Annals of some remarkable aërial and alpine voyages, including those of the author : to which are added, observations on the partial deafness to which aerial and mountain travellers are liable, and an essay on the flight and migration of birds, the whole being intended as supplementary to "Researches about atmospheric phenomena" / by T. Forster.

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OBSERVATIONS ON THE PARTIAL DEAFNESS TO WHICH AERIAL AND MOUNTAIN TRAVELLERS ARE LIABLE,

AND AN ESSAY ON THE

FLIGHT AND MIGRATION OF BIRDS,

THE WHOLE BEING INTENDED AS SUPPLEMENTARY TO

"RESEARCHES ABOUT ATMOSPHERIC PHENOMENA."

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CORRIGENDA.

N.B.—P. 85, line 8, being the date—*Monday, Aug.* 22, 1808, belongs to the paragraph beginning at line 21, and line 20 bearing date, Monday, Aug. 27, 1804, belongs to paragraph beginning line 9, that is to say, MM. Gay Lassac and Biot ascended from Paris, *Aug.* 27, 1804, whereas MM Andreoli and Brioschi ascended at Padua, *Aug.* 27, 1808.

EPISTOLA DEDICATORIA.

TO MY ESTEEMED FRIEND THE LEARNED COUNSELLOR AND EMINENT NATURALIST, J. E. BICHENO, ESQ.

Greeting,

"*Quoi dono lepidum novum libellum?*" said I, in a sort of soliloquy, the other day, while correcting the proof sheet of these truly volatile Annals. And it then occurred that if studies in some measure similar, long acquaintance, and an equal taste for the beauties and curiosities of Natural History and Philosophy, conferred on me a right to hope that you would be willing *meas esse aliquid putare nugas*, you would be a proper person to whom I might dedicate this *Opusculum fugax*. I have particular satisfaction in this opportunity of acknowledging how much, in common with other naturalists, I am indebted to yourself for both instruction and amusement, in those sciences wherein we take a common interest; as well as in the prosecution of important enquiries into the moral condition of man, considered as a gregarious animal destined, by his organization and the nature of his wants, to live in a state of society, and to depend for his support and protection on the mutual assistance of his fellow beings. In the first of these departments of human knowledge, the Transactions of the Linnæan Society, and your various and luminous expositions of the relation between Botany and Geology, will do you ample credit. In the latter, I need only appeal to the account you have published of your "Tour in Ireland," and to your book "On Benevolence;" the one demonstrative of your talent for useful observation on men and manners; and the other proving that you do not entertain any of those narrow and selfish views of the spring of human charities, which are so often entertained by hypocritical theologians and the mock moralists of this age of cant and fanaticism. For the bearings of your work seem to be to show, that amidst the

vices and defects of ill conducted human beings, there are seeds of virtue enough, if duly cultivated, to improve, in a degree at present unknown, the actual sum of animal happiness; and that, by giving to the better propensities of our nature the advantage of example, and of early culture, we may learn to labour habitually AD MAJOREM DEI GLORIAM, without founding our actions on that mercenary anticipation of personal reward, which is too common in Western Europe, and particularly in Britain, owing to the peculiar features of modern superstition, and the bias of commercial prejudices.

The wide expanse of Nature must be the object of every good man's solicitude; and of every reflecting philosopher's admiration. And no system of benevolence can be perfect which shuts out any part of the animal creation from its pale; nor hypothesis in science valid, which limits, within the narrow bounds of bigoted man's interests, the universal range of benevolence in reciprocal causes and effects, which emanate from the Final Cause. Since, as the learned Abbé de la Mennais observes, *Dieu est la Vérité et la Vérité est l' Etre.*

It is with mixed sentiments of pleasure and regret that I learn from yourself that you are about to undertake a voyage of discovery in the less cultivated parts of America. For although I rejoice at the benefit that science will receive from the exercise of sober discriminating judgment on the new materials which the other continent affords; yet when two persons have respectively a taste for enterprises so detrimental to safety as flying and sailing—when it is possible that while you are floating on the giant streams of the Mississippi, or exploring the majestic waterfalls of the Niagara, or wading through Χειμαρροι ποταμοι καὶ ορεσφι ξεονιες, amidst rocks, whose summits touch the heavens, I may be routing the chamois or the marmot from their mountain lodges; or trying, as the sequel to these Annals will show you, *de disputer avec l'Aigle le haut chemin des nues;* there is perhaps an exaggerated possibility that we may never more enjoy together the *convivium fabulosum* of assembled philosophers, as we did at the last Anniversary of the Linnæan Society. *Personne ne peut prévoir la couleur changeante de la possibilité!*—Without, however, brooding over these melancholy forebodings, which would

cast a shadow on the Chameleon corruscations of Hope's glittering camera, I shall suppose you destined to make a successful voyage, to accomplish an interesting excursion, and to return stored with riches from the fruitful waters of the St. Lawrence to the land of our patron St. George. And as it has ever been my custom, on undertaking any hazardous enterprize, to get a clear conception beforehand of what would shortly become objective reality; so will I try to bring before your view the circumstances of your coming excursion, and to point out to you, as far as my more humble forecast be capable, what objects you should endeavour to accomplish, during your sojournment in the new world—*teque nec lævus vetet ire picus, nec vaga cornix*—trusting, at the same time, that you will give to the public the result of your enquiries; as the success of your former works has already shielded you from the diffident caveat of Arellano, who said of his first lucubrations—Si, como siempre, et publico me honra con su aprobacion, proseguiré dandole mis obras in sucesivos tomos; pero si por desgracia no acierto á agradarle mi silencio sará justa conseqüencia de su desaprobacion.

After a hearty farewell from your friends in the capital, you will get aboard one of those excellent ships, usually fitted out for the transatlantic passage, amidst the innumerable flags and particoloured streamers which fly over the muddy shores of old Thames, stored with the vessels of every nation. I can fancy you already on deck and leaning over the larboard chains, with your eyes fixed on the West India and London Docks; reflecting that our metropolis and Amsterdam have rivalled the ancient Tyre and Sidon in the splendour of their commercial greatness; and while pondering on the question whether the westering wheel of Fortune may not be rolling, like yourself, to America, I can imagine you startle at the command to get under weigh. The parting gun is fired: you have now no grapple but the sheet anchor of Hope; the foresails are presently unfurled, and the bark floats along the placid mirror of the river. All is increased activity: the boatswain's call, the cuckoo from the green shores of Kent and Essex, and the salutations from the Flora of your native fields, as she still treads the green lawns, cowslips, and harebells, of this emerald isle; the harsh scream of the seamew as you get

towards the Ocean, and the receding prospect of what but just before had been the present mistress city of the sailclad main, where all was bustle and preparation; but which, by a few undulations of the tide, are made as absent to your senses as Palmyra, whose busy crowds lie buried in the silent level of the desert sand, or Nineveh, whose name sounds like the evanescent voice of oblivion,—are scenes which will long be remembered. However, the skiff goes along with the ebb, close hauled on the starboard tack, makes what headway she can round the North Foreland, a light breeze freshens on the beam, every sail is set, and the flying jib is on the boom, and at length, under full press of canvas, with nought of Britain before you but her pennant, you are launched, without a single lurch to leeward, into the wide waters of the Atlantic deep, where on the smooth and scarcely rippling brine, sleek Panope with all her sisters plays. Evening at length draws on, the sun sets on the watery horizon; and as you are preparing to give up to your Guardian Angel the care of your tired carcase, while the starspangled Heavens glitter round the shady chariot of Night, I can hear the Genius of Linnæus from the clouds, invoking the elements in your favour, and singing—

Sic te Diva potens Cypri
Sic fratres Helenæ lucida sidera
Ventorumque regat pater.

By this time you are packed in your hammock, and while musing on the amphibious life of a sailor, you are rocked to sleep by the motion of the vessel, and the dashing against its sides of the κυμα πολυφλοισβοιο θαλασσης.

I have seen the earth recede from view in both directions, vertically and horizontally, and I assure you, when we leave it in a Ship, the effect, if less exciting and impressive, is the more melancholy of the two. In the Balloon, the calm which succeeds the noise on the earth below, is calculated rather to lull the senses into the enjoyment of the present than to rouse past recollections: one is astonished, too, at the fanciful scenery of the varied clouds; we are among the very airy dragons and griffins and figured monsters which we had seen, in the changing shapes of those floating vapours, as Erasmus alludes so well to, in his journey to Antwerp. Among such scenery it is no

wonder that philosophers themselves, possessed of all the cool collectedness of wisdom, should have done so little in science. One seems to say with Göethe—O Finsternisse des Abends! O Verschiedenheit der Wolken! meine Seele so ganz im Gefühle des ruhigen Hierseyns versanken ist, dass meiner Kunst darunter leidet! The reverse is the case with a ship: and though I have never left our shores for the enlightened countries of the Continent without acute sensations of pleasure, I have always been sensible of the peculiar effect of distancing the white cliffs of the land of infantine recollections; which I believe may be aided by the mechanical effect of the mouvement rouleur of a vessel at sea, on the liver, and through it, by sympathy, on the lateral upper lobes of the cerebrum. This is not the case in a balloon, for there I have been conscious of pleasure even amidst the fiery menaces of Electra and the pain of distended blood vessels; for the vast panorama that surrounds us, while in full view of the earth, fills the mind with delight: and when we get into floating mists in the air, or lose the distinct view of terrestrial objects, there is a silence which is unfriendly to fear, and a stillness wholly indescribable by words: the descent however to the ground is alone unpleasant: it affords a metaphorical picture of human life, in which we mount enchanted by the new objects which arise in succession in the horizon, involve our heads in the clouds in an endeavour to strike the stars, and dèscend again to our mother mould, as in the final passage to the grave, annoyed by difficult respiration and diminished sensibility. The voyage in the ship is longer, and reminds one by analogy more of the boat of Charon, and of that ultimate passage to a haven of discovery, to which we must inevitably make progress when once embarked on the ocean of existence.

But I must now follow you to the shores of the "Land of Freedom," where Liberty has placed her standard amidst the sale of slaves; and has blown her clarion to the rattling of the bondsman's chains. Amidst the mercantile bustle of New York, and under the towers of Quebec, I fear you will not find that prospect of a Golden Age returned, which Fancy may have depicted: you will find that however delightfully the mountain nymph may dance on the lutestrings of Euphrosyne,

in real life man is always the same being, and you will exclaim, as you penetrate this fairy ground—

Pauca tamen suberunt priscæ vestigia fraudis,
Quæ tentare Thetim ratibus, quæ cingere muris
Oppida, quæ jubeant telluri infindere sulcos.

You must penetrate the tractless forests of the interior, and dwell where human vestiges are not seen; you must scan the Cordilleras, lighted by the firefly, keeping only the Cross of the South for your lodestar; or must pursue the condor up the Andes and sit on Chimborazo and meditate on the littleness of Ararat, and of Caucasus; you must skim along the waters of Missouri, and skulk under the roar of cascades, or descend into the silent dens of the coujuar, the jaguar, and the opposum; if you wish to escape from the cry of tyrannical oppression and enjoy a temporary repose from the sorrows of humanity. I am far from having any particular dislike to the inhabitants of any quarter of the globe; but I confess the nature of my mind has led me to form those antiquarian alliances with the past ages, and to live so much in recollection of early study, that I should not enjoy a newly made country, nor like the shelter of temples and of institutions of mushroom growth. I love the fabled gardens of the Hesperides; the avenues of old Corycius, and the plants described by Pliny and Dioscorides, better than a parterre of bog mould filled with American shrubs however beautiful. You know well that my own garden is full of the botany of Clusius and of Boerhaave, and I prefer the lily, the lychnis, and the tulip, to the finest display of camelias, of dahlias, and of rhododendra—we are pleased to lay up new specimens in the Hortus Siccus from the love of novelty, but I confess it is the flowers of early poetry which please me. The rath primrose that forsaken dies, the tufted crowtoe and pale jasmine, the white pink, and the pansy freaked with jet, the glowing violet, the musk rose, and the well attired woodbine, are the flowers for me. Amaranthus shall shed around his beauty when I am pleased; and when I am in a pensive mood, let the cowslip and daffodil fill their cups with tears. After a certain time of life, the classic associations of childhood are so strong, that Flora's gorgeous wardrobe must be reflected in the magical lantern of

memory to be fully enjoyed. In the monk's hood and friar's cowl, in the snowdrop, in the Herb Trinity, and in the lily of the lowly vale, I can see a thousand historical emblems, and I would rather have my lawn covered with Our Lady's Mantle, and sheltered with Judæan palms, than boast of the richest azaleas of the country of your destiny.

In scenery and in buildings these associations are still stronger. As you are already booked for America, I hope you will study its novelties, and bring back from the Delaware a rich store of curiosities into the Medway. But for my part, Europe and her mouldering institutions are preferable. They tell us that the wishes of the child are fulfilled by the achievements of the man; and when I ramble abroad it is to enjoy those grand remains of antiquity of which the world may seem proud. The pyramids of Egypt, built when Pharoah held Israel captive, the Sphinx, and the Needle of Cleopatra, together with the monumental remains of still older times in India, may tempt me to expatiate beyond the bounds of Europe. I like to gather on the spot the plants known and recorded of old, from the cedar trees of Libanon to the hyssop that springeth out of the wall, and to be pensive under weeping willows, beneath whose shade the exiles of Jerusalem in their bondage sat down by the waters of Babylon and wept. I have an instinctive dislike to novel productions. History, the great teacher of wisdom, seems a stranger to the Occidental plane and the American oak. And when retired leisure leads me to sport with Amaryllis in the shade, or with the tangles of Neæra's hair, let it be—*Qua pinus ingens albaque populus, umbram hospitalem consociare amant ramis; et obliquo laborat lympha fugax trepidare rivo.* And when in a more serious mood, I would sit in the grotto of Academus, or in the portico of Zeno, and reflect while gazing on the trees that—*Justus ut palma florebit, sicut cedrus in Libano multiplicabitur*—the cyprus that shades the urn, the laurel worn by the conqueror, have charms. There is no West Indian perfume that should rival the musk of Thibet, or the myrrh, aloes, and cassia of the old world. If I stretch my journeys to remote climes again, it shall be for antiquity's sake, the woody Ida's inmost grove, or the spot *ubi Sarpedon*, are worth the trouble of a visit. In America you can trace the path of no con-

queror before Columbus. I love to follow in the train of old glories; and if I be destined to wander again from home, it shall be to the pillars of Hercules, or to the spot where the fabled Hydaspes washed up her gold and her gems on the walls of Nysa, and first taught Asiatic damsels how to garnish native beauty by the foreign aid of ornament: whence the diamond and the ruby, the turquoise blue and the emerald green, the amethyst, the topaz, the sapphire, the frankincense, the amber, and the ivory, were brought into general use as baubles of aristocracy for European courts. If I be to learn the spirit of commerce it shall be in the valley of Cashmere, famous for its shawls, or in the confines of the kingdom of Alexander, whence the peacocks, the monkeys, and the parrots of India were brought to Athens and to Rome; and from these I would trace the progress of trade to our times. But I confess I should have no interest in opening new sources of profit on the Susquehanna, nor in speculating how far America may be the land where the tragedy of civil revolution is to be began again—when *Alter erit tum Tiphys, et altera quæ vehat Argo. Delectos heroas: erunt etiam altera bella, Atque iterum ad Trojam magnus mittetur Achilles.* And while you are exploring the giant mountains and falls of the new continent, I will content myself with the little hill of Helicon, and the Castalian spring; or, in the absence of these, will praise the liquor of the Falernian slopes, and shall be happy, at some festive board with you, on your return, to drink the health of the Pope, and of every King, from Solomon downwards, with all your American friends, in the juice of the Rhenish vines, and make you, when tired of the Amazon, say to the purple stream from the champagne bottle—*Fies nobilium tu quoque fontium!* And this brings me to the pleasing anticipation of your hithercoming, when you shall have finished your discoveries in Florida. I can now fancy you again afloat on the ocean, encountering perhaps a few storms in your passage, helping to rig a jurymast, or stop a leak, amidst billows that wash the stars of heaven, in hopes of regaining the comforts of home. A storm at sea is an interesting phenomenon to a meteorologist. You will foreknow its approach by signs indubitable. The vane on the mast wavers to all points of the compass; Castor and Pollux play about the

rigging in small sparks of electric fire, or prance in lambent flames along the shrouds, running from the truck to the decks; and while the rolling black clouds canopy the peculiar swell of the ocean, and cast passing shadows on the bows, the helmsman often finds the vessel make an extraordinary leeway from some hidden pressure of the wind and waves; dolphins gambol on the surface, the stormy petrels flock to the wake, and at length the bolt of Jove is hurled down in lightning which strikes the masthead, and darting outward, cuts down some rash younker in the gangways, and even melts brass cannon in its passage through the portholes to the water; peals of thunder now roar all around; up then springs the gale in an instant; every hand is called forth, a horrid shout of—the foremast gone! is heard, all the lanyards are cut to pieces, and everything hauled down that can catch the wind. The philosopher does not know which way to be of service to the crew; he sees the mainstays a line of electric fluid, which forms a glory round the point of the conductor; all the mizen rigging is in rags, and if you look ahead, Fancy points to old spellbound Glaucus on the waves, or Zyphius, whom mariners eschew. At length the loud Whistler is heard, the tempest abates, and a can of grog convinces you how necessary a precursor care is to the full satisfaction produced by returning security. I can see you smoking on the forecastle to beguile the time, while the bowsprit, pointing steadily to the shores of Albion, makes you anxious to take Britannia by the hand, but fearful, from the situation in which you left her, that you may be forced to exclaim with the Mantuan bard—*En quò Discordia cives perduxit miseros! en queis consevimus agros!* But I will flatter you with better hopes. On landing, you will hasten to Gerard Street, Soho, to deposit your treasures in the Cabinet of the Linnæan; after a few words with MM. Browne, Kōnig, Maton, Anderson, and other companions of your studies, you will visit the orchards and granaries of your own soil, the tanned haycock and the bound wheatsheaf, standing as before, in the meadows and fields; the sun setting as the milkmaid sings in her pail, and the labourer his basket of fruit, for your *cibo di latte e del frutto* like the faithful shepherd: meanwhile the wattled

flocks bleat from the sides of the bourne; the kine low as they return from the pasture to the pond; some Berkshire village cock chants the night watches to his feathery dames; and at last, from the porch, covered with the flaunting woodbine, comes the old house dog, with his honest bark, to greet the wanderer home. "*Nescio quid certe est, et Hylax in limine latrat,*" says your old housekeeper to the bailiff across the blazing hearth. In a few minutes you will be snugly placed *ante focum, si frigus erit, si messis in umbra.* And when your friend Forster leaves his ivy bower to visit you, and to quaff a draught of home brewed ale, and to hear your tales of transatlantic wonder, he will surely say, to you at least, who have never been anxious "*latè conspicuum tollere verticem*"—

> Fortunate senex! ergo tua rura manebunt:
> Et tibi magna satis; quamvis lapis omnia nudus,
> Limosoque palus obducat pascua *junco.*

Meanwhile I shall have been pursuing my enquiries, and catching at those airy castles, which, though they fall, yet please us while they float in the atmosphere of our imaginations. I shall be glad to see you in my rustic sequestration at Boreham, reminding you only that English cheer must be purchased by American treasures, some rich perfume or Colonial preserves, and that if you have any view to tap my beer barrels, or desire to scuttle my wine casks—NARDO VINA MEREBERE, NARDI PARVUS ONYX ELICIET CADUM; and then once more, with the same convivial feelings as we did on the 24th of May, 1832,

ΧΡΟΤΑΦΟΙΣΙΝ ΑΜΒΟΣΑΝΤΕΣ
ΠΙΝΩΜΕΝ ΑΒΡΑ ΓΕΛΩΝΤΕΣ

Till then believe me most truly your's,

THE AUTHOR.

