my heart, and I complained in my foul at the ways of Providence as I looked upon the beautiful steamer gaily decked in streaming colours, and I longed by one leap to be on her and away to the grand old world she was bound to. Yes, I murmured.

We sailed out together, and the night soon came on, and a storm, then a hurricane, so frightful that to me it seemed a carnival of all the wind-demons of the skies. When the morning broke we were toiling about on the billows, and our captain with his glass sighted the steamer in the distance labouring in the seas. "She is making no steam," remarked Captain Packard, gravely; and then, as the old man telescoped his glass, he said, solemnly—"She can't live; she must go down!" And the eye of our captain was in all probability the last mortal eye that looked upon the hapless, ill-fated "President." She was never heard of more!

Twelve years later, in July, 1853, I sailed for Europe in the Collins steamer "Pacific," returning in the "Arctic" (same line) in October. The same month of the year following, the "Arctic" went down off Cape Race with 360 souls on board. And six months afterwards the "Pacific," taking the "North'ard passage," steamed out from Liverpool into regions of darkness, where sunlight never enters—and no man lived to tell the tale! And since then, how many more? Alas! how many?

And the winds and the waves still conspire against us, and the principle of flotation in ship-building remains to-day where Noah found it, and the Norsemen and the Vikings left it, and the ocean is still strewn with wrecks, and the deep is a graveyard still! And the crape and the moans of the mourners, and the sick hearts of the desolate, and sighs for the loved and the lost, for the dead that shall never return! Alas, poor hearts!

If mechanical flotation be possible in air, why not in water? If water reptiles, the Crustacea, and fishes can float themselves by mechanical means, why not vessels that are propelled by steam? Would it be any harder to propel the steamer towards the sky than

straight ahead? And if there were propellers enough about the boat, and the right kind of propellers, and fixed in the right places about the ship, and connected with the steam-engine in the right way, and placed at the proper angle to propel towards the sky, wouldn't they lift the ship, and couldn't this lifting power be made so great as to keep the vessel from going down even though leaking and full of water?

If it could be done, we might stop making a graveyard of the ocean. Why can't it be?

All the water-creatures that are lighter than water are under just as much necessity of employing mechanical force to travel down through the waters, as the heavier ones are to travel up: so it seems to come to about the same thing for both of them. Getting through the water is a mechanical matter any way; and it takes no more force apparently to make the heavy creatures float than it does to make the light creatures sink.

Why, then, can't we have Mechanical Flotation for Steamships?

I am afraid there are a great many people yet who can't give up the balloon principle for water-flotation any more than some others can't give it up for air-flotation. And the former of these good people believe to-day as firmly in the pretty legend of the "swim-bladder" to float the fish up through the waters as the latter do in "heated air cells" and "hollow bones filled with air" to make the birds light enough to fly! And yet there isn't anything in nature to warrant one more than the other.

Locomotion (including flotation) in the water is just as purely a mechanical affair as locomotion in the air and on the land.

And the history of all water-animals proves what I say.[4]

And if it requires no more motive-power to produce flotation than propulsion, why can we not employ the power of the Steam-Engine of Steamships to create Mechanical Flotation and prevent the vessel from sinking, no matter how leaky or how far distant from land?

And stop making a graveyard of the Deep!

It isn't an agreeable sensation to be on board a steamer in mid ocean and have something happen. It makes you feel badly enough when it's nothing more

---

4 "The otaria or sea-bear," says Pettigrew, "swims, or rather flies, under the water with remarkable address, and with apparently equal ease in an upward, downward, and horizontal direction, by muscular efforts alone!" (The italics and exclamation are mine.) Pettigrew continues as follows: "An observation which may likewise be made regarding a great number of fishes"—(why not all?)—"since the swimming-bladder or float is in many entirely absent!" In confirmation he quotes the following from Owen: "The air-bladder is wanting in the dermopteri, plagiostomi, and pleuronectidæ." —Owen, op. cit., p. 255.

than the vessel coming to a sudden stop—and nobody knows why—and all the officers of the ship are suddenly seized with the majesty of a great dignity and the solemnity of a mysterious silence; and all the passengers at the dinner-table lay down their knives and forks, suddenly lose their appetites, and begin to look into each other's faces; and a few benevolent and courageous gentlemen (determined not to be left) rush upstairs to find out the news, and come back and tell you all about it: and the ladies at the table don't laugh any more, and white lilies bloom faster in pale cheeks than common. Ah! these are sensations!

Or to be awakened at midnight by gurgling sounds of water in your state-room—and no light!—and without waiting to calculate distances, you jump down from a top berth and suddenly feel something very hard against your head, and something very wet all over the floor, the gurgling sounds going on all the while! It isn't pleasant, such things, ——for nervous people.