Boreham, Tuesday, June 5, 1832.

AVANT PROPOS.

AT a time when the progress made in almost all other sciences has been recorded in regular chronological order, Aërostation alone has had hitherto no regular Annals. I have long desired to supply this desideratum, by giving an account of the origin of this art and of the principal voyages which have been made, selecting chiefly those which were undertaken by scientific men for philosophical purposes: knowing, however, how imperfect a notion of things we get from the mere description of others, and how incapable we are of judging of the merits of the assertions of narrators without having had experience of the subject ourselves, I determined to postpone these Annals till I had some convenient opportunity of repeating the experiment myself, which did not occur till last year. Generally speaking, the observations which I have made have corresponded with those of other aëronauts, and my own experience having at least enabled me to judge of the comparative accuracy of foregoing accounts, I have put some of them together by way of affording to enquirers a means of reference to each remarkable voyage in the air which preceding philosophers have made, and at the same time I have inserted some brief notices of the most important of the excursions to the summits of mountains that have been undertaken with similar views, and have compared them with my own. After all, I confess, too little useful information has been gained, and though it is right that all such novel enterprizes should be recorded, it must be admitted that science has not benefitted so much therefrom as might fairly have been anticipated, in the beginning of our aërostatical experiments. Indeed had I not considered the observations made in the air, both on mountains and in balloons, as being a necessary appendage to other works on meteorology, I should have hardly deemed them worthy of record, but the results having been referred to in my "Researches about Atmospheric Phenomena," it seemed advisable to give the original discoveries in the sequel. For a similar reason I have joined to the last chapter some short hints on the flight of Birds, and on the Division of the Year into Six Seasons: and the engravings on wood and vignettes have been added, according to the

fashion of the present day, by way of facilitating the conceptions of the reader, and adding to the interest which every writer wishes that the public should take in his book.

With regard to the proposed plan of guiding balloons in the air, I have little to say, except that after some experience of and much enquiry into aërostation, I do not believe the thing to be possible. The learned Father Lana, who wrote, very early, on the art of flying, comes to a similar conclusion; and stated his opinion of the reason of this failure to be that, if God had permitted us to move in these machines in the air, in any direction we pleased, the science would have been the means of overthrowing all the social and civil relations of man; and indeed the powers of the steam vessel would have been nothing compared to those of the air balloon, in enabling oppressive hostility to annoy weak and defenceless states, and to establish a means of piracy and warfare greatly exceeding any belligerent engine hitherto known: the learned Jesuit therefore justly concludes as follows:—La sola difficoltà insuperabile ch' io trovo e questo, che Dio non permetterà mai ch' il uomo per l' aria si sollevi per che turbato troppo ne verebbi l'ordine civile e politico.

If I should be questioned as to what are the useful results to which aërostation has led, I should say first of all that we had been enabled to visit the electrified clouds, and to add to our knowledge both of nepheology in particular and of electricity in general; and to get a better and more familiar view of the forms which water in a state of vapour assumes in the higher regions of the air. In the second place we have been enabled by analyzing the air brought down from great heights, to show its similitude to that which envelopes us below; and to make many other discoveries, the detail of which would be tedious; besides indulging that curiosity so natural to man to see new objects, to view old ones in a new point of view, and to move in a novel manner in an element hitherto considered to be the exclusive support of birds and insects. There is something likewise in the circumstance of a good ascent calculated to fill the mind with grand and imposing ideas, and to suggest useful reflections. On first rising we seem amidst thousands of faces, to be central to the directed gaze of oceans of human countenances, forming a crowd which seems to swell like the waves of the sea: then the astonishing prospect which succeeds and by degree expands into one boundless scene of diversified objects lost in distance, between which and the balloon is a vast and vertigeniferous chasm, to traverse which, with the eyes, particularly

if we look directly down produces a peculiar sensation not describable by words; then the silent and agreeable calm which succeeds when in a region elevated above the restless currents that sweep the face of the earth, we seem to have ascended into the habitations of ethereal spirits: the very danger itself, the consciousness that a snapping of ropes, or bursting of the balloon, might precipitate us headlong to the ground, enhances the effect of the enterprize; and when we lean over the car, suspended as it were between Earth and Heaven, the mind indulges in a thousand romantic reveries; and we could almost stretch out our hand to stay the chariot of some goddess drawn by peacocks, or to catch a few of those fairy phantoms of the air which fable acting on credulity may have built up in the imagination during the season of curious childhood.

Taken as a whole, Aërostation, as well as navigation, proves the persevering industry of man in overcoming the difficulties which the elements present to his projects, and in attaining to as much knowledge as can be gained of surrounding Nature, in this our earthly pilgrimage. A mode of employing time both useful and agreeable, and which feeds the flame of life with new combustibles, while the measured grains of our span of existence are running out through the hourglass of mortality.

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CHAPTER I.

PRELIMINARY REMARKS — ORIGIN OF AEROSTATION, AERIAL AND ALPINE VOYAGES.

IT has always appeared to me that short and accurate annals of the origin and progress of any new science, independent of the facility which they afford to philosophers, as a means of reference to particular experiments, are of use, inasmuch as they enable the student to get a comprehensive view of the subject under consideration; and by demonstrating the progress which the science has made in a given time, serve to assist our conjectures as to its future advancement. In my work on Atmospheric Phenomena, I have inserted a sketch of the history of meteorology in general; in the present, my endeavours have been directed to bring together such accounts as are extant of experiments made by philosophers in the more elevated regions of the atmosphere in particular, by means of aërial voyages in balloons. In describing these, however, I have not omitted to insert, in chronological order, some brief notices of such excursions to the summits of high mountains as able men have made with scientific views, or in which they have been prompted by that spirit of enterprize which characterized the close of the last and the beginning of the present century.

As this brochure is intended merely as a supplement to my larger work on the atmosphere, an extended Preface or Introduction would be superfluous. Previous to giving an account of my own voyages into the higher regions of the atmosphere, and of the experiments and observations which I have made respecting the effect of rarified air and electricity

on the organs of hearing and other parts of the animal machine, I shall briefly record some of the principal aërial voyages which have been made since the discovery of the science of aërostation, with a view to give, to such readers as may desire to pursue this subject, a compendious view of its origin and development.

A more detailed account of the earlier experiments will be found in the works written expressly on aërostation, by M. Faujas de Saint Fond, Paris, 1785 ; and by M. Tiberius Cavallo, London, 1785 ; and some scientific observations on the more modern ascents are contained in the works of several French writers.

A desire to fly in the air is almost as old as anything in history; and it seems that aërostation, as well as navigation, were first contemplated by the ancient inhabitants of Egypt, Asia Minor, and Greece. The Phœnician mariners however succeeded better than Dædalus and his son Icarus: and although of the three artificial modes of conveyance, the chariot, the ship, and the balloon, which civilization has added to the natural motion of our pedestrian species, travelling by air is by far the most agreeable and expeditious, it has been the last that has been accomplished, and is the least likely to be brought to perfection and rendered a useful science.

Of the assertion of some of the historians, that aërostatic machines were known before the eighteenth century, I shall say nothing here, nor enter into any enquiry what might have been the nature of the artificial dragon which was seen flying over France during one of the early fêtes, of which the late antiquary M. Richard Gough had a curious picture: the subject belongs to history and not to science, and to historians I leave it. Our present aërostation began in France in 1782, and is due to the inventive genius of MM. Montgolfier and other Frenchmen, who launched several small balloons into the air that year, and excited an interest in this science which in a short time extended itself all over Europe.

M. Clarke has made the following observation :—

"While pursuing my antiquarian researches the other day, in a very rare poetical work, entitled, "The Shipwrecke of Jonas," translated from Dn. Bartas, by Sylvester, 4to. 1592, I was much struck on meeting with the following couplet :—

"Against one ship, that skips from stars to grounde—
"From wave to wave (like WINDY BALLOONES bounde.")

"In this single couplet, therefore, we appear to be presented with "confirmation, strong as proof of holy writ," that, instead of balloons being, as is generally supposed, an invention of no more than some 60 years' standing, they were known at least *two centuries* previous!

"Balloons were certainly in existence long before 1782, if not in England, at all events on the Continent. What can the most sceptical say to the following?— "Thos. Macfarlane, Esq. of Gressnal, when in Germany, on his way home with those specimens of the *Ruta Baga*, which he had the happiness to introduce to the notice of the British agriculturist, in 1797, and for which he was voted an honorary member of the Norfolk and other agricultural Societies, had the singular felicity of being introduced to the celebrated mathematician, M. Von Mendlesheim, at Stettin, on the Oder, who showed him a drawing, &c. of a balloon, in a scarce work, published by John Christopher Sturm, bearing date 1701!" It was drawn and described, says M. Macfarlane, as used by the inventor, and two others, *many years previous*, for the purpose of bringing them on shore from a ship anchored off Windaw."*

My late uncle, M. Benjamin Megot Forster, of Walthamstow, excited in me, at a very early period of my life, a strong desire to explore the phenomena of the higher regions of the atmosphere: in addition to his well known devotion to the practice of aerostation, his various and novel experiments in electricity, galvanism, magnetism, and other sciences connected therewith, at which I so frequently assisted, from my earliest childhood, gave to my mind so decided a bias towards this pursuit, that my hours of leisure in the evenings of Sundays and holidays were usually occupied by experiments with electrical kites, small air balloons, and other instruments, which tended to illustrate meteorology; which science I have since pursued on a more

* *Colchester Gazette for* 1832.

extended scale in various parts of Europe, particularly the mountainous districts of Wales, and the alpine regions of Switzerland. The peculiar affection of the auditory organs experienced by aërial travellers early excited my curiosity; and though subsequent experiments on this effect, during descents from mountains, and from the air in a balloon, have not completely developed its cause, yet they have, I trust, enabled me to describe with accuracy of detail what, as will be found, most other aëronauts have hinted at, and thus to prepare the way for an inquiry which may in time furnish a useful addition to our knowledge of physiology. After briefly noticing several voyages in chronological order, including my own, with those of my two brothers in law, I shall proceed to subjoin such remarks as subsequent reflection may have suggested.

Let me advise the reader not to be discouraged by the slow progress of aerostatic science, nor hastily deny its utility because we have not yet acquired a method of directing the courses of balloons through the air. The first boats, like the first balloons, floated, no doubt, *au gré des vents;* nor had the first man who ventured on the wavy surface of the sea, on a hollow raft of Pelian pines, much more notion of the use of the rudder, than the Frenchman who first ventured into the placid region of the atmosphere, under a bag filled with rarified air! Of what account would foreign trade have been now, if the persevering industry of the Tyrian mariners, guided only by the Cynosure or the Pleiades, had not overcome the apparent obstacles to navigation, converted floats into ships, and at length coasting the Peninsula, bending their course to the Persian Gulph and filling the ports of Idumea with the riches of India, of Arabia, and of Egypt, set an example of mercantile enterprize, and become the prototype of our more modern commercial nations? The wealth and importance of empires fluctuates as city after city breaks like a brilliant gem on the billows of time; but the ingenious efforts of one country are transferred to another; they are not lost. And the glory

which was the lot of Thebes and of Memphis, of Tyre and of Sidon, in the dawn of history, was afterwards transferred to Athens and to Rome, is now the fate of London and of Amsterdam, and may before long be transferred to America, by some unalterable decree by which commerce is doomed to move westward, like the stars which have guided her fleets through the pathless waters of the ocean.

There are some reasoners who think that the instincts of man, unlike those of other animals, require to be excited to useful activity by accidents in nature; they say the wind blowing into hollow reeds suggested flutes; and the accidental sound of metallic vessels first gave the hint for the construction of bells: this may possibly have been the case; and the rising up of inflated sacks in the wind may at an early period have suggested flying carriages. It seems, however, to me, that imagination has anticipated practice, both in aërial and aquatic navigation; nor do I recognize in the fables of the flying Pegasus, or of the Golden Fleece of Phryxus* and the fate of Helle, or in the story of Arion carried on the sea by dolphins, anything more than an effort to transmit to posterity, by means of the figures of mythology, the early *nisus in adversum*, which conceived the possibility of aërial conveyance, to escape from encompassing danger, and of unsinkable life boats, constructed for the safe reception of shipwrecked mariners.

The utility of balloons, in various points of view, claims our attention, and care and industry may diminish the danger of their frequent employment. They are useful as indicators of the upper currents of the air, which are found to descend by turns to the surface of the earth; balloons may, by this means, become of use to those who are getting under weigh, or who are about to put to sea; they may also serve to send expresses across dangerous channels in rough weather; they may be turned into signals; may be made the bearers of

* Some persons, as F. Guerrin du Rocher, thus identify the *Vellus Aureum* with the Fleece of Gideon, and pretend that the story of the Trojan war is only a version of the Song of Deborah.

signs or flags of telegraphic import; and lastly, the larger kind may carry in the air sentinels to survey the ranks of contending armies; and philosophers to make many experiments hitherto untried. But I shall proceed to a sketch of the history of aërial voyages. The reader will observe that I begin these annals with the year 1782, and bring them down to the end of last year; but as I intend hereby to notice principally such voyages as have led to discoveries in philosophy, many will of course be omitted, undertaken by aëronauts merely for the purposes of public amusement.

Sect. II.—*Of the early Attempts to Fly in the Air.*

Birds probably by their lofty excursions first excited the desire on the part of men to fly in the air;* hence the imagination always soaring aloft towards heaven, gave peacocks to the chariot of Juno, and swans and doves to Venus; while fable proceeded to ascribe winged horses to Apollo, and dragons to Medea. In later ages attempts were actually made to navigate the air, but of these the accounts are so vague, that they prove nothing but the great fondness for an art which it was reserved for the ingenious Frenchmen of the eighteenth century to accomplish. Diodorus Siculus describes the flight of Abaris round the earth; but we consider it to be as fabulous as the story of the flying oracle of Hierapolis. The earliest notice of any ingenious attempt to fly mechanically, is that of the monstrous aërostatic pigeon constructed by Archytas, in the fourth century, as related by Aulus Gellius. In the thirteenth century Roger Bacon wrote ably on mechanical flying; and in the Journal des Savans of Sept. 12, 1678, some interesting accounts will be found of attempts of this kind.

* I believe it has never been ascertained to what height the boldest flight of birds have carried them. Eagles are said to fly the highest; but I have seen the Ravens, when I have been 3000 feet high, soaring still higher above me; and once in November, above thirty years ago, I remember a flight of birds, of the migrating kind, crossing over Hackney, at an immense altitude. The flight of the albatros has, perhaps, been exaggerated. Every species of bird has some different mode of flight, as every webfooted bird has of swimming.

The monks, friars, and others of the religious orders, who have always been the foremost to contribute to the useful arts, by the exercise of great inventive genius, unalloyed by the paralyzing impulses of passions that so often debilitate the minds of other men, have contributed their share to the advancement of this science. Among the most ingenious of these was the learned Jesuit Francis Lana, who wrote some able observations on flying in his *Prodromo, di alcune invenzioni nuove premesso all'arte maestra*, Brescia, 1670. Afterwards, in 1709, a friar Bartholemeo Lorenzo applied to the King of Portugal for a patent for a machine wherein to traverse the air: and the Treatise, *De Arte Volandi*, of John Wilkins of Chester, is well known even to scholars of our own country. There are also treatises on the subject by J. Fr. d'Almeida, in Portuguese, by Borelli, in Italian, by M. Bourgeois, in French, Essai *Sur l'Art de Voler*, and several others; nor should we pass over the researches of the late M. Henry Cavendish, of Cavallo, and other philosophers of our days. But it is only necessary to notice them, to show how universal had been the desire to fly, and how general the failure of the attempt. Philosophers, up to the days of Montgolfier, had not got beyond the small balloons made of soap and blown out of pipes, commonly called soapbubbles; a plaything with which the greatest aëronauts have sometimes begun their career; one which first excited Garnerin to make balloons, and which I confess has always been so pleasant a source of amusement that, in the absence of business, I could even now play at it with all the eagerness of a child.

Sect. III.—*Of the first Balloons and of Aërial Voyages.*

Contrary to all expectation, at the close of the year 1782, the two brothers Montgolfier natives of Annonay, produced machines which turned out capable, after repeated improvements, of carrying up persons in the air. After some private experiments during the foregoing winter, the

first balloon was launched on Thursday the 5th June 1783, amidst numerous scientific spectators and the States General of Vivarais. The balloon was an immense globular bag filled with heated and so rarified air; it was 36 feet in diameter; it rose to a great height, and fell in a few minutes to the ground, amidst the astonished multitude. Soon after this, the mode of filling balloons with inflammable air was discovered; and before the close of the year small balloons of both sorts became common, and were seen flying about in all directions; a thing which spread in Europe with great rapidity, as the science was one of almost universal interest. A distinction was now made between the rarified air balloons and those filled with hydrogen gas; the former being inflated by means of fire, were called fire balloons; the latter, air balloons; a distinction which I shall observe in the ensuing accounts. Several large balloons were now made, by means of which animals and also persons were raised in the air in France, the machines being fixed with ropes. But as these experiments are not worth notice, I shall pass on to the aërial voyages, in which the balloons, carrying up passengers, were let loose into the atmosphere.

Friday, Nov. 21, 1783, M. Pilatre de Rozier, accompanied by the Marquis d' Arlandes, made the first aërial voyage, and the subsequent unhappy fate of this intrepid aëronaut will be marked by many superstitious persons as the result of a novel experiment first made on a Friday; for he was killed, as will hereafter be seen, in attempting to navigate two balloons at once suspended one below the other.* The present experiment, which was very successful, was made from the Jardin du Chateau de la Muette: the machine, which was a large fire balloon, being filled by a little before two o'clock, was let up with the voyageurs in this

* This superstition is supported by innumerable facts, which the philosopher will content himself with referring to coincidence. Many mariners have related to me accounts of ships lost or damaged by first sailing on Friday. Whether this day was equally unlucky when dedicated to Frea and to Venus, I leave it to the learned to determine.

untried element, and after reaching the altitude of above 500 feet, passing over the dome of the Invalids, crossing the river, and then bearing southward to the Boulevards, at length descended at 20 minutes past two o'clock. All Paris was abroad, every steeple crowded with spectators, and an astonishment mixed with fear was produced such as no ordinary event can occasion. The next voyage which I shall have to relate was in an air balloon. And the knowledge of these events being spread abroad in the newspapers, the interest became general, and, as will appear, almost every considerable town in Europe became in turn the place of an aerostatic experiment.

Monday, *Dec.* 1, 1783, MM. Charles and Robert ascended from Paris in an air balloon ; the first filled with hydrogen which ever carried up human beings. They ascended from the Thuilleries at three quarters past one o'clock, taking up with them as was usual, clothing, food, and ballast : on the rising of the balloon, the astonished spectators stood silent ; it moved with a gentle ascent, and maintained nearly the elevation of 2000 feet, they descended at Nesle, 27 miles distant, by three quarters past three o'clock. On M. Robert getting out, the balloon rapidly rose with M. Charles near 10000 feet, in consequence of which he felt extreme pain in his right ear and jaw, and some deafness on descending ; an affection generally felt by those who have mounted high. This rapid ascent was very dangerous, and might have been attended by the bursting of the balloon. He pulled, however, the valve, and came down within half an hour afterwards.

The observations made by the above aëronaut on the sudden affection of his ears so nearly correspond with mine, and he expressed himself in so much the same way, that I shall insert his own words :—

Le froid étoit vif & sec, mais point insupportable : j'interrogeois alors paisiblement toutes mes sensations ; je m' écoutois vivre, pour ainsi dire, & je puis assurer que dans le premier moment, je m' éprouvai rien de désagréable dans ce passage subit de dilatation & température. Je me relevai

au milieu du char, & m'abandonnai au spectacle que m'offroit l'immensité de l'horizon. A mon départ de la prairie, le soleil étoit couché pour les habitans des vallons. Bientôt il se leva pour moi seul, & vint encore une fois dorer de ses rayons le globe & le char : j'étois le seul corps éclairé dans l'horizon, & je voyois tout le reste de la nature plongé dans l'ombre. Au milieu du ravissement inexprimable, & de cette extase contemplative, je fus rappelé a moi même, par une douleur très extraordinaire, que je resentis dans l'intérieur de l'oreille droite & dans les glandes maxillaires ; je l'attribuai à la dilatation de l'air contenu dans le tissu cellulaire de l'organisme, autant qu'au froid de l'air environnant.

At Grenoble, a city of Dauphiny, the first small air balloon was launched on the 13th January, and the same day a large one, 37 feet high by 20 wide, was sent up from the Chateau of Pisançon, which fell 10 minutes afterwards, having ascended 6000 feet high. A rabbit and two Guinea pigs were sent up in a balloon on the 16th of January, from Franconville, and though the balloon rose enormously high, and travelled 18 miles, the animals were found five days afterwards, alive and well, enclosed in the basket under the balloon.

Monday, *Jan.* 19, 1784, the beautifully painted and enormous fire balloon called la Fleselle ascended at Lyons, carrying in its gallery seven persons, among whom were Pilatre de Rozier and Joseph Montgolfier, to the astonishment of thousands of spectators.* This balloon was above 100 feet in diameter, and weighed, when charged with its luggage, 1600 pounds. The machine was moved by several currents of air, but at length the seven adventurers were landed in safety.

Friday, *Feb.* 3, 1784, a small balloon, launched at Sandwich, crossed the channel, and was found three hours afterwards at Warneton, near Lisle.

Monday, *Feb.* 24, 1784, Signor Paul Andreani, of Milan, made the first aërial voyage ever performed in Italy.

* The following are the names of the seven travellers:—M. Joseph Montgolfier, M. Pilatre de Rozier, Count de Laurencin, Count de Dampierre, Prince Charles de Ligne, Count de Laporte d'Anglefort, and M. Fontaine.

The fire balloon was of singular construction, and 68 feet in diameter. Andreani ascended, accompanied by two mechanics named Gerli, and remained some time in the air.

The authenticated account of this, the first voyage performed in Italy, concludes as follows:—

Contro l'aspettazione dei circostanti, che non riguardavano questa que una prova privata, videse salire impetuosa la machina ad una surprendente altezza. L'occhio dei piu calcolò quest' altezza superiore di tre volte all' altezza della maggior guglia del nostro domo ossia di due cento tese Francesi. La machina in aria librata fu veduta fino dalla città di Milano che e distante, da detto luogo, per ben otte miglia, ma la barca, in quell'erano i viaggatori, non era piu visibile agli spectatori, che aspettando una fenomeno si nuovo e grande, perpiù non facilmente credevano a suoi occhi. Uno timore pero accompagnava la dolcezza della lor maraviglia, al videre perduto di vista il nobile cavaliere ed i suoi compagni viaggiatori.

Tuesday, *March* 2, 1784, M. Jean Pierre Blanchard, the distinguished aëronaut, who afterwards crossed the sea from England, made his first voyage at Paris, in an air balloon, 27 feet in diameter: he carried up with him wings, a gouvernail, and a sort of umbrella to break his fall in case of an accident: after floating over Paris in various directions, and crossing the river to Passy, he descended at Billancourt, near Sevres. In this voyage M. Blanchard got much above the clouds, attaining to the height of 5200 feet.

Small balloons of both kinds then became very common all over Europe, and were seen floating in the air about Paris and London both by day and by night, being almost as common as kites. This passion still continues in some places both in England and France. On Sunday, Sept. 11, 1831, I went, accompanied by my wife and a party of friends, to the fête and waterworks at Versailles, and in returning home to Paris at night, our attention was attracted by a beautiful fire balloon which was passing over that town. Indeed small balloons are very common at every fête in France.

Saturday, *March* 13, 1784, Sig. Andreani ascended again near Milan.

Sunday, *April* 25, 1784. MM. Morveau and Bertrand ascended in an air balloon at Dijon in Burgundy; they were up 25 minutes, attained the height of near 13000 feet, and travelled 18 miles.

Saturday, *May* 8, 1784, MM. Bremond and Maret ascended with a fire balloon, 50 feet diameter, at Marseilles.

Saturday, *May* 15, 1784, two persons were raised in the air in a balloon from Strasbourg, but almost immediately came down.

Sunday, *May* 23, 1784, M. Blanchard made his second voyage, in the same balloon, from Rouen, at 20 minutes past seven in the evening. The quicksilver in the barometer descended from 30·16 to 20·57 inches.

Saturday, *May* 29, 1784, MM. Maret and Bremond went up a second time, and ascended to a considerable height; the balloon caught fire in the air, and they saved themselves with difficulty.

Monday, *May* 31, 1784, M. Rambaud ascended with a fire balloon at Aix, to the height of 2450 feet. The machine soon afterwards escaped and burnt in the air.

Friday, *June* 4, 1784, M. Fleurant, and Madame Thible ascended at Lyons, with a very large fire balloon, called le Gustave, in the presence of the King of Sweden: they reached the height of 8000 feet, and travelled only two miles in 45 minutes.

Saturday, *June* 12, 1784, MM. Morveau, and Virly ascended from Dijon at seven o'clock in the morning, and went 14 miles in an hour.

Monday, *June* 14, 1784, MM. Coustard de Massy, and Monchet ascended in an air balloon, 32 feet diameter, named le Suffrein, at Nantes, at half past six in the evening.

Wednesday, *June* 16, 1784, MM. Darbolet, Desgranges, and Chalfour, ascended with a fire balloon from Bourdeaux and landed in a vineyard.

Wednesday, June 23, 1784, M. Pilatre de Rozer and M. Prout ascended with a fire balloon of 91 feet high by 79 diameter: they travelled 36 miles in three quarters of an hour.

Thursday, July 15, 1784, the two brothers Robert, the Duke of Chartres, and another person, made a voyage attended with extraordinary incidents, dangers, and scenery of unparalleled magnificence, from the park of St. Cloud, near Paris, at seven in the evening. The air balloon was of a strange construction, being oval, and with a smaller balloon enclosed within it, filled with common air. The particulars in Cavallo's Hist. Aëros. p. 145, are as follow :—

This balloon was of an oblong form, measuring 55 feet and a half in lenght, and 34 in diameter. It ascended with its greatest extension nearly horizontal; and, after remaining in the atmosphere about 45 minutes, it descended at a little distance from whence it had ascended, and at about 30 feet distance from the lake *de la Garenne*, in the Park of *Meudon*.

But the incidents that happened in this aërial excursion deserve to be particularly described, as nothing like it had happened before to any of the aërial travellers. This machine contained an interior smaller balloon, filled with common air; by which means, according to a scheme hereafter to be mentioned, the machine was to be made to ascend or descend without any loss of inflammable air or ballast. The boat was furnished with a helm and oars, intended to guide it.

On the level of the sea the barometer stood at 30·25 inches, and at the place of departure it stood at 30·12. Three minutes after its ascending, the balloon was lost in the clouds, and the aërial voyagers lost sight of the earth, being involved in a dense vapour. Here an unusual agitation of the air, somewhat like a whirlwind, in a moment turned the machine three times from the right to the left. The violent shocks, which they suffered, prevented their using any of the means prepared for the direction of the balloon, and they even tore away the silk stuff, of which the helm was made. Never, said they, a more dreadful scene presented itself to any eye, than that in which they were involved. An unbounded ocean of shapeless clouds rolled one upon another beneath, and seemed to forbid their return to the earth, which was still invisible. The agitation of

the balloon became greater every moment. They cut the cords, which held the interior balloon, which consequently fell on the bottom of the external one, just upon the aperture of the tube, which went down into the boat, and stopped it up. At this time the thermometer showed a little above 44°. A gust of wind from below drove the balloon upwards, to the extremity of the vapour, where the appearance of the sun showed them the existence of nature; but now both the heat of the sun, and the diminished density of the atmosphere, occasioned such a dilatation of the inflammable air, that the bursting of the balloon was apprehended; to avoid which, they introduced a stick through the tube that proceeded from the balloon, and endeavoured to remove from its aperture the inner balloon, which closed it; but the dilatation of the inflammable air pushed the inner balloon so violently against the aperture of the tube, that every endeavour proved ineffectual. During this time, they still continued to ascend, until the mercury in the barometer stood not higher than 24·36 inches, which shows their height above the surface of the earth to be about 5100 feet. In these dreadful circumstances, they thought it necessary to make a hole in the balloon, in order to give an exit to the inflammable air; and the Duke of Chartres took himself one of the banners, and made two holes in the balloon, which tore open between seven and eight feet. They then descended very rapidly, seeing at first no object either on earth or in the heavens; but a moment after they discovered the fields, and were descending straight into a lake, wherein they would inevitably have fallen, had they not quickly thrown overboard about 60 pounds weight of ballast, which occasioned their coming down at about 30 feet beyond the edge of the lake. Notwithstanding this rapid descent, occasioned by the great quantity of gas, which escaped out of the two rents of the balloon, not one of the four adventurers was hurt; and it is very remarkable, that out of six glass bottles full of liquor, that were simply laid down in the boat, only one was found broken.

Sunday, July 18, 1784, M. Blanchard and M. Boby ascended from Rouen, about five p.m. and in less than two hours and a half they landed near Grandcour.

During the voyage, M. Blanchard says, that by agitating the wings of his boat, he often ascended, descended, and went side way, and even, in some measure, against the wind; but one of the certificates says, that, previous to the final descent, M. Blanchard, in order to gratify the spectators, descended and reascended three times at pleasure, by means of the wings.

Monday, July 26, 1784, the same three persons again ascended at Bourdeaux, as on the 16th June.

Aërostation now spread through Europe and even to America. About this time an aëronaut in Spain had nearly been killed by the burning of his balloon, and the same thing is said to have happened near Philadelphia.

Friday, August 6, 1784, the Abbé Carnus professor of philosophy, and M. Louchet ascended in a large fire balloon 57 feet in diameter.

At 17 minutes past eight o'clock in the morning, the fire began to be lighted under the machine, and 11 minutes after it ascended. The wind being very weak, the machine did not travel farther than about 14900 yards in 46 minutes; after which time the want of fuel obliged the aëronauts to descend; they and the machine being quite safe. According to their barometrical observations, the height they reached was at least 3920 yards above the level of the town. They saw the horizon well defined, filled two bottles with the air of that high region, and observed that the thermometer descended not lower than the 66th degree, which was 34 degrees lower than what it stood at on the earth before the machine ascended. They had the curiosity to introduce a thermometer into the machine, and found that it ascended to between 167 and 179 degrees. On examining the air of one of the bottles, that had been filled above, they found that it contained a quarter less air than if it had been filled at about the level of the sea; this air, being tried by the admixture of nitrous air, was found to suffer a greater diminution, and consequently to be purer, than the air near the surface of the earth. If this superior degree of purity of the air above is constantly true, as indeed it seems probable, we may expect to see patients sent up with a balloon for a certain time every day, or week, in order to breathe a purer air in their own country, instead of being sent abroad.

Monday, Sept. 6, 1784, MM. Coustard de Massy and Dolagnes made a second voyage at Nantes.

Sect. IV.—*Of Aerostation in England and other Countries.*

Hitherto the accounts have related to experiments made in France, where this science has continued for many years to be carried on with much success, as the numerous

voyages of M. and Madame Garnerin, M. and Madame Blanchard, and others, up to the beginning of the present century, fully prove. The late Duc d' Orleans is said to have ascended, and indeed many persons of distinction went up; nor did the unlucky fate of Madame Blanchard, and some others who were killed in these experiments, by any means check the ardour of discovery, till repeated trials fully proved the inability to guide balloons in the air.

Wednesday, Sept. 15, 1784, Sig. Vincenzio Lunardi, an Italian, made the first aërial voyage ever seen in England, from the Artillery Ground at London. The excitement produced by this novel experiment was immense. I have accurate notes of it in the M.S. Journal, kept for 60 years by my late uncle, B. M. Forster, Esq. who with my father and the present Edw. Forster of Walthamstow, Esq. had got on the roof of a house in Curtain Road to see the balloon, which passed so near them that the grapple took a tile off the roof on which they were sitting. M. Lunardi ascended at two o'clock, with a cat, a dog, and a pigeon. I might insert here an excellent account of this voyage from that given by Cavallo, but I will content myself with referring to his work, page 160. Lunardi descended at South Mimms, and landed the cat, when mounting again he went as far as Ware.

What follows is a translation of the account which Lunardi himself sent to one of his friends. One cannot but lament that in this voyage, as in so many others, accidents before setting off deprived the observer of instruments. Lunardi seems to have had nothing but a thermometer :—

Sept. 15, at about five minutes after two, the last gun was fired, the cords divided, and the balloon rose, the company returning my signals of adieu with the most unfeigned acclamations and applauses. The effect was that of a miracle on the multitudes that surrounded the place; and they passed from incredulity and menace into the most extravagant expressions of approbation and joy.

At the height of 20 yards the balloon was a little depressed by the wind, which had a fine effect. It held me over the ground for a few seconds, and seemed to pause majestically before its departure.

On discharging a part of the ballast, it ascended to the height of two hundred yards. As a multitude lay before me of a hundred and fifty thousand people, who had not seen my ascent from the ground, I had recourse to every stratagem to let them know I was in the gallery, and they literally rent the air with their acclamations and applause. In these stratagems I devoted my flag, and worked with my oars, one of which was immediately broken, and fell from me. A pigeon too escaped, which, with a dog and cat, were the only companions of my excursion.

When the thermometer had fallen from 68° to 61°, I perceived a great difference in the temperature of the air. I became very cold, and found it necessary to take a few glasses of wine.

When the thermometer was at 50°, the effect of the atmosphere, and the combination of circumstances around, produced a calm delight, which is inexpressible, and which no situation on earth could give. The stillness, extent, and magnificence of the scene, rendered it highly awful. My horizon seemed a perfect circle; the terminating line several hundred miles in circumference. This I conjectured from the view of London, the extreme points of which formed an angle of only a few degrees. It was so reduced on the great scale before me, that I can find no simile to convey an idea of it. I could distinguish St. Paul's, and other churches, from the houses. I saw the streets as lines, all animated with beings, whom I knew to be men and women, but which I should otherwise have had a difficulty in describing. It was an enormous beehive, but the industry of it was suspended. Indeed, the whole scene before me filled my mind with a sublime pleasure of which I never had a conception. I had soared from the apprehensions and anxieties of the Artillery Ground, and felt as if I had left behind me all the cares and passions that molest mankind.

I had not the slightest sense of motion from the machine. I knew not whether it went swiftly or slowly; whether it ascended or descended; whether it was agitated or tranquil, but by the appearance or disappearance of objects on the earth. I moved to different parts of the gallery. I adjusted the furniture and apparatus. I uncorked my bottle, ate, drank, and wrote, just as in my study. The height had not the effect which a much less degree of it has near the earth, that of producing giddiness. The gradual diminution of objects, and the masses of light and shade, are intelligible in oblique and common prospects. But here every thing wore a new appearance, and had a new effect. The face of the country had a mild and permanent verdure, to which Italy is a stranger. The sea

glistening with the rays of the sun, the immense district beneath me spotted with cities, towns, villages, and houses, pouring out their inhabitants; you will allow me some merit at not having been exceedingly intoxicated with my situation. To prolong the enjoyment of it, and to try the effect of my only oar, I kept myself in the same parallel respecting the earth for nearly half an hour. But the exercise having fatigued and the experiment having satisfied me, I laid aside my oar, and again had recourse to my bottle. This I emptied to the health of my friends and benefactors in the lower world. All my affections were alive, in a manner not easily to be conceived; and you may be assured that the sentiment, which seemed to me most congenial to that happy situation, was gratitude and friendship. I sat down and wrote four pages of desultory observations, and pinning them to a napkin, committed them to the mild winds of the region, to be conveyed to my honoured friend and patron, Prince Caramanico.

During this business I had ascended rapidly; for, on hearing the report of a gun, fired in the Artillery Ground, I was induced to examine the thermometer, and found it had fallen to 32°. The balloon was so much inflated as to assume the form of an oblong spheroid, the shortest diameter of which was in a line with me, though I had ascended with it in the shape of an inverted cone, and wanting nearly one third of its full complement of air. Having no valve, I could only open the neck of the balloon, thinking it barely possible that the strong rarefaction might force out some of the inflammable air. The condensed vapour around its neck was frozen, though I found no inconvenience from the cold. The earth, at this point, appeared like a boundless plain, whose surface had variegated shades, but on which no object could be accurately distinguished.

I then had recourse to the utmost use of my single oar; by hard and persevering labour I brought myself within three hundred yards of the earth, and, moving horizontally, spoke through my trumpet to some country people, from whom I heard a confused noise in reply.

At half after three o'clock I descended in a corn field on the common of South Mimms, where I landed the cat. The poor animal had been sensibly affected by the cold, during the former part of the voyage. Here I might have terminated my excursion with satisfaction and honour to myself; and the people about me were very ready to assist at my disembarkation. But my affections were afloat, and in unison with the whole country, whose transport and admiration seemed boundless. I bad them, therefore, keep clear, and I would gratify them by ascending directly in their view.