I left New York on Wednesday, the 3rd of May last, in the "Catalonia," Cunard Line. All went well until Sunday, the 7th, four days out, with Newfoundland north of us. It was the Sabbath, clear and beautiful, and all on board were so happy! light hearts and smiling faces, and not one omen of evil (the ship had broken her propeller shaft on a former voyage; but this, to me, was good evidence that it wouldn't happen again). It was four o'clock in the afternoon when the shaft broke for the second time. I had just started for the promenade deck, when a sound, more terrific to our ears than the bursting of seven thunders over head, was suddenly heard proceeding from the engine-room; and at the same instant the deck under our feet commenced to quiver and shake with an upheaval like the undulations of great billows. The thumpings and thunderings and hangings in the engine-room were tremendous; the vessel seemed going to pieces, and we in the midst of the ocean. Nothing about us! Nothing in sight of us but the everlasting stretch of the great water plain from horizon to horizon. The heavens above us too far to reach, and the waters below us—Ah! so deep to sink into!—and thirty seconds seemed an age! To those who have never experienced a scene like this my words are meaningless.

For those who have, what need of saying more?[5] The theory and practice of building and running steamers on the ocean, as far as I have been able to investigate the matter by some thirty or forty trips over the Atlantic, appears to be about as follows:—1st, speed; 2nd, safety; 3rd, comfort of tobacco-smokers.

The contact-friction[6] of the water and sides of the vessel appears to be left to take care of itself; and yet Nature very carefully provides a well-lubricated surface for her swimmers with means for a continuous lubrication. May it not be that the saving in coals would pay for the cost of oil, or lubricator? The extra speed being so much clear gain.

The propelling power of fishes depends upon convolutions: the convolutions being lubricated, adjustible, flexible, inclined planes, capable of transmitting, practically, the whole of the motive-power for reacting against the water-fulcrum. A very different affair from "screw-propellers."

On the screw I cannot do better than quote again from Pettigrew. At pp. 152,153 he writes as follows: —"In the ordinary screw the blades follow each other in rapid succession, so that they travel over nearly the same particles (whether water or air) in nearly the same interval of time. * * * If the screw employed in navigation be driven beyond a certain speed, it cuts out the water contained within its blades: the blades and the water revolving as a solid mass. Under these circumstances the propelling power of the screw is diminished rather than increased. * * * The vanes or blades of the screw, as commonly constructed, are fixed at a given angle, and consequently always strike at the same degree of obliquity. * * * In this arrangement power is lost, the two vanes striking after each other in the same manner, in the same direction,

---

5 To prevent a misapplication of my remarks on the "dignity, &c, of ship's officers" on occasions like the one I have described, I wish to say for the captain of the "Catalonia," that this gentleman lost no time in giving his passengers the earliest information as to the exact state of the ship, and the extent of the accident. No one could doubt the good faith of Captain Gill, and the fears of the passengers from any immediate danger were quieted. What we had reason to apprehend was, drifting to the north among fields of floating ice and icebergs. But, providentially, we were soon in sight of other vessels, and all ended well The "Catalonia" is the easiest vessel on the waters I was ever in.

6 The late Thomas Winans, of Baltimore, Md. U.S.A., showed me, some twenty-five years ago, the tabulated results of his numerous experiments (some thousands, I think) on the friction produced by the passage of vessels through the waters, and its effect on the power of the ship; and the results were amazing; Mr. Winans remarking, that in his judgment too little attention had been paid to this point. But his ideas, like those of naval architects, for lessening such friction, were confined to model: to leaving the water on lines as sharp as the entering ones.

and almost precisely at the same moment—no provision being made for increasing the angle and the propelling power at one stage of the stroke, and reducing it at another to diminish the amount of slip, incidental to the arrangement."

I think no one can doubt the correctness of the above criticism: and the defects appear to me beyond remedy so long as the propeller is a screw.

Fishes propel themselves by the tail and flexible portion of the trunk: and screw-propulsion is designed to imitate this method—and may be called the fish method. But aquatic birds that pursue their prey under water— some even going to the bottom of rivers —swim with their wings. These creatures are a sort of "side-wheelers." And both plans work well.—Why, then, confine ourselves to the stern-power method?

If a vessel were constructed with receptacles or concavities in the sides made within the water-lines and furnished with a number of small propellers working within these spaces—the propellers being capable of adjustment to any required angle—such a vessel should not only be proof against sinking, but should also be capable of movement in any direction at the will of the engineer, and would also have the guarantee of a number of propellers, in case of accident, in place of the rifle of only one.

And if vessels by the application of apparatus worked by motive-power can be floated, why not persons? Why not mechanical contrivances to lessen the labour of swimming, to make "treading water" easy, so that people could walk out from shore to vessels, and from vessels to shore, making "lifeboats" something more than a name, "life-saving" a certain "art," rendering water tricycles useful to merchants and others living out of town on river sites, besides much else?

Finally, and as I have already remarked, the duty and the work of changing the present order of things in the interest of all mankind belongs to no single individual. If the theory of mechanical flotation herein set forth should prove to be correct, a new field for invention will be opened up, demanding far more inventive talent than can ever be hoped for by any one man, and certainly more than is claimed by

THE AUTHOR.

Note.—This edition, which consists of a few hundred copies, is printed with a view mainly to private distribution. To the original three hundred printed for distribution, two hundred have been added for sale to those who may possibly feel sufficient interest in the subject to care to purchase.

A Corvus Edition
corvuseditions.com