My general course to this place was something more than one point to the westward of the north. A gentleman on horseback approached me, but I could not speak to him, being intent on my reascension, which I effected after moving horizontally about forty yards. As I ascended, one of the ballustrades of the gallery gave way; but the circumstance excited no apprehension of danger. I threw out the remainder of my ballast and provisions, and again resumed my pen. My ascension was so rapid, that before I had written half a page, the thermometer had fallen to 29°. The drops of water that adhered to the neck of the balloon were become like chrystals. At this point of elevation, which was the highest I attained, I finished my letter, and fastening it with a corkscrew to my handkerchief, threw it down. I likewise threw down the plates, knives, and forks, the little sand that remained, and an empty bottle, which took some time in disappearing. I now wrote the last of my dispatches from the clouds, which I fixed to a leathern belt, and sent towards the earth. It was visible to me on its passage for several minutes; but I was myself insensible of motion from the machine itself during the whole voyage. The earth appeared as before, like an extensive plain, with the same variegated surface, but the objects rather less distinguishable. The clouds to the eastward rolled beneath me, in masses immensely larger than the waves of the ocean. I therefore did not mistake them for the sea. Contrasted with the effects of the sun on the earth and water beneath, they gave a grandeur to the whole scene which no fancy can describe. I again betook myself to my oar, in order to descend; and by the hard labour of fifteen or twenty minutes, I accomplished my design, when my strength was nearly exhausted. My principal care was, to avoid a violent concussion at landing, and in this my good fortune was my friend.

At 20 minutes past four I descended in a spacious meadow in the parish of Stondon, near Ware, in Hertfordshire.

The reader will observe that one of the difficulties of landing, when any wind blows, arises from the concussion of the car on the ground, and even if that be avoided, the wind blowing the balloon, while the car remains on the ground, is liable to drag it along, as the foregoing figure of the landing of M. Lunardi shows, the axis of the machine being on such occasions inclined. The same takes place when the grapple catches a tree.

Sunday, *Sept.* 19, 1784, the longest and most varied and interesting voyage as yet undertaken was made at Paris, in a large cylindrical balloon, like a long spheroid, made to float horizontally. The three aëronauts were the two MM. Roberts, and M. Collin Hullin: after encountering storms and various dangers, getting into and above clouds, and repeatedly losing sight of the earth, they at length descended near Arras in the evening, having been seven hours in the air.

The same balloon which conducted MM. Charles and Robert, in December last, having been destined to carry a greater weight, was cut through the middle, and a cylindrical piece was added between the two hemispheres; so that the whole together formed a kind of oblong spheroid, $46\frac{1}{4}$ feet long, and $27\frac{1}{4}$ in diameter. It was made to float with its longest part parallel to the horizon. A net went over it as low as about the middle, from which limit cords came down to the edge of the boat, which was near 17 feet long. The wings or oars were shaped like an umbrella without the handle; to the top of which a stick was fastened, which stood parallel to the aperture of the umbrella. Five of those oars were disposed around the boat; and from the account of the voyage, it appears, that they were of considerable use.

The balloon was filled, at Paris, in three hours time, by M. Vallet. The two Messrs. Roberts, and M. Collin Hullin, entered into the boat, and, with the addition of 450 pounds of ballast, they were perfectly balanced. At noon they threw out 24 pounds of ballast; in consequence of which, they began to rise very gently. At that time the mercury in the barometer, on the level of the sea, stood at 29·61 inches; and the thermometer stood a little above 77 degrees. Soon after, they threw out 8 pounds of ballast, in order to avoid going against some trees; in consequence of which, they soon rose to 1400 feet. At this elevation, perceiving some

stormy clouds near the horizon, they went up and down, endeavouring to find some current of air which might carry them out of the way of the storm; but from 600 feet height, to 4200 feet, the current of air was quite uniform. Having lost one of the oars, they suppressed another on the opposite side of the boat, and by working with the remaining three, found that they accelerated their course. "We travelled," says their account, "at the rate of 24 feet per second; and the manœuvring of the oars helped us about a third." At 40 minutes past 3 o'clock, they heard a thunder clap, and, three minutes after, they heard another, much louder; at this time the thermometer, from 77 degrees came down to 59. This sudden cold, occasioned by the approach of the stormy clouds, condensed the inflammable air, and made the balloon descend very low; hence they were obliged to throw out 40 pounds of ballast. They had the curiosity to examine the degree of heat within the balloon, and, introducing a thermometer into one of the appendices, the quicksilver rose immediately to 104 degrees; whereas the external thermometer stood at about 63. The barometer stood at 23·94 inches. In this region of the atmosphere they were so becalmed, that the machine did not go even two feet a minute; and, availing themselves of that opportunity to try the power of their oars, they worked them for about 35 minutes, and, by observing the shadow of the machine on the ground, they found that they had described an elliptical track, the smallest diameter of which was about 6000 feet.

The rest of this voyage being very interesting, is best described in their own words.—"We perceived below us some clouds that ran very rapidly from south to north. We descended to the level of these clouds, in order to follow that current, the direction of which was changed since our departure. The close of daylight being near, we determined to follow that current for 40 minutes only: increasing our velocity by the use of our oars, we endeavoured to deviate from the direction of the current; but we could not obtain a deviation greater than 22 degrees towards the east. The length of our route, during about one hour and a quarter, was 2100 feet. Willing to try whether the wind nearer the earth was strong, we descended to the height of 300 feet, where we met an exceedingly rapid current. At some distance from Arras, we perceived a wood, over which we did not hesitate to pass, though there was hardly any day light upon the earth; and in 20 minutes time we came beyond Arras, to the plain of Beuvry, distant nearly three quarters of a mile from Béthune, in Artois. As we could distinguish, amongst the shadows, the body of an old mill,

upon which we were going to descend, we avoided it by the help of our oars, and descended amidst a numerous assembly of inhabitants."

Saturday, Oct. 16, 1784, M. Blanchard ascended from Little Chelsea, at nine minutes past noon, and took with him M. Sheldon professor of anatomy: the weather was cloudy and hazy; he soon after descended at Sunbury, deposited M. Sheldon, and ascending again, pursued his voyage to Romsey Marshes, in Hampshire, where he landed before two o'clock. A pigeon which he took with him was frightened during the voyage by the bursting of a bladder from rarefaction, and flew away, but like Noah's dove, finding no resting place, returned to the car. The aëronauts of this voyage had near met with an accident on first rising by striking against a wall.

Friday, Nov. 12, 1784, M. Sadler, sen. who has since made so many voyages, ascended from the Physic Garden, at Oxford.

Tuesday, Nov. 30, 1784, M. Blanchard made his fifth voyage; he was accompanied by Dr. J. Jefferies, an American Physician: they ascended from the Rhedarium, Grosvenor Square, London, and landed at Stone, in Kent.

Tuesday, Jan. 4, 1785, M. Harper ascended at Birmingham.

Friday, Jan. 7, 1785, M. Blanchard and Dr. J. Jeffries performed the extraordinary voyage across the Channel from Dover to Calais, which has been so well described by Cavallo. The balloon in which this voyage was made was afterwards hung up as a trophy in the Church of Calais, and I saw its car still preserved in the Maison de Ville, as late as last Autumn. The splendid view of the two coasts is well described by these aëronauts, and the whole voyage and its accidents, being curtailed in Cavallo's history of aërostation, is hereunder inserted:—

Being a fine clear morning, after a very frosty night, and the wind about N. N. W. but hardly perceptible, M. Blanchard, accompanied by Dr. Jeffries, departed in

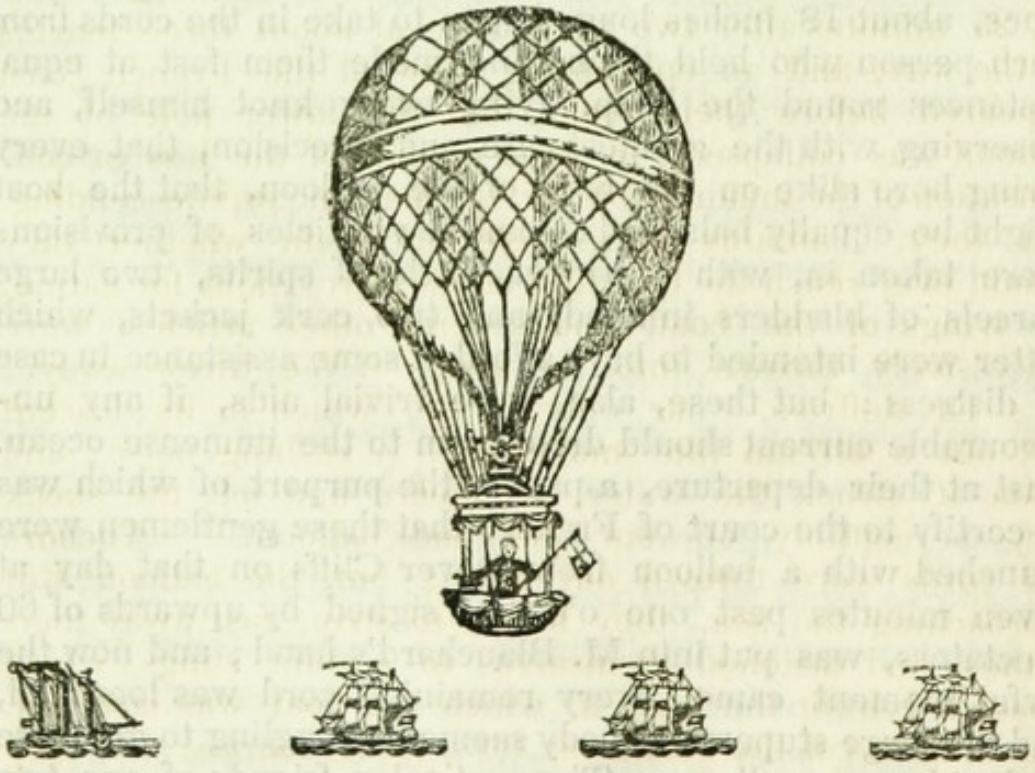
the old balloon from Dover Castle, directing their course for the French coast. The balloon was begun to be filled at about 10 o'clock; and whilst the operation was going on, two small balloons were launched, in order to explore the direction of the wind.

Soon after twelve o'clock, the balloon was sufficiently filled for the experiment; the form was a long oval, supposed to be equal to 94 feet in circumference, covered with strong net work half way over it, from whence the cords were continued, by which the passengers and their carriage were to be suspended. The gas was supplied from thirty butts, which it is supposed could have filled the balloon in much less than two hours if it had been necessary; the inflammable air was conveyed in tin pipes from each butt, which terminated in two receivers at the lower part of the balloon; the whole apparatus was exceedingly well adapted, and much credit was due to the chemist through the whole process of filling. The cords from the net work were held by ten or a dozen men, till the boat, which was seven feet and a half long, three feet and a half wide, and two feet nine inches deep, was placed in its proper situation to be suspended. Dr. Jeffries then seated himself at the head, taking with him a barometer and flag, and, pulling off his coat, put on a loose flannel jacket. The active and ingenious little Frenchman, who had on a great coat and flannel trowsers fastened to his shoes, soon followed him, and taking up the hoop which was fastened to the boat by eight or ten strong sash lines, about 18 inches long, began to take in the cords from each person who held them, and made them fast at equal distances round the hoop, tying every knot himself, and observing with the greatest care and precision, that every string bore alike on the body of the balloon, that the boat might be equally balanced; some few articles of provisions were taken in, with a pocket bottle of spirits, two large parcels of bladders inflated, and two cork jackets, which latter were intended to have afforded some assistance in case of distress; but these, alas, were trivial aids, if any unfavourable current should drive them to the immense ocean. Just at their departure, a paper, the purport of which was to certify to the court of France, that these gentlemen were launched with a balloon from Dover Cliffs on that day at seven minutes past one o'clock, signed by upwards of 60 spectators, was put into M. Blanchard's hand; and now the awful moment came, every remaining cord was loosened, and this large stupendous body seemed struggling to get loose to float in purer climes. The particular friends of our two aërial heroes on each side of the boat, kept it gently gliding on the ground till it came to the utmost edge of the

cliff. Then was realized that famous description of Shakspeare, in his tragedy of King Lear, when Gloster is about to throw himself from the cliff on the other side of the town ;

> How fearful
> And dizzy 'tis, to cast one's eyes so low!
> I'll look no more
> Lest my brain turn, and the deficient sight
> Turn me down headlong

From a precipice like this let the admiring world be told, that these two men were launched to swim in air—or meet inevitable death ; and from this precipice, to the rapturous astonishment of thousands of spectators, these bold adventurers floated safe in the atmosphere, buoyed up by a power lighter than air itself. The sight was truly sublime, the spectators were all eyes, and their hearts all feeling. The serenity and composure visible on the countenances of these two extraordinary characters, the display of two beautiful flags, the Red Ensign of England and the Royal Standard of France, the elegance of the little wherry that sustained the passengers, the expansion of the silken oars, and the stupendous magnificence of the balloon itself, with the sun beams full upon them, was a sight which leaves all description at a distance, and requires, indeed, a thousand witnesses to establish the truth of this most wonderful spectacle to the absent public.



At one o'clock the intrepid Blanchard desired the boat to be pushed off; but the weight being too great for the power of the balloon, they were obliged to throw out a

considerable quantity of ballast, in consequence of which they at last rose gently and majestically, though making very little way, with only three sacks of ballast, of ten pounds each. At a quarter after one o'clock the barometer, which on the cliff stood at 29·70, was fallen to 27·30, and the weather proved fine and warm. Dr Jeffries, in a letter to Sir Joseph Banks, P. R. S. describes with rapture the prospect which at this time was before their eyes. The country to the back of Dover, interspersed with towns and villages, of which they could count 37, made a beautiful appearance. On the other side, the breakers on the Goodwin Sands appeared formidable. They passed over several vessels, and enjoyed a view perhaps more extended and diversified than any that was ever beheld by mortal eyes. The balloon was much distended, and at 50 minutes past one o'clock it was descending, in consequence of which they were obliged to throw out one sack and a half of ballast, in order to rise again. They were now one third of the way from Dover, and had lost distinct sight of the castle. A short time after, seeing that the balloon was descending very fast, all the ballast was thrown out, but that not being sufficient to lighten the boat, a parcel of books was next thrown overboard, when they rose again, being at about midway between the English and French coasts. At a quarter past two o'clock, the rising of the mercury in the barometer showed that the balloon was again descending, which obliged them to throw away the remaining books At 25 minutes after two they were at about three fourths of the way, and an enchanting view of the French coast appeared before their eyes; but the lower pole of the balloon was collapsed, in consequence of the loss or condensation of the inflammable air, the machine was descending, and they, Tantalus like, were uncertain whether they should ever reach the beautiful land. Provisions for eating, the wings of the boat, and several other articles, were successively thrown into the sea. "We threw away," says Dr. Jeffries, "our only bottle, which in its descent cast out a stream like smoke, with a rushing noise; and when it struck the water, we heard and felt the shock very perceptibly on our car and balloon." Anchors and cords were thrown out next; but, the balloon still approaching the sea, they began to strip, cast away their clothes, and fastened themselves to certain slings, which proceeded from the hoop to which the boat was fastened, intending to cut the boat away for a last resource: but they had the satisfaction to find that they were rising; their distance from the French shore was about four miles, and they were approaching it very fast. Fear was now vanishing

apace; the French land showed itself every moment more beautiful, more extended, and more distinct; Calais, and twenty other towns and villages, were clearly distinguished. Their actual situation, with such an unusual vehicle, made them little sensible of the want of their clothes; and I doubt not but the sympathizing reader will feel an unusual sensation of admiration and joy in imagining their situation. Exactly at three o'clock they passed over the high grounds about midway between Cape Blanc and Calais, and it is remarkable that the balloon at this time rose very fast, so that it made a magnificent arch. The balloon rose higher than it had ever done in any other part of the voyage, and the wind increasing, varied a little its direction. The two adventurers now threw away their cork jackets, which they had taken for safety, and of which they were now no longer in want. At last they descended as low as the tops of the trees in the forest of Guinnes, and Dr. Jeffries, laying hold of a branch of one of the trees, stopped their progress. The valve of the balloon was opened, in consequence of which the inflammable air got out with a loud rushing noise, and some minutes after they came safely to the ground, between some trees, which were just open enough to admit them; after having accomplished an enterprise, which will perhaps be recorded to the remotest posterity.

Wednesday, Jan. 19, 1785, M. Crosbie ascended at Dublin, and rose so rapidly as to be out of sight in four minutes.

Wednesday, March 23, 1785, Count Zambeccari and Admiral Vernon ascended at London, and were safely conveyed to Horsham, in Sussex: at the height of near two miles, an accident obliging them to descend, they passed through a dense cloud and were covered with snow: the balloon revolved now so rapidly on its axis, as to perform each revolution in four seconds.*

Thursday, May 5, 1785, M. Sadler ascended with M. Windham from Moulsey Hurst, and after some dangerous gusts of wind by which they had very near been blown out to sea, they landed at the conflux of the Thames and Medway.

* Zambeccari was afterwards killed by a fall from a balloon in Italy, and I crossed from France last year with an Italian who witnessed his death. Young M. Windham Sadler met with a similar fate; and I have known, by accident, several persons who have died by the same means.

Saturday, *May* 7, 1785, M. Blanchard made another voyage from Langhorn's Repository. The wind was westerly and he went right before the gale all the way, and was safely landed after some difficulties and dangers near Hornchurch in Essex.

Thursday, *May* 12, 1785, M. Crosbie went up again at Dublin; on descending, a M. McGuire got into the car, and the balloon broke away and carried him to sea, from which he narrowly escaped.

Wednesday, *June* 1, 1785, M. Deker, a very clever and ingenious mechanic, ascended at Norwich; the balloon rose almost perpendicularly but afterwards getting a little wind, it took its course towards Yarmouth.

Friday, *June* 3, 1785, Admiral Vernon, Major Money, M. Blake, and M. Lockwood, took their departure in a balloon from Tottenham Court road about one o'clock, and about four were set down near Higham Farm, in Essex, where M. Blake jumped out. The balloon was no sooner lightened than it was again lost in the clouds; and, after having sailed about 36 miles farther, the voyagers opened the valve, and came down on a heath near Colchester. Major Money and M. Blake, in their way to London, dined with Lord Orford at High Beach, on Epping Forest, where they found M. Pilatre de Rozier and his friend already seated.

The same day M. Thornton mounted in another balloon from South Lambeth, and taking a dog with him by way of experiment, precipitated him in a *parachute*, a sort of umbrella, which descended to the earth with great velocity, and broke the poor dog's bones to pieces. M. Blanchard afterwards ascended in the same balloon and took a cat with him, which he likewise threw out in a like vehicle, which descended gradually, and lighted on a tree, where the cat was afterwards found, inclosed in a net. He himself descended near Woolwich.

Wednesday, *June* 15, 1785, M. Pilatre de Rozier the first aëronaut, and M. Romain, made their last fatal voyage from

Boulogne. The history of this voyage is very remarkable: P. de Rozier had contrived a double machine, by fixing an inflammable air balloon above a rarified one; and thus having the combustible substance and the source of combustion too close together, the whole took fire in the air, at the height of three quarters of a mile, when an explosion taking place the unfortunate aërial travellers were precipitated to the ground and killed. Their intention was to have crossed over to England. The following account of the particulars is very interesting:—

At about a quarter after seven in the morning, the 15th of June, M. Pilatre de Rozier and the Sieur Romain ascended in a balloon, intending to cross the British Channel; for the first 20 minutes they appeared to take the best possible direction; for a few seconds they seemed to vary their direction; and at length seemed for a moment stationary; but in less than ten seconds the whole apparatus was seen in flames, and the unfortunate adventurers came to the ground from the supposed height of more than a thousand yards. M. de Rozier was killed on the spot, his body burst, and his breast bone broken; the Sieur Romain survived about ten minutes; before he expired, he waved his hand, in sign of being sensible. It is not certainly known, says the writer, whether the balloon was actually set on fire by the montgolfier, or, being over rarified by the heat beneath, burst, and by that means the inflammable air was set in a blaze. It is said, that M. de Rozier had some presages of his impending fate, which made him less sanguine, though resolutely predetermined to attempt the voyage. Previous to his ascension he made his will. He left a wife and two sisters in the deepest distress. The machine in which M. de Rozier and his friend ascended, consisted of a balloon filled with inflammable air of a spherical form, 37 feet in diameter; under this balloon a montgolfier or little fire balloon was suspended, 10 feet in diameter; the gallery which held the aeronauts, was attached to the net of the upper balloon with cords, which were fastened to a hoop rather greater than the montgolfier, and descended perpendicularly to the gallery. The montgolfier was intended to promote and prolong the ascension, by rarifying the atmospheric air, and by that means gaining levity. The unfortunate adventurer was the first who explored the regions of the air, accompanied by the Marquis d'Arlandes at Paris, in the presence of the first personages in France for rank and literature; M. Montgolfier, who was

the first inventor, never having trusted himself off *terra firma*.

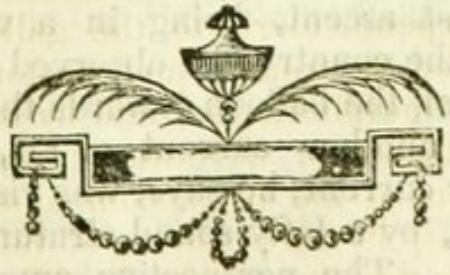
M. Pilatre de Rozier dined at Lord Orford's, on Blackheath, in company with M. Blanchard, on the King's birth day, and left London with the Marquis de la Maisonfort, who he had promised should accompany him in his expedition across the Channel; but on his arrival at Boulogne, M. Romain insisted on a prior promise of ascending with him; and thus the Marquis may thank his guardian angel that he escaped this horrid disaster.

MONUMENT ERECTED ON THE SPOT WHERE THEY FELL.

Dans ce cimetière sont inhumés François Pilatre de Rozier, & Pierre Ange Romain, qui voulant passer en Angleterre dans un Aérostate, où ils avoient réuni le procédé du feu à l'air inflammable, par un accident, dont on ignorera toujours la véritable cause, le feu avoit pris à la partie supérieure du balon; ils tomberent de la hauteur de plus de 5000 pieds, entre Wimereux & la mer. L'on a placé une inscription au pieds de l'aiguille de l'endroit de leur chûte; une seconde sur le mur extérieur de l'église. Passants, plaignez leur sort, & priez Dieu pour le repos de leurs âmes.

L'estime, la douleur,
Et l'amitié leur ont élevé
Ce monument en l'année
1786.

Ardent ami des arts & de la vérité,
Au printemps de ses jours, par un noble courage,
Le premier dans les airs il s'ouvrit un passage,
Et perit au chemin de l'immortalité.
Le matin dans les airs comblé de la gloire,
Le soir ne reste d'eux que la mémoire;
Montrant de l'homme au même instant
Et la grandeur & le néant.



Tuesday, July 19, 1785, M. Crosbie again ascended at Dublin.

Friday, July 22, 1785, Major Money went up at Norwich, and dropped into the water, and was picked up by a cutter.

Wednesday, Aug. 31, 1785, M. Arnold and his son attempted a voyage in a fire balloon from St. George's Fields: the machine, however, after rising and going a short distance, came down and threw M. Arnold out; his son then rose again alone, but the balloon taking fire in the air, he was soon precipitated with its remnants into the river. My late uncle Benjamin, my father, M. Eldridge, and M. H. Williams of West Ham were witnesses of this unfortunate affair.

In August of this year, M. Blanchard made a very long voyage from Lisle, accompanied by the Chevalier de L'Epinard. They travelled in the air 300 miles.

Sept. 8, 1785, at forty minutes past one p.m. M. Baldwin ascended from Chester in M. Lunardi's balloon. After traversing in a variety of different directions, he first alighted, at 28 minutes after three, about 12 miles from Chester, in the neighbourhood of Frodsham; then reascending and pursuing his excursion, he finally landed at Rixton Moss, five miles N.N.E. of Wavington, and 25 miles from Chester. The following are some of M. Baldwin's most important observations:—

The sensation of ascending he compared to that of a strong pressure from the bottom of the car upwards against the soles of his feet. At the distance of what appeared to him seven miles from the earth, though by the barometer scarcely a mile and a half, he had a grand and most enchanting view of the city of Chester and its adjacent places below. The river Dee appeared of a red colour; the city very diminutive; and the town entirely blue. The whole appeared a perfect plain, the highest building having no apparent height, but reduced all to the same level, and the whole terrestrial prospect appeared like a coloured map. Just after his first ascent, being in a well watered and maritime part of the country, he observed a remarkable and regular tendency of the balloon towards the sea; but shortly after rising into another current of air, he escaped the danger: the upper current, he says, was visible to him at the time of his ascent, by a lofty sound stratum of clouds flying in a safe direction. The perspective appearance of things

to him was very remarkable. The lowest bed of vapour that first appeared as cloud was pure white, in detached fleeces, increasing as they rose: they presently coalesced and formed, as he expresses it, a sea of cotton, tufting here and there by the action of the air in the undisturbed part of the clouds, so that the whole became an extended white floor of cloud, the upper surface being smooth and even. Above this white floor he observed, at great and unequal distances, a vast assemblage of thunder clouds, each parcel consisting of whole acres in the densest form: he compares their form and appearance to the smoke of pieces of ordnance, which had consolidated as it were into masses of snow, and penetrated through the upper surface or white floor of common clouds, there remaining visible and at rest. Some clouds had motions in slow and various directions, forming an appearance truly stupendous and majestic. He endeavours to convey some idea of the scene by a figure. M. Baldwin also gives a curious description of his tracing the shadow of the balloon over tops of volumes of clouds. At first it was small, in size and shape like an egg; but soon increased to the magnitude of the sun's disc, still growing larger, and attended with a most captivating appearance of an iris encircling the whole shadow at some distance round it, the colours of which were remarkably brilliant. The regions did not feel colder, but rather warmer than below. The sun was hottest to him when the balloon was stationary. The discharge of a cannon, when the balloon was at a considerable height, was distinctly heard by the aëronaut; and a discharge from the same piece, when at the height of 30 yards, so disturbed him as to oblige him for safety to lay hold firmly of the cords of the balloon. At a considerable height he poured down a pint bottle full of water; and as the air did not oppose a resistance sufficient to break the stream into small drops, it mostly fell down in large drops. In the course of the balloon's track it was found much affected by the water, a circumstance observed in former aërial voyages. At one time the direction of the balloon kept continually over the water, going directly towards the sea, so much as to endanger the aëronaut. The mouth of the balloon was then opened, and he in two minutes descended into an under current blowing from the sea; he kept descending, and landed at Belleair farm in Rinsley, 12 miles from Chester.

Balloons now got common, and M. Blanchard and M. Garnerin on the Continent, and M. Sadler and his sons in England, not to mention numerous others, have been up so often, that to record them all would be tedious.

I shall conclude the annals of the year 1785 with the following extract from the *Gentleman's Magazine* for that year :—

There is something in M. Sadler's account of his journey on the 19th of May, from Manchester to Pontefract, that is worthy of remark. When at the highest, which he thought was more than two miles, and far above the clouds, he felt himself much affected by a short respiration, a severe pain in his ears, and extreme cold. The balloon strained much ; he feared it would burst, and he was much terrified when he found he could not open the valve, as it was frozen stiff. He saw nothing of the earth for three quarters of an hour, and the clouds appeared to him as if rolling on the surface of it. While he was in this situation, a kind of transparent sleet hung round him, which, from the reflection of the sun, made a most beautiful appearance. The shadow of the balloon also appeared upon the clouds, and seemed passing on a different direction ; and, after sailing upwards of fifty miles, he landed near Pontefract, at a place where no person being near to assist, except a man on horseback, who, being terrified at his appearance, rode off full gallop ; he was dragged over hedge and ditch, till being no longer able to keep his hold, he dropped down, much lacerated, and his balloon took a second flight, and was not recovered till after he had reached Manchester again in a chaise.

Among other aëronauts the Persian physician ought not to pass unnoticed, who, at Constantinople, without any subscription, constructed a balloon, and in the presence of the Grand Seignior, accompanied with all his sultanas, richly dressed, ascended with two gentlemen belonging to the court, from the grand terrace, which was elegantly decorated on the occasion. Previous to their ascension they approached the sultan, who presented each with a magnificent pellice, with which they immediately entered their car, and ascended to the astonishment of the spectators ; but much more so to the inhabitants at thirty leagues distance, who were witnesses to their descent ; all of whom were struck with inexpressible horror, under the apprehension of the coming of their prophet to chastise them for the enormity of their crimes, and fell everywhere prostrate before them, so that they could scarce prevail upon any of them to rise to give them assistance. At length two of the most courageous were sent to the Pacha of the place, who enabled them to secure the balloon, and furnished them with the means of returning to court, where they were received with uncommon marks of honour by the Grand Seignior. His sublime highness ordered the balloon to be hung up in the mosque

of St. Sophia, to perpetuate the memory of so wonderful an event.

The Empress of Russia, on the contrary, had prohibited their being essayed in her dominions.

The aërial voyage of an army surgeon in the Spanish service deserves notice. About the middle of July last, he took his departure from Arangues, and when he had ascended to the height of 700 fathoms, the balloon, to which he was attached, took fire, which obliged him to cut the canvas, and he came down with astonishing velocity, and by falling on the bough of a tree, broke both his legs, and was otherwise much bruised, scorched, and wounded. The prince of Asturias, in compassion to his sufferings, has settled a pension of 8000 rials on him for life.

M. Lunardi's voyage from Herriot's Gardens near Edinburgh, on the 20th of December, was rather an act of obstinacy and desperation than of prudence and true courage. He had promised the people, that on that day he would ascend; and he did ascend, though, by the course of the wind, he was almost certain of being dropt in the sea. As he expected, so it happened. He fell in the water about a mile and a half from the rocks of Findra and Lamb; and was scudding through the Ocean like a Nautilus, when he was providentially taken up by a fishing boat, and brought safe to shore, with the loss however of his balloon, which was afterwards taken up by the Royal Charlotte cutter, and returned to him. In a letter to some of his friends, dated in the evening, he writes:

"Gentlemen, I have the honour to acquaint you, that I have had an hour of the most agreeable aërial voyage, and an hour and a quarter of the most disagreeable sea voyage. I was picked up by a fishing boat while I was going full sail towards the Island of May, and am now very well at M. Nesbet's," &c.

Sect. V.—*Aërial and Alpine Voyages subsequently to the Year* 1785.

The desire to explore the lofty regions of the air, which ballooning had excited, began now to prompt philosophers to pursue meteorology on the tops of mountains, where in addition to the splendid scenery from their summits, which almost equalled the view from balloons, the magnificent country through which they passed in order to reach them, and the observations to be made en passant, became an additional inducement to undertake Alpine voyages. Having

myself had experience of both, I can safely affirm that the journeys up mountains afford opportunities of making more varied observations than voyages in balloons, although the latter are effected with less fatigue.

Wednesday, August 1, 1787, the professor Saussure, his domestique and 18 guides set off for the top of Mont Blanc, which they reached on the 3rd, descending again with safety on the 4th.

Monday, August 7, 1786, MM. Jacques Balmat and Paccard ascended from the vale of Chamouni in Savoy, and on the next day reached the vertex of Mont Blanc for the first time that any human being had been there, enjoying a view of Alpine scenery of great magnificence.

Wednesday, August 8, 1787, my father in law Col. Beaufoy, and his attendant and 10 guides ascended, and reached the summit of Mont Blanc on the 9th, they came down safely on the 10th delighted with an excursion of such curiosity and beauty. Col. Beaufoy mentioned to me some remarkble sensations of distortion of features when on the top, and of deafness on descending. The particulars of this interesting voyage will be found in the Annals of Philosophy, vol. ix for 1817, and in the scientific works of Col. Beaufoy.

In the summer of 1788 the summit of the same mountain was reached by M. Bouritt, his son and some guides.

Monday, June 28, 1802, M. Garnerin and Captain Sowden ascended from Chelsea Gardens, and came down near Colchester in less than an hour. No unpleasant sensation, except the slight affection of the ears, before alluded to, was felt. The balloon was seen at a prodigious height passing over Chelmsford, Boreham and the adjacent villages. I subjoin the following authenticated particulars:—

About five o'clock M. Garnerin, the celebrated aëronaut, accompanied by Captain Sowden, of the navy, ascended in his balloon, which, for neatness of construction, as well as for the admirable philosophic principles by which it is distinguished, far surpasses any thing of the kind ever before witnessed in this country. Its ascent was, in the first instance, very gradual, in order that all possible gratification might be afforded to the crowd of fashionable

and admirable spectators who attended on the occasion; and the interest which the scene excited in every mind, seemed great beyond all power of description. Having evinced his unrivalled skill in the management of his stupendous vehicle, by manœuvring for a few minutes immediately over the gardens, M. Garnerin took his leave of the company, and saluting them with a flag which he held in his hand, proceeded upon his aërial voyage, in a north eastern direction over the town, at so moderate a height as to be distinctly observed in every part of the metropolis. The atmosphere being exceedingly clouded and heavy, he was under the necessity of parting with the greatest part of his ballast to enable him to ascend to the desired height. This, however, in a very short time he effected; but the numerous clouds, which from the unfavourable state of the weather he had to encounter, in the course of 15 minutes entirely obscured him from their view; nor did he from that time present himself again to the sight of the multitude, who, with the utmost interest, continued for a considerable time to gaze for him amidst the ponderous clouds. The balloon was about 30 feet in diameter, and about 35 in height; the car, about six feet by four, and about two feet and a half in depth, with a seat at each end, and a space between the ballast, hung from the extremity of the netting with which the balloon was covered, at a distance of nearly eight feet, suspended by no more than four cords; so that, when the number of accidents that every day are heard of, by falling overboard ships, encompassed as they are with rigging, and familiarised as men are with them, were considered, the most lively anxiety prevailed for the safety of the daring adventurers who were to ascend. The figure and proportions of the balloon were grand and beautiful; its colours alternate sections of dark green and yellow, diversified by the netting. The vessels in which were contained the materials from which the gas was generated, the tubes by which it was conveyed to the balloon, the most minute part of the instruments, and the process, were examined with the most particular attention that wonder and curiosity could excite. Garnerin is of the middle size, with an expressive countenance and quick eyes, extremely active and alert, and particularly so in the moment of ascending. At their first ascent Capt. Sowden was seated; but M. Garnerin, for what reason we know not, desired him to rise, or the consequences might be fatal to him. Near the gardens every window, every house top, every tree, was filled; Chelsea gardens were crowded; the river was covered with boats; while the banks on both side, and every avenue from towards Ranelagh, were so thronged, it was difficult to find a passage through

them. The great road from Buckingham gate was absolutely impassable; or at least the carriages, which formed an unbroken chain from the turnpike to Ranelagh door, could only advance so slowly that many persons preferred getting out on the way, and struggling through the crowd at any risque. It is in fact impossible to form an idea of the numbers who went out to view this sublime and novel sight. Those who were unable, or unwilling to go to the spot, were extremely fortunate in seeing it pass over the town so slow as to be perfectly seen; M. Garnerin and Captain Sowden saluting as they passed along, and seeming to contrive, by the management of their ballast, &c. to remain purposely at that elevation, from which the whole city would be likely to have the best view.

From Ranelagh, the balloon took its direction towards Westminster, passing over Duke Street, whence it kept its line, between the river, and the Strand, Fleet Street, Ludgate Hill, and St. Paul's Church Yard. No balloon that ever before went up took a course so directly over London, from West to East, as M. Garnerin's did. He passed over Westminster Abbey and St. Paul's, and could be distinctly seen above every street. Every house and shop was totally deserted; every soul flocked into the street as if there had been an earthquake. He could be distinctly seen waving the flags, and at one time he came very low; upon which he threw out ballast, ascended, and was lost behind a cloud. Soon after this a smart shower fell, and we suppose he had not the most comfortable voyage. The weather was very hazy; had it been clear, the sight, passing so directly over London, and so low, would have been one of the most beautiful ever seen. The sight produced a great sensation in town; great astonishment and anxiety. Every inhabitant saw it; and never had any spectacle so many spectators.

Next morning the following letter was received from M. Garnerin, dated Colchester, June 29, one o'clock in the morning.

"I take the earliest opportunity of informing you, that after a very pleasant journey, but the most dangerous descent I ever made, on account of the boisterous weather, and the vicinity of the sea, we alighted at a distance of four miles from this place, and 60 from Ranelagh. We were only three quarters of an hour on the way. To night I intend to be in London with the balloon, which is torn to pieces. We ourselves are all over bruises."

Colchester is 51 miles from London, in the east north east direction; so that the velocity cannot be estimated at less than 70 miles in the hour.

The appearance of the balloon excited astonishment among the country people, and in Colchester. That town was in an uproar all Monday night and till Tuesday afternoon; and the two travellers were much delighted with their reception.

Monday, *July* 5, 1802, I saw M. Garnerin ascend again in a long balloon, from Marylebone: he descended at Chingford. The voyage was performed during rain, which, I remember, much impeded the view of the spectators. B. M. Forster, my father, and other scientific men were present. A long account of it is to be found in the Event Book, MS. 4to, 1802, where there is the following marginal drawing, showing the shape of the balloon:—

The following is from the proces verbal of this experiment:—

From the extreme density of the clouds the balloon was out of sight in three minutes after the cords were cut, and gazing on the wide expanse, they left one of the most immense multitudes ever assembled in the metropolis. Notwithstanding the violence of the wind, they rose to the height of 7,800 feet, about a mile and a half, and descended at ten minutes after five, without the least injury, at Chingford, near Epping Forest, having traversed a space of 17 miles in nearly 15 minutes. Such interest had this famous aëronaut excited, that for several hours before the ascent all the Metropolis was in an uproar; the accidents that occurred and depredations committed in the crowd would fill many pages. This was the 27th aërostatic voyage M. Garnerin had made in Europe.

Tuesday, August 3, 1802, M. and Madame Garnerin and M. Glassfurd all three ascended from Vauxhall, in a long air balloon in which M. Garnerin had gone up before. I remember seeing them from London Fields at Hackney; they rose to the height of rather less than 6000 feet, and descended at Hampstead. They appear to have let down a cat in a parachute in perfect safety. The same evening I saw what I believed to be their pilot balloon passing over Hackney from W. to E. at an immense elevation.

Tuesday, August 10, 1802, MM. Forneret d'Ortern and guides set out on an excursion to the top of Mont Blanc, and after some magnificent views of the Mer de Glace and other Alpine scenery, they next day reached the summit, from which Italy, Switzerland, Savoy, Tyrol, and France, may be discerned.

Friday, August 13, 1802, one M. Barret at Greenwich having made a balloon with which he intended to mount, found it would not take him, and let it off alone with a cradle instead of a car; it rose high and fell in the neighbouring marshes.

Tuesday, Sept. 7, 1802, M. Garnerin and M. Glassfurd made a very grand ascent from Bath, at half after five, over which city they hovered for some time. They then steered S.E. and landed at half past seven at Mell's Park, 16 miles distance.

Tuesday, Sept. 21, 1802, M. Garnerin ascended from the Park, London, and came down in his parachute. This novel mode of descent made him sick and faintish, but in no other way injured him: the rapid whirling and oscillation of the parachute in falling is sufficient to account for his faintness. I witnessed this whole affair; and after the parachute was detached, the balloon which was of an oval form seemed to float on its side and ascending to a prodigious height, went over towards Kent, where it fell. The following is an extract from authentic minutes of the voyage:—

About half past five, a small pilot balloon was launched,

to ascertain the current of air, which proved to be very light from the southward and westward, with a clear horizon. The parachute consisted of a case or bag of white canvas, or sail cloth, formed by 32 gores into a hemispherical form, 23 feet diameter, at the top of which was a truck, or round piece of wood, 10 inches in diameter, with a hole in its centre, fastened to the canvas by 32 short pieces of tape. At about four and a half feet from the top of the canvas, a wooden hoop about eight feet in diameter was put on and tied by a string from each seam; so that, when the balloon ascended, the parachute hung like a curtain from this hoop, between the balloon and a cylindrical basket, covered with canvas, about four feet high, and two feet and a quarter diameter, in which M. Garnerin ascended. He exerted himself much in attaching the apparatus of his parachute and the net of the balloon. At about five minutes before six he entered his machine; and, amidst the plaudits of an immense multitude, the balloon ascended in a majestic manner, Garnerin waving the tricoloured flag. Every eye was fixed, in expectation of the parachute being separated from the balloon; which in 10 minutes attained an immense height, when M. Garnerin cut the rope. The rapidity of the descent for the first 30 seconds was astonishing. The machine was at that time completely expanded, and for about a minute came down steadily; it then began to swing violently, like the pendulum of a clock, which increased to such a degree, that the basket appeared frequently on a line with the parachute, while the cotton seemed fallen in on the other side. The descent occupied rather more than 10 minutes. The parachute alighted in a field at the back of St. Pancras church yard, about 100 yards east of the road; where near 5000 people and 50 horsemen soon collected. M. Garnerin, on horseback, preceded by several gentlemen, was then conducted home in safety; though not without much inconvenience from the pressure of the mob.—The balloon descended in safety the next day at M. Harding's, near Farnham Mill, Surrey.

Sunday, November 14, 1802, Citizen Oliviers, says a French letter, ascended in a fire balloon from Orleans: the machine was soon lost in the clouds, and the adventurer found soon afterwards dashed to pieces about three miles from the town, so that it probably took fire in the air.

Friday, July 1, 1803, M. and Madame Garnerin ascended from St. Petersburg.

In the middle of July, of the same year, M. Robert-

son, accompanied by M. Lhoest, went up in a balloon from Hamburg, and having attained a great height, he could scarcely endure the cold; his teeth chattered, his head became swelled, and blood came from his nose. M. Lhoest, his companion, was violently affected, but in a different way; it was simply such a swelling of the head that he could not bear his hat on. They both had singing of the ears all the way down, but the other sensations of pain disappeared on getting towards the earth. At their greatest elevation they could scarcely hear each other speak. A bird, taken up with them, was killed by the extreme rarefaction of the air.

By some further particulars which M. Robertson has since published at Hamburg, it appears that he rose to the height of 2600 toises. When the balloon rose, says he, the thermometer was at 28 inches. At eleven o'clock the machine, which had not been entirely filled, became so dilated that the inflammable air issued with noise from the lower tube. As this aperture was not sufficient, I was obliged to open the upper valve. It remained open nearly a quarter of an hour, during which time the balloon ascended in a perpendicular direction: at intervals we threw out some ballast. The atmosphere below us was serene, but above us it was somewhat cloudy. Though we approached the sun, the heat decreased as we ascended, and we could look at that luminary without being dazzled. When the barometer was at 14 inches it appeared to become stationary. The thermometer was below zero. The cold was not excessive; but the singing in my ears increased, and all our faculties seemed to be palsied by a general indisposition. Having taken a little wine to recruit my strength, I began some experiments, but they were not satisfactory. I proposed to my companion to ascend higher: he consented, though as much indisposed as myself. We successively threw out ballast. The mercury in the barometer fell to 12·40 inches. At that height the cold out of the car was insupportable, though the thermometer was only one degree below the freezing point. We were obliged to respire faster, and our pulse beat with extreme rapidity. We could scarcely resist the strong inclination to sleep with which we were seized. The blood rushed to our heads, and M. Lhoest remarked that it had entered my eyes. My head was so swelled that I could not put on my hat. In

this region, where the balloon was invisible from the earth, M. Robertson made the following experiments :—

1st. Having let a drop of ether fall on a piece of glass, it evaporated in four seconds.

2nd. He electrified by friction glass and sealing wax. These substances gave no signs of electricity which could be communicated to other bodies. The Voltaic pile, which when the balloon was set free from the earth acted with its full force, gave only a tenth part of its electricity.

3rd. The dipping needle seemed to have lost its magnetic virtue, and could not be brought to that direction which it had at the surface of the earth.

4th. He struck with a hammer oxygenated muriate of potash. The explosion occasioned a sharp noise, which, though not very strong, was insufferable to the ear. It is also to be observed, that though the aëronauts spoke very loud they could with great difficulty hear each other.

5th. At that height M. Robertson was not able to extract any electricity from the atmospheric electrometer and condenser.

6th. In consequence of a suggestion from professor Helmbstadt of Berlin, M. Robertson carried with him two birds: the rarefaction of the air killed one of them; the other was not able to fly, it lay extended on its back, but fluttered with its wings.

7th. Water began to boil by means of a moderate degree of heat maintained with quicklime.

8th. According to observations made, it appeared that the clouds never rose above 2000 toises, and it was only in ascending and descending through clouds that M. Robertson was able to obtain positive electricity.

Friday, *August* 12, 1803, M. Robertson made his second aërial voyage from Hamburg, of which he gives the following account :—

At a quarter past twelve he stepped into the car, with his friend M. Lhoest, carrying with him barometers, thermometers, a speaking trumpet, &c. At 35 minutes after twelve, the balloon being at the height of 600 toises, M. Robertson launched a parachute, which fell very slowly. At three quarters after twelve the balloon was at the height of about 1200 toises. During this ascent M. Robertson made several new experiments, which had been suggested to him by some of our philosophical men.

Another account observes—

It was 42 minutes past twelve when M. Robertson detached his balloon from the earth when he made his last

ascent. The barometer being at 21 inches 12 lines, and the thermometer at 21 degrees, he launched two parachutes of different sizes, and loaded with equal weights, in order to calculate the resistance of the air. The second, which was launched a hundred toises higher than the first, fell with much greater velocity, but did not unfold itself till it had passed over a double space. At 51 minutes after twelve he passed between two large clouds, which seemed to open to afford a passage to the balloon. The form of these masses of vapour is oblong. They resemble rags suspended above the earth. Their upper parts do not form in their aggregate a smooth surface, as appears to those who look at them from the earth; on the contrary, they resemble long pyramids. This effect ought to be ascribed to caloric, which, if we may use the expression, converts these masses into montgolfiers, the elevation of which is proportioned to the density of the atmosphere. They appeared to M. Robertson to plunge towards the earth, in consequence of an optic effect resulting from the apparent immobility of the balloon, which, however, was rising at the rate of 50 feet per second. When the thermometer indicated one degree above freezing, and the barometer stood at 15 inches,M. Robertson set at liberty two pigeons, which descended with the rapidity of lightning, without moving their wings, and in a plane slightly inclined. When the barometer stood at 14 inches he let off a third pigeon, which, having fluttered about for a moment with difficulty, perched on the net work, and would not quit it. Two butterflies let go at the same time tried to use their wings, but in vain, as the air was too rare: they never quitted the car, and fluttered, but in a very feeble manner. Tinder exposed to a convex glass of six inches focus did not catch fire till the end of some minutes. The rays refracted by the prism no longer exhibited lively and distinct, but weak and confused, colours. Weights attached to a spring balance had lost one half of their gravity. The magnetic needle began again to put itself in motion. By means of a very ingenious instrument invented by M. Hez, mechanician, he inclosed four inches of the surrounding air along with mercury, and marked exactly the point where the air and the mercury were united. When he reached the earth, he found that the latter filled the whole tube within a tenth. This important experiment seems to prove, that in the upper regions there exists nothing but vapours, and no atmospheric air. If this conjecture of M. Robertson be verified, there will be no reason why people may not ascend to a much greater height than that of 3670 toises, to which we know some have ascended: but for this purpose a balloon of 40

or 50 feet in diameter would be necessary; otherwise the loss of gas experienced by the balloon might make it descend with a velocity which would endanger the lives of the aëronauts. M. Robertson experienced this during his ascént before the last, when he was in danger of being killed.

About Midsummer, 1804, Professor Robertson ascended from St. Petersburg. The following is a translation of the Russian account, drawn up by his companion the Academician Sacharof :—

The principal object of this voyage was to ascertain exactly the physical state of the atmosphere, and the component parts of it, at different determinate heights. The academy had entertained an opinion, that the experiments made by De Luc, Saussure, Humboldt and others, on mountains, must give other results than those made in the open air ; that this difference might arise from the attraction of the earth and the decomposition of organized bodies ; and that by these means the law which accurately determines the height of the atmosphere might perhaps be found. The academy afterwards requested the academician Lowitz, who undertook to make the proposed experiments in the atmosphere, to confer on this subject with professor Robertson. M. Robertson declared he would consider it as a particular honour to be of any service to the academy in this respect ; that he would with pleasure accompany this philosopher ; and that the balloon he had constructed at Petersburgh was at the service of the academy for that purpose: he only requested that the academy would defray the expense which would arise from filling the balloon with hydrogen gas. The academy thanked M. Robertson for the zeal he had manifested, and set apart a certain sum for carrying this aërial voyage into effect. While preparations were making for this excursion, and while the aëronauts were waiting for a favourable wind, M. Lowitz fell sick, and the president, Nicolai Nikolayevitsch Novossilzof, proposed to me to supply his place. As this proposal showed that particular confidence was placed in me, I embraced it with pleasure ; and, after the accomplishment of the excursion, I now have the honour of laying before the academy the following account of the experiments and observations I made.

The experiments proposed by the academy, which were to be made at the greatest distance from the earth, have been already described by several aëronauts, but have been either doubted or entirely rejected: as for example, the faster or slower evaporation of fluids; the decrease or in-

crease of the magnetic force; the inclination of the magnetic needle; the increase of the power in the solar rays to excite heat; the greater faintness of the colours produced by the prism; the existence or non existence of the electric matter; some observations on the influence and changes which the rarefaction of the air occasions in the human body; the flying of birds; the filling with air, flasks exhausted by Torricelli's method, at each fall of an inch in the barometer; and some other chemical and philosophical experiments.

The instruments I carried with me for these experiments were:—1st. Twelve flasks in a box with a lid; 2nd. A barometer and thermometer; 3rd. A thermometer; 4th. Two electrometers, with sealing wax and sulphur; 5th. A compass and magnetic needle; 6th. A watch that beat seconds; 7th. A bell; 8th. A speaking trumpet; 9th. A prism of crystal; 10th. Unslaked lime, and some other things for chemical and philosophical experiments.

But as no means have hitherto been found of ascertaining with certainty over what part of the earth a balloon is hovering, and to what quarter it is driven by the wind, especially when there are clouds below it, by which means terrestrial objects cannot be seen, and where the aëronaut in his car (where he is not sensible of the motion of the balloon) cannot discover the direction of it for want of fixed objects of comparison, I employed the two following methods to ascertain to which side it was impelled by the wind:—

1st. I fixed perpendicularly, in an aperture made in the bottom of the car, an achromatic telescope, which showed me very distinctly those terrestrial objects over which the balloon happened to be, and to which side it directed its course. 2nd. I laid together, crosswise, two sheets of black paper; that is to say, I bound together two surfaces at right angles, fastened them with thread, and suspended it from the car with a piece of packthread. This light body showed me, as will be hereafter mentioned, better than I could have believed, all the variations in the direction of the balloon; on which account I shall call it the *waywiser*.

The balloon was filled with hydrogen gas in the Garden of the first corps of Cadets, whence it ascended in the presence of a great many persons of distinction, the members of the Academy of Sciences, and various men of science. The decomposition of the water was effected by sulphuric acid and iron filings, mostly from cast iron. The chemical apparatus consisted of twenty five vessels, from each of which a tin plate tube was conveyed to a tub. For separating the carbonic acid gas, unslaked lime was thrown into water. Into each vessel were put three pood of iron filings with fifteen pood of water, and three pood of sulphuric acid

were poured over them. The balloon began to be filled at eleven in the morning; and, though the operation was completed at four in the afternoon, the experiments to serve as a point of comparison with those made in the higher regions of the atmosphere retarded our voyage till a late period. The balloon contained 9000 cubic feet of hydrogen gas.

	Pood*	Pounds
It weighed, with its whole apparatus.	5	2
M. Robertson and myself	8	10
The instruments and other apparatus for experiments.	1	1
Clothing.	0	18½
Bottles with water and provisions.	0	21½
Ballast taken in.	2	30
Total of the weight.	18	3

The balloon, which in order to try its strength was first filled with common air, was thirty English feet in diameter, and perfectly round; but in the air, as it was not entirely filled with hydrogen gas, but sufficiently so for the voyage, it appeared to be elongated.

The wind was north east, and favourable for our purpose; but, that I might ascertain the direction of it more accurately, we let off a small balloon before our departure at about seven o'clock. At first it was driven by the north east wind towards the land side; but when it rose to a greater height it appeared to change its direction, and proceed straight towards the sea. Nevertheless we did not suspend our aërial voyage; but, having put into the car every necessary, placed ourselves in it. But as one of the most important experiments in my opinion was to collect air in the exhausted flasks which I took with me, at different heights, at each fall of an inch in the barometer, which rendered a gradual and slow ascent of the balloon necessary, we added so much ballast to that already taken in, after we had seated ourselves in the car, that the balloon was not able to raise us up. About fifteen minutes after seven, when the barometer stood at 30 inches English, and the thermometer indicated 19 degrees of Reaumur, we threw out a handful of the ballast, which consisted of sand. The balloon immediately began very slowly to rise, but sunk down again over the Neva after it had attained to a considerable height. The reason of this, in all probability, was, that the balloon had been surrounded by a very warm atmosphere at the earth, by which means the gas in it occupied more space, and was the cause of its greater lightness; but at a height

* A pood is about forty pounds.

where the air, particularly over the Neva, was colder, where the matter of heat was absorbed by the watery vapours which arose, and where the hydrogen gas, on cooling, contracted, by which the balloon became smaller and heavier in regard to the more rarefied air; it must necessarily lose some of its power to ascend, and consequently fall a little. But after a small quantity of ballast was thrown out, the balloon again rose. The telescope, fixed in the bottom of the car, clearly showed me the places over which we were. The balloon, according to appearance, took its direction towards the land side. About 31 minutes after seven, when the barometer had fallen to 29 inches, and the thermometer indicated 18 degrees of heat, I filled the first flask with air; the second I filled at 37 minutes past seven, the barometer being at 28 inches, and the thermometer at 17 degrees of heat. I filled the third flask at 42 minutes past seven, at which time the barometer stood at 27 inches, and the thermometer had fallen to 15 degrees. At this time, or at this height, I experienced a heaviness in my ears, but in conversing I heard as well as before. During the continuation of our voyage the balloon turned round several times. This always took place gradually, slowly, and almost imperceptibly. The direct motion of the balloon during a perfect calm, and when there is no apparent motion in the air, is not perceptible. In consequence of the fog I could not see distant objects, such as Lake Ladoga, Cronstadt, &c. I here threw out the paper waywiser I had made; by means of which I observed, not only here, but during the rest of the voyage, that it showed much quicker than the barometer, the direction and also the sinking and rising of the balloon; for as soon as the balloon fell, the waywiser, as it was much lighter than the balloon, and found more resistance in falling, flew up and rose almost up to it, so that it was necessary to pull it down when the balloon rose: it was below suspended from the thread in a diagonal direction, and followed us in such a manner, that a person habituated to such observations could easily determine with a compass, from the position of the waywiser, the true direction of the balloon. As we found ourselves, with a north east wind, over the islands at the mouth of the Neva, M. Robertson was afraid, in consequence of the changed direction of the small balloon which was let off from the Garden of the Cadets, that the wind might drive us out to sea; for it is well known that in the atmosphere there are several currents of air which have a contrary course, and which in all probability produced the before-mentioned cruciform turning of the balloon. Not being accustomed to this cruciform movement, I was not able, by the waywiser, to determine the real direction of

the balloon, and on this account M. Robertson suffered to escape a considerable quantity of gas; on which we again fell till the barometer stood at 29 inches, about 50 minutes past seven.

At this height the heaviness in my ears went off, and I experienced in them no more heaviness. Having continued our voyage along the coast a good way behind Katerinenhof, we began again, on my earnest request, to ascend. About 25 minutes past eight the barometer stood at 26 inches, and the heat was equal to 14½ degrees. Here I filled the fourth flask with air. About 31 minutes past eight we found ourselves over the water, at a height where the barometer stood at 25 inches, and the heat had decreased to 13 degrees. At this height we could see the circles produced in the water by the fall of some bottles which I threw down. The north east wind still appeared to be favourable to us, and about 45 minutes past eight we found ourselves entirely over the terra firma. Here we could see at one view the Newski islands at the mouth of the Yamelianofka, and the whole of that river. As we were now at a distance from the sea, and M. Robertson saw no further danger, he began to throw out his ballast, of which little remained, in order to rise as high as possible; so that about nine minutes after nine the barometer had fallen to 24 inches, and the thermometer indicated 9 degrees. Here I filled the sixth flask with air. About 20 minutes past nine we were at a height where the barometer stood at 23 inches, and the heat was 6½ degrees. At this height I filled the seventh flask with air, and suffered to escape two canary birds and a dove. One of the canary birds, when let loose from the cage, would not fly; but when thrown into the air, it fell down with precipitation. The dove also, when thrown from the car, flew down almost in a curved line to a village that lay below us. When we had thrown out almost the whole of our ballast, with a view to rise to as great a height as possible, I threw out my great coat and the remains of my supper, which I had eaten with the greatest appetite, some necessaries for my experiments which I had carried with me, and also some instruments; on which we began to ascend. I here made an experiment on the power of hearing by means of the bell; whieh I also threw down, as I did not observe any perceptible difference, in consequence perhaps of the air not being perceptibly more rarefied. About 30 minutes past nine the barometer had fallen to 22 inches, and the thermometer indicated 4½ degrees of heat. I now filled the eighth flask with air. Before this I suffered the other dove to escape, or rather threw it from the car, as it sat on the edge of it and would not fly away. For two or

three minutes it flew around the car at the distance of thirty fathoms, and again perched upon it. I then took it in my hand, without its making any resistance or showing the least fear, and threw it down; but it flew violently round in a circular manner, either because it was not able to rise, or because it saw no objects before it. At this height I made experiments on the electric matter and the magnet; but in consequence of the instruments, and particularly the dipping needle, being deranged by throwing out the ballast, and the lateness of the hour, I was not able to make any others.

At this height we saw the sun, but only one half; and on account of the thick fog which took place, I cannot say whether the other half was concealed by the horizon or by a cloud. The earth, covered with this fog, seemed to be involved in a smoke coloured atmosphere, through which objects could not be clearly distinguished by the help of the telescope.

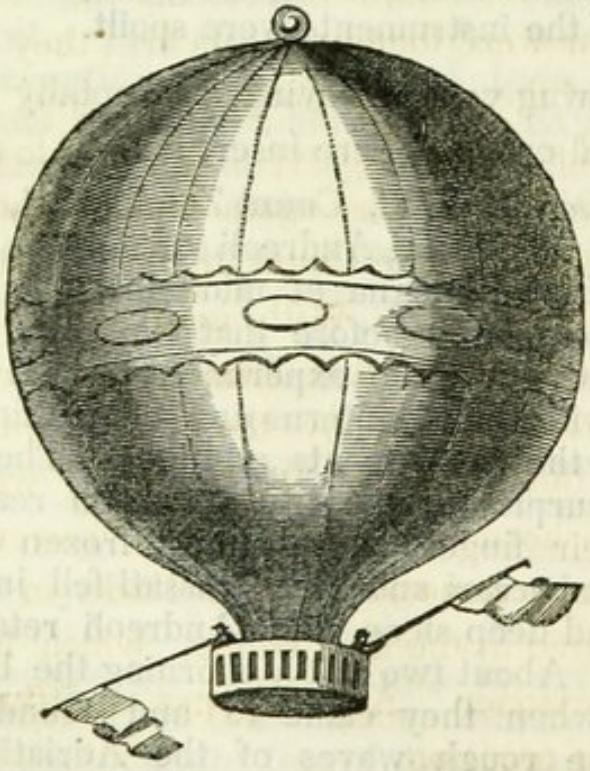
At this height the effect of the electric matter was perceptible; for when sealing wax was rubbed with a piece of cloth, it put in motion Bennet's electrometer. But as the magnetic needle which I took with me for the purpose of examining the inclination was spoilt, I was desirous of trying whether the magnetic power had as much influence over iron as at the earth. With this view I placed a common magnetic needle on a pin, and, to my great astonishment, saw the north pole of it rise considerably, while the south pole sunk down, making an angle of eight or ten degrees. I repeated this several times; and, to be more certain, I gave the needle to M. Robertson, that he might make the same experiment. The result, however, was always the same. The magnetic needle, which I have still in my possession, stands at present horizontal. Experiments in regard to the attraction of the magnetic needle, and some others, I was not able to make. At this height I did not experience the smallest change in regard to myself, except that my ears seemed, as it were, benumbed. My pulse beat as on the earth, that is, 82 times in a minute; and my breathing was neither accelerated nor impeded, that is to say, I breathed 22 times in a minute. In a word, I was exceedingly tranquil and cheerful, and experienced no change or uneasiness. At that time there were white clouds at a great height over us, but the heavens in general were clear and bright; yet though the sky was so clear I could observe no stars. I now proposed to M. Robertson to continue our voyage the whole night, in order that we might see the sun rise, and to make some other experiments; but ignorance of the local situation of the country, the almost

total consumption of our ballast, and the continual, though slow sinking of the balloon, prevented him from acceding to my proposal. While we were flying over several villages and rivers, I took my speaking trumpet, and, directing it towards the earth, called out as loud as I could. Contrary to expectation, I heard, after a considerable interval, my words clearly and distinctly repeated by an echo. I then called out again; and each time the echo repeated my words. I observed that the sound was reverberated in ten seconds; but I could not remark the height of the barometer, because we had begun to make preparations for descending to the earth: and to effect this as slowly as possible, for the sake of security, we tied all our instruments and warm clothing into a bundle and let it down, together with the anchor, by a rope. The balloon, which was driven by the wind with considerable force, and which fell with great rapidity, was so light when the bundle touched the earth, that it drew up the rope, and endeavoured again to ascend. In the mean time M. Robertson gradually suffered the gas to escape, and the balloon descended slowly, and touched the earth so softly, that we did not experience the least shock; though the contrary is for the most part the case when balloons are suffered to descend, and in consequence of the violence with which they touch the earth great danger is experienced. We descended safe to the earth, at 45 minutes past ten, on the estate of counsellor Demidof, in a field almost opposite to his house; and his boors and servants assisted us to arrange and pack up the balloon. By the bundle being dragged on the earth, the greater part of the instruments were spoilt.

The following voyage having accidentally been omitted in chronological order, I here insert it:—

Friday, Oct. 7, 1803, Count Zambeccari, Dr. Grassati of Rome, and M. Pascal Andreoli of Ancona, ascended in a fire balloon from Bologna at midnight, the inflation not having been completed before that time, and the populace being too impatient for the experiment to wait till morning: they took up with them lanterns and other things necessary for observing the instruments at night. The balloon rose with a most surprising velocity and soon reached such a height that their fingers were almost frozen by the cold, when both Zambeccari and Dr. Grassati fell into a state of insensibility and deep sleep. M. Andreoli retained the use of his senses. About two in the morning the balloon began to descend; when they came to and found themselves falling into the rough waves of the Adriatic sea which washed the coast of Romagna. The lantern had gone out

and was with much difficulty lighted. The balloon continued to descend rapidly, and fell into the water, in which the three travellers were drenched: to avoid being drowned they threw out ballast, when they rose again and surpassed three successive strata of clouds which covered their clothes with rime, and in this situation were deaf and could not hear each other speak. About three o'clock the balloon again descended and a gust of wind drove them over to the coast of Istria: bounding in and out the sea till eight o'clock, one Antonio Bazol picked them up in his ship, and the balloon, left to itself, went over to the Turks, having mounted to an amazing height. The Captain carried the aëronauts ashore into the port of Pola, where they were forced to remain some days in order to recover their strength. The height to which they had ascended must either have exceeded five miles, or from some cause, the air must have been in a very cold state, for they suffered more than most aëronauts have done who have mounted into the air. The most intense interest for their fate was excited, and bulletins of health reported sent from Venice to Bologna. Count Zambeccari suffered most, and was forced to have his fingers incised: however they ultimately recovered, and as will be hereafter seen, continued next year to persevere in their efforts to manage balloons constructed on this principle, which are, in my opinion, far less safe than the air balloons. But the disaster of this and other voyages proves the danger of ascending too rapidly into the highest parts of the air.



Monday, October 3, 1803, M. Garnerin made his thirty fifth ascent: he went up from near Moscow: in this voyage he saw the shadow of his balloon in the clouds, surrounded by a coloured halo: he descended in safety at the seat of Prince Visemsky.

Tuesday, Oct. 4, 1803, Garnerin ascended again to the height of 20,000 feet, when he suffered from intense cold: he then galvanized himself; he also fired a gun which he indistinctly heard himself. On descending in a wood, he narrowly escaped being killed by the peasants, who took him for some flying monster from another world.

Wednesday, August 22, 1804, M. Pauli ascended from Scean in a balloon which he professed to guide by means of a rudder of some kind; and indeed at the height of above 1000 feet he contrived to turn the balloon round, and to make it move in a direction not precisely that of the wind: he descended at Osinville, near Arpajon, fifteen miles distant.

In August, 1804, Count Zambeccari made a second attempt to cross the Adriatic with a fire balloon, in company with M. Andreoli. They ascended soon after six in the morning, and rose to a prodigious height, being soon lost sight of. When soaring over the village of Coo, some spirits in the car were found to be on fire; they consequently descended, and the grapple going into a tree, M. Andreoli jumped out and slid down the rope, and tried to fix it; but not succeeding, the balloon rose again with fearful velocity into the clouds, exposing the Count to the horrid danger of being burned in the air. With great presence of mind, however, he extinguished the flames; but having been by this time carried to sea by the wind, was obliged to descend into the waves of the Adriatic, where he was picked up by fishermen. The balloon, however, escaped, and is said to have gone over to the Turks in Bosnia, who had formerly fired at the first balloon which landed there, and taken it prisoner. An immense multitude were assembled on this occasion.

Friday, July 6, 1804, M. Blanchard is said to have made his 56th ascent in so large a balloon that it carried up eight persons to the height of 1500 feet. The whimsical account in the papers that they danced a quadrille in the air deserves not much credit.*

Saturday, Sept. 15, 1804, or 29th of Fructidor, An. 12. A voyage of considerable scientific interest was made by M. Guy Lussac, of which the following extract is an account, translated from the *Journal de Physique* :—

All our instruments being ready, the day of my departure was fixed for the 29th of Fructidor. I, indeed, ascended that day from the *Conservatoire des Arts et Metiers*, at 40 minutes past nine, the barometer being at 76·525 centimetres, the hygrometer at 57·5°, and the thermometer at 27·75°. M. Bouvard, who makes meteorological observations every day at the observatory of Paris, thought the atmosphere full of vapours, but without clouds. Scarcely had I risen a thousand metres when I indeed saw a light vapour dispersed throughout the whole atmosphere below me, and through which I observed distant objects confusedly.

When I reached the height of 3032 metres, or 1555 toises, I began to make my horizontal needle oscillate, and I obtained 20 oscillations in 83^s, while at the earth, under the same circumstances, 83·33^s would have been necessary for the same number.† Though my balloon was affected by the rotary motion which I experienced in my first voyage, the motion of the needle allowed me to count twenty, thirty, and even forty oscillations.

At the height of 3863 metres, or 19,821 toises, I found that the inclination of my needle, taking a mean of the amplitude of the oscillations, was sensibly 31°, as at the earth. A great deal of time and patience was necessary to make this observation, because, though carried away by the mass of the atmosphere, I felt a light wind, which continually deranged the compass; and, after several fruitless attempts,

* Of M. Blanchard's other voyages I have not been able to collect any authentic accounts: he appears to have been one of the most indefatigable balloonists. But M. Green with whom I ascended has made near 100 voyages: M. Garnerin made above half that number.

† Though I here indicate hundredth parts of a second, it may be readily conceived that I was not able to observe fractions so small; but they were given to me by division, because at the earth I made commonly thirty oscillations which required 126·5^s.

I was obliged to renounce making any more observations. I am of opinion, however, that the observation I here present deserves some confidence.

Some time after I wished to observe the dipping needle; the following was the result:—The dryness, favoured by the action of the sun in a rarefied air, was so great, that the compass was so far deranged as to make the metallic circle on which the divisions were traced out to bend, and become warped. The motions of the needle could not be performed with the same freedom; but, independently of this disappointment, I remarked that it was very difficult to observe the declination of the needle with this apparatus. It happened, indeed, that when I placed the compass in such a manner as to make the shadow of a horizontal thread. which served as a style, coincide with a fixed line, the motion I gave the compass communicated one to the needle, and, when the latter had attained nearly to a state of rest, the shadow of the style no longer coincided with the fixed line. It was still necessary to put the compass into a horizontal position; and during the time which this operation required, every thing was again deranged. Without persisting to make observations in which I could place no confidence, I gave them up entirely; and, free from every other care, I directed the whole of my attention to the oscillations of the horizontal needle. I am, however, convinced, in acknowledging the faults of my compass, that it is possible to employ one fitter for the purpose, which would determine the declination with more precision. I shall observe, that to attempt this experiment I had let down other needles, separately, in linen bags to the distance of fifteen metres below the car.

That the whole of the results I obtained may be better seen at one view, I have collected them in a table added to the end of this memoir; and they are such as they occurred to me, with the corresponding indications of the barometer, the thermometer, and the hygrometer. The heights were calculated according to the formula of Laplace, by M. Gouilly, engineer of bridges and causeways, who was so kind as to take this trouble. As the barometer did not sensibly vary on the day of my ascent, from ten o'clock till three, to calculate the different heights at which I made observations, we took the height of the barometer, 76·568 centimetres, which was the height at the earth at three o'clock; a height which, agreeably to the observations made by M. Bouvard at the observatory, is greater by 0·43 millimetres than that observed at the moment of our departure. The heights of the barometer in the atmosphere were reduced to those which would have been indicated by a

barometer at a constant level placed under the same circumstances, and for each height was taken the mean between the observations of two barometers. The temperature at the earth, having varied between ten and three o'clock, it was supposed constant and equal at 30·75° of the centigrade thermometer.

If we now cast our eyes on the table it will be seen that the temperature follows an irregular law in regard to the corresponding heights; which no doubt arises from this,—that, having made observations sometimes in ascending and sometimes in descending, the thermometer must have followed these variations too slowly. But if we consider only the degrees of the thermometer which form a decreasing series, we shall find a more regular law. Thus the temperature at the earth being 27·75, and at the height of 3691 metres 8·5°, if we divide the difference of the heights by that of the temperatures we shall first obtain 191·7 metres, or 98·3 toises, of elevation for each lowering of temperature. Performing the same operation for the temperatures 52·5° and 0·5°, as well as for those of 0·0° and —9·5°, we shall find in both cases 241·6 metres, or 72·6 toises of elevation for each degree of lowering in the temperament, which seems to indicate, that towards the surface of the earth the heat follows a less decreasing law than in the upper parts of the atmosphere, and at greater heights it follows a decreasing arithmetical progression. If we suppose that from the surface of the earth, where the thermometer was at 3·75°, to the height of 6977 metres, or 3580 toises, where it fell to —9·5°, the heat decreased as the heights increased, an elevation of 173·3 metres, or 88·9 toises, will correspond to each degree of the lowering of temperature.

The hygrometer had a very remarkable progress. At the surface of the earth it was only 57·5°, while at the height of 3030 metres it marked 62°. From this point it continually fell till the height of 5267 metres, where it indicated only 27·5°, and thence to the height of 6884 metres it gradually rose to 34·5°. If we wish from these results to determine the law of the quantity of water dissolved in the air at different elevations, it is evident that attention must be paid to the temperature, and by adding this consideration it will be seen that it follows an exceedingly decreasing progression.

If we now consider the magnetic oscillations, it will be remarked, that the time for ten oscillations, made at different heights, is sometimes above and sometimes below that of 42·16^s, which they require at the earth. Taking a mean of all these oscillations made in the atmosphere, ten

oscillations will require 42·20^s, a quantity which differs very little from the preceding; but if we consider only the last observations made at greater heights, the time for ten oscillations would be a little below 42·16^s, which would indicate, on the other hand, that the magnetic force has a little increased. Without wishing to draw any consequence from this slight apparent increase, which may arise from the errors committed in experiments of this kind, I must conclude that the results I have presented confirm and extend the fact observed by M. Biot and myself, and which, like universal gravitation, proves that the magnetic force does not experience any sensible variation at the greatest heights to which we can attain.

The consequence we have deduced from our experiments may appear a little too precipitate to those who reflect that we were not able to make experiments on the inclination of the magnetic needle. But if it be recollected that the force which makes a horizontal needle oscillate, necessarily depends on the intensity and direction of the magnetic force itself, and that it is represented by the cosine of the angle of the inclination of the latter force, no one can help concluding with us, that, since the horizontal force did not vary, the magnetic force ought not to have varied either, unless we choose to suppose that the magnetic force could vary exactly in a contrary direction, and in the same ratio, as the cosine of its inclination; which is in no manner probable. We should have besides, in support of our conclusion, the experiment of the inclination made at the height of 3863 metres, or 1982 toises, which proves that at this height the inclination did not vary in a sensible manner.

When we reached the height of 4511 metres, I presented to a small magnetic needle, and in the direction of the magnetic force, the lower extremity of a key. The needle was attracted, and then repelled by the other extremity of the key, which I made to descend in a direction parallel to itself. The same experiment, repeated at 6107 metres, was attended with the same success; a new and very evident proof of the action of terrestrial magnetism.

At the height of 6561 metres, or 3353 toises, I opened one of my two glass balloons, and at that of 6636 metres, or 3405 toises, I opened the second: the air entered into both with a hissing noise. At length, at 11 minutes after three o'clock, the balloon being completely full, and having no more than 15 kilogrammes of ballast, I resolved to descend. The thermometer was then at 9·5° below the temperature of melting ice, and the barometer at 32·88 centimetres; which gives for my greatest elevation above

Paris 6977·37 metres, or 3579·9 toises; or 7016 metres, that is, 3600 toises above the level of the sea.

Though well clothed, I began to feel cold, especially in the hands, which I was obliged to keep exposed to the air. My respiration was sensibly confined, but I was still far from experiencing any uneasiness so disagreeable as to oblige me to descend. My pulse and respiration were very much accelerated; breathing, therefore, very frequently in very dry air, it need excite no surprise that my throat should be so dry as to make it painful for me to swallow bread. Before I set out I had a slight headache, arising from the fatigue of the preceding day, and being up all night, and it continued the whole day without its appearing to increase. These are all the inconveniences I experienced.

A phenomenon which struck me at this height was to see clouds above me, and at a distance which appeared to be considerable. In our first ascent the clouds were not sustained at a greater height than 1169 metres, or 600 toises; and above, the heavens were exceedingly pure. The colour of them in the zenith was even so intense that it might be compared to Prussian blue; but in the last voyage I could not see clouds below me. The sky was much filled with vapours, and its colour dull. It is, perhaps, needless to observe, that the wind on the day of our first ascent was north, north east, and that on the last it was south west.

As soon as I perceived that I began to descend, I thought only of moderating the descent of the balloon, and rendering it exceedingly slow. At 45 minutes past three my anchor touched the earth, and became fixed; which gives 34^{s} for the time of my descent. The inhabitants of a small neighbouring village soon ran up to me; and while some of them took pleasure in drawing towards them the balloon, by pulling the rope to which the anchor was fixed, others, placed below the car, waited with impatience till they could reach it with their hands, in order to deposit it on the earth. My descent then took place without the least shock or accident; and I do not think that there could be one more fortunate. The small village at which I descended is called Saint Gourgon: it is six leagues north west from Rouen.

When I arrived at Paris, my first care was to analyse the air I had brought back. All the experiments were made at the Polytechnic School, under the inspection of Messrs. Thenard and Gresset; and I depended as much on their judgment as on my own. We observed, in turn, the divisions of the eudiometer without communicating with each other; and we did not write them down till we perfectly

agreed. The balloon, the air of which was introduced at the height of 6636·5 metres, or 3405 toises, was opened under water, and we all judged that it had filled at least the half of its capacity ; which proves that the balloon had well preserved its vacuum, and that no foreign air had entered it. We intended to weigh the quantity of air which remained in the balloon to compare its capacity ; but, as we could not at that time find what was necessary, and being very impatient to ascertain the nature of the air contained in it, we could not make the experiment. We first employed Volta's eudiometer, and analysed it comparatively with atmospheric air collected in the court before the Polytechnic School. The comparative analysis of these two airs is as follows :—

Analysis of the Atmospheric Air.		Analysis of Air collected at the Height of 6636 Metres.	
Exp. I.	Measures.	*Exp.* I.	Measures.
Atmospheric air.....	3	Air.....	3
Hydrogen gas.....	2	Hydrogen gas.....	2
Residuum after combustion..	304	Residuum.....	305
Exp. II.	Measures.	*Exp.* II.	Measures.
Atmospheric air.....	3	Air	3
Hydrogen gas	2	Hydrogen gas	2
Residuum.....	305	Residuum.....	304

Tuesday, August 4, 1807, M. Garnerin performed a voyage of peculiar interest, from the gardens of Tivoli, at Paris, during the night with an illuminated air balloon, the incidents of which voyage are so remarkable that I shall give them at length in a translation of his letter to the editors of one of the French Journals :—

Before I undertake a second nocturnal aërial voyage, which will take place at Tivoli, on Saturday, the 19th of September, I ought to give some account of that which I performed in the night between the 4th and 5th of August last.

My balloon was lighted by twenty lamps. Many persons felt some alarm from the number of these lights, and their proximity to the balloon, in case a diminution of the pressure in the upper regions should oblige me to let out the hydrogen gas by the lower orifices. They feared lest, in this case, the gas should find its way to the lights, take fire, and communicate the flame to the balloon. I had foreseen this inconvenience. In the first place, the balloon, which was the same in which I ascended at Milan, was only

two thirds filled, that I might defer the emission of the gas as long as possible; in the next, the nearest lamps to the balloon, were fourteen feet distant from it; and lastly, conductors were placed in such a manner, as to convey the gas away in a direction contrary to the lights.

Having made these arrangements, I felt no hesitation to undertake a nocturnal voyage; I ascended from Tivoli, at eleven at night, under the Russian flag, as a token of peace. There was not any decided current in the atmosphere, but only undulations, which tossed me about, I believe, a great part of the night. To this it was owing, that I was first carried towards St. Cloud, and afterwards brought back over Vincennes, in a diametrically opposite direction. How favourable this circumstance would have been to the speculations of those who pretend to direct balloons! I was in the full force of my ascension, when the fire works of Tivoli were let off; the rockets scarcely seemed to rise from the earth: Paris, with its lamps, appeared a plain, studded with luminous spots. Forty minutes after my departure, I attained an elevation of 2200 fathoms; the thermometer fell three degrees below Zero. My balloon dilated considerably as it passed through a cloud, in which the lights lost their brilliancy, and seemed ready to be extinguished. It was as urgent to give vent to the hydrogen gas, dilated to such a degree as to threaten to burst the balloon, as it was interesting to collect some of the air of this region. Both these operations I performed at once, without difficulty; and the emission of the gas brought me to a milder region.

At twelve o'clock, I was only 600 fathoms from the earth, and heard the barking of dogs. A quarter of an hour afterwards, I lost sight of all the lights on the earth, grew extremely cold, and could no longer perceive the stars, doubtless on account of the clouds.

At one in the morning, the cold still continuing, I was carried to a higher elevation; the hydrogen gas again expanded. About two, I perceived the stars, and saw several meteors dancing about my balloon, but at such a distance, as not to give me any alarm.

At half after two, the day began to dawn with me, and having again descended, I perceived the earth, which I had not before seen since my departure.

At a quarter to three, I heard country people speaking, and remarking the illumination of my balloon. Having asked them, they informed me that I was over the department of L'Aisne.

The sun gradually approaching, afforded me, at half past three, the magnificent spectacle of his rising above an

ocean of clouds. The warmth of his rays acting on the balloon, the hydrogen gas again expanded ; the atmospheric air became more rarefied, while there was nothing to add to the quantity of the counterbalancing weight. The consequence was a new ascension, during which, I was tossed about between Rheims and Chalons, and carried at four o'clock to an elevation of more than 3000 fathoms ; there, under a magnificent sky, and a resplendent sun, I experienced a cold of ten degrees. The balloon dilated much more considerably than it had yet done. The temperature was insupportable ; tormented by cold, hunger, and a disposition to sleep, I resolved to descend in an oblique direction, which brought me to the ground in the commune of Courmelios, near the bank of the Vesle, five leagues from Rheims, not far from Loges, and 45 leagues from Paris. after a voyage of seven hours and a half.

The air collected 40 minutes after my departure, in a cloud, in which the lights lost their brilliancy, and seemed on the point of going out, presented, on analysis, no remarkable difference from the air taken on the surface of the earth.—There was only a very small additional portion of carbonic acid, but not sufficient to produce any change in the state of my lights. It was nothing but the density of the clouds, ready to be converted into rain, that diminished their brilliancy. Though I was carried, at four o'clock, to the height of more than 3000 fathoms, my head was not so swollen but that I could put on my hat ; on the contrary, I felt such a pressure upon the temples and jaws, as to produce pain. The sun, at that elevation, lost none of his resplendence ; I never beheld that luminary so brilliant ; and the loadstone lost none of its magnetic virtues. Thus falls the system invented by M. Robertson, a few years since, and already discredited by reason : thus the story of swollen heads, of air without oxygen, collected by living beings ; of the sun without resplendence ; of the loadstone without virtue ; of matter without gravity ; of the moon the colour of blood ; and of all the wonderful things invented by the same aëronaut, can, in future, find a place only in the wretched rhapsodies of the celebrated Kotzebue.

Saturday, September 19, 1807, M. Garnerin ascended again ; and of this voyage he observes :—

My second aërial journey by night will not afford an opportunity for the brilliant narratives which I have had occasion to make in the course of my forty preceding ascensions. I shall not have to describe the majestic appearances which Nature continually offers to the eyes of an aëronaut who ascends in favourable weather. I can only

give a narrative of an aërial tempest, which was nigh terminating in a shipwreck.

The obstacles which the wind caused to the inflation of the balloon, sufficiently apprised me of the approach of the storm; and to the difficulties of the weather was added the turbulence of a party, by which I was prevented from placing the cord of the valve so as to regulate the tube, which, in case of expansion, was to conduct the gas into a direction different from the lights which surrounded the bottom of the balloon.

I was to have been accompanied by M. De Chassenton; but the aërial storm, which continually increased until the moment of my departure, gave me reason to apprehend such a disaster as M. Blanchard and another aëronaut met with in Holland. M. De Chassenton was actually in the boat; I must bear witness to his determination; for I am convinced that nothing could have made this young man, remarkable for his merit, quit the boat, if the well grounded apprehension which I entertained of seeing him exposed to certain destruction, had not suggested to me the idea of declaring to him, that the balloon was not capable of carrying up two persons.

It was thus, in the most adverse weather, and exposed to the greatest opposition, and the tumult of a cabal, the head of which it is easy to guess at, that I ascended from Tivoli, at half past ten o'clock, on the night of the 21st of September. An unexampled rapidity of ascension, but extremely necessary to prevent me from coming in contact with the adjoining houses, raised me above the clouds, and in a few minutes carried me to an immense height, the extent of which I cannot precisely ascertain, on account of the dangers and embarrassments which suddenly affected my imagination, and prevented me from observing the declension of the mercury in the barometer. Elevated in an instant to the frozen regions, the balloon became subject to a degree of expansion which inspired me with the greatest apprehension. There was no alternative between certain death, and giving an instant vent to the gas; and this at the risk of seeing the balloon take fire. I gradually opened with one hand an orifice, of about two feet diameter, by which the gas escaped in large volumes, while, with the other, I extinguished as many of the lights as I could. During this effort, I several times was near overbalancing myself, and falling out of the boat.

Deprived of the opportunity of regulating the valve, my balloon, like a ship without a rudder, floated in air, obeying the influence of the temperature, the winds, and the rain. Whenever the force of these made me descend, the storm, which kept still increasing, obliged me to throw out ballast,

for the purpose of avoiding it, and escaping from imminent shipwreck. At length, at four o'clock in the morning, after having been almost continually enveloped in thick clouds, through which I could seldom see the moon, all my means of supporting myself in the air were exhausted. Whatever skill I possessed was no longer of use to me. My boat several times struck against the ground, and rebounded from thence. The tempest often drove me against the sides and tops of mountains. Whenever my anchor caught in a tree, the balloon was so violently agitated by the wind, that I experienced all the inconvenience of a violent sea sickness. Plunged at one time to the bottom of a precipice, in an instant after I ascended, and acquired a new elevation. The violence of the concussions exhausted my strength, and I lay for half an hour in the boat, in a state of insensibility. During this tempest I recovered; I perceived Mont Tonnerre, and it was in the midst of crashes of thunder, and at a moment which I supposed would be my last, that I planted upon this celebrated mountain the Eagle of Napoleon joined to that of Alexander.

I was carried away for some time longer by gusts of wind, but fortunately some peasants came to my assistance at the moment that the anchor hooked in a tree. They took hold of the cords which hung from the balloon, and landed me in a forest upon the side of a mountain, at half past five in the morning, seven hours and a half after my departure, and more than 100 leagues distant from Paris. They took me to Clausen, in the canton of Waldfischback, and department of Mont Tonnerre. M. Cesar, a man of information, and mayor of the neighbouring town, came and offered me every assistance in his power, and at my request drew up a narrative, of which he gave me a copy.

Monday, *April* 7, 1806, M. Mosment ascended for the ninth time, at Lisle, and when at a great height by some accident fell out of the car and was found dashed to pieces in one of the fosses of the town.

Saturday, *July* 7, 1810, MM. Sadler ascended from Merton meadows, Oxford, and descended near Stow.

About this year, M. Degen, of Vienna, invented his flying machine attached to a balloon.

Monday, *August* 12, 1811, M. Sadler, jun, and Capt. Paget went up from the Mermaid Tea Gardens, Hackney, at about three o'clock, and descended near Tilbury Fort, Essex. In perusing the account of his voyage, I find

temporary deafness noticed on descending. See *Philosophical Magazine* for 1811.

Thursday, August 29, 1811, M. Sadler, sen. and my friend and relative M. Henry Beaufoy ascended from the same place, Hackney, which voyage is described as follows in the Journals of the day :—

As the balloon ascended, M. Beaufoy was totally unconscious of the motion ; it appeared as if the balloon was the only point stationary, and that the earth and the people were suddenly sinking away. The rapidity with which it ascended was such, that it prevented every sensation of giddiness, the whole country appearing in the course of a few seconds, as one prodigious map. The almost instantaneous transition from the shouts of the spectators, and from the absolute tumult in which the traveller had been engaged, by the contention around the car, to the deathlike stillness that reigned in the upper regions, only broken at intervals by the report of cannons at Walthamstow, filled the mind with indescribable sensations. It appeared difficult to persuade the mind that it was a reality—and the mixed sensations of delight and astonishment, completely deprived M. Beaufoy of the power of expressing his wonder at the scene beneath the eyes.

A few moments, however, were all that the observer allowed himself to feast on the delightful scene—for the confusion that had taken place around the car, had compelled those that had taken charge of the instruments to use very great exertions to convey them to the aëronauts in the car. They were accordingly laying in a distressing state of confusion at the bottom of the car, though, on examination, fortunately without having suffered the smallest injury.

After having made many useful observations, M. Beaufoy had an opportunity of viewing, at his leisure, the prospect from the balloon. The first and most striking object was the Thames, which was seen meandering in endless gigantic sinuosities, through the long line of country down as far as the Nore. The ships, and even boats, were distinguishable on its mirror like surface, with astonishing minuteness; and M. Beaufoy has no doubt, that had the ascent been made with reference to that particular object, the number of ships afloat in the River and Wet Docks might have been most accurately counted.

The sun shone full upon the River, and presented at once the grandest and most delightful sight imaginable. It would be fruitless to attempt the description of the scene,

though in candour it must be acknowledged, that it agreed precisely with the idea that M. Sadler's companion had preconceived, and differed in no respect whatever from the view from the summit of a lofty situation, except that it was infinitely more extended in its range, the eye embraced a larger field within its scope, and then that listless sensation of delight, which is derived from the nature of the voyage itself. In short, as has been already stated, the gratification arising from the situation is altogether indescribable, but to such as have experienced it themselves. Though moving with such wonderful velocity, the travellers are themselves totally unconscious of any motion whatever. They feel themselves floating in a most delightful aëriform fluid, and seeming to convey a most exquisite idea of unlimited elasticity. The extreme elasticity, indeed, was found on this occasion to be materially against the accuracy required in all barometrical observations, the slightest motion on the part of either of the travellers causing a vibration of the quicksilver in the tube of an inch, a half, and two inches, which required to be steadied with the hand, to bring it to anything like a stationary point. Finding this to be the case, the observer noticed each time the two extreme divisions of vibration, and took the mean, as the sum to be placed in the barometer column. In no one instance was the barometer stationary, for even when the travellers were both of them perfectly still, the barometer ebbed and flowed with great rapidity, though not to such an extent as in the case already mentioned.

In looking over the country, it gave the idea of an immense map, executed with uncommon neatness—the fields presenting a much livelier and brighter green than the trees. The colours of objects were not in the least changed or affected in any instance that came under observation. In passing over Epping Forest, M. Beaufoy was particularly struck with its appearance: it seemed to consist of a vast number of clumps of something of a very dark green, certainly conveying an accurate idea of what it really was, of forest, but so much foreshortened as to preclude any idea of comparative elevation. M. Beaufoy particularly noticed that the Forest presented to the eye a tract of dark green detached patches; where the turf (as he supposed) was visible, there seemed to be an edging of varied extent of courses of a green of a much brighter colour. All objects of whatever kind, ceased to give any idea of comparative height, unless when seen at a considerable angle, before the balloon became in a vertical situation. M. Beaufoy observed, that white objects, as Chigwell and Ongar Churches, Wanstead House, and the

Town Hall at Chelmsford, conveyed a much better idea of their elevation above the surface of the earth, than any other objects that he observed. The small rill of water that run through the main street of Chelmsford, sparkled with peculiar brilliancy, much more so indeed than either the Thames or any other water that caught the eye in the course of the voyage. Such of the roads as took the attention, seemed all of one uniform colour, and that an orange yellow, and, at the elevation at which the balloon was at that time, conveyed the idea of fine gravel walks. In one instance in which a flock of sheep were passing in a direction from London, the dust they left behind them was very distinguishable, and this at an elevation of nearly 3000 feet. All sounds seemed to be transmitted with distinctness to the travellers aloft, at a distance in which they could not make themselves heard by those under them. This was to be expected, as there could be no objects near enough to the balloon to assist in reflecting the sound, whereas to those beneath them, this objection did not apply; the hills and hollows all tending to influence the propagation of sound on the earth. It did not appear that any change in the state of the atmosphere affected the propagation of sound.

The balloon had sometimes a rotatory motion, which tended to confuse any very distinct idea of situation. This motion was most probably caused by some accidental twirl in the confusion in which the balloon was launched.

At 20 minutes past three, the balloon was in the midst of a heavy shower of rain, which was presently changed into a violent hail storm. The sound produced by the battering of the hail and rain against the upper surface of the balloon, contrasted with the general stillness that otherwise reigned around the balloon, was very striking. Threw out a board which had been taken up to answer the purpose of a table, but not used, because the weight of the load caused the angle formed by the ropes, by which the car was attached to the netting, to become more acute, and the travellers were apprehensive that the edges of the board would cut the ropes. Threw out the wicker basket. The effect of the rain and hail on the balloon was exhibited in a copious discharge of fluid through the neck of the balloon, arising probably from a condensation of the warm hydrogen gas, by the constant succession of cold fluid pouring in torrents on the upper surface of the balloon. This fluid appeared to have dissolved a portion of the varnish, for wherever it fell on the clothes, or hat, it left a permanent stain of a whitish looking gummy appearance. At this time the travellers experienced a very strong current of air or wind, not only cold and chilly to the feelings, but apparently

blowing from no one particular point of the compass, as it rushed sometimes from one, at another moment from a directly opposite direction. This current of air caused the balloon to acquire a rotatory vertical motion, which made the compass traverse as nearly as the observer could guess, for he did not note it by the watch, once in about 20 or 30 seconds.

The confusion round the car at the launching was here productive of inconvenience, for the car did not hang perfectly parallel. The observer was at the lowest end, and he therefore found this vertical motion exceedingly inconvenient. The car was lowest on the right hand of the observer, so that it was not only lowest towards that end, but was lopsided on his right. The motion of the balloon was from his left towards his right hand. The wind made no noise, and would not have been perceptible but for the freshness of the air on the face, and the singular motion of the balloon. It was now about half past three o'clock.

M. Sadler now announced to his fellow traveller, that the balloon was passing through the clouds, and almost immediately after, the clouds were seen beneath, presenting the appearance of fleecy masses; on throwing some small pieces of silver paper over the side of the car, the rapidity with which they appeared to be precipitated downwards convinced the travellers that the balloon was rapidly ascending. The rain still continued, and the air damp and chilly to the feelings. The aëronauts seemed to be stationary, as far as progress over the country went, but still ascending with rapidity.

At this time placed a pigeon on the edge of the car; the poor animal seemed excessively alarmed: standing on the edge of the car and looking round. The earth was concealed from the view by the clouds beneath. After some little time the observer precipitated the pigeon gently from its perch, when it fell like a stone until lost in the haze, which was almost in an instant. As long as it remained in sight it did not make any attempt to assist itself with its wings. The rain still came down heavily, and the fluid continued to pour down, as before, through the neck of the balloon. Barometer 24·30; thermometer 54°.

M. Sadler inquired of his companion the heat by the thermometer, and on his receiving the answer, directed one of the bottles to be emptied of its water, for the purpose of collecting air; M. Sadler observing at the same time that he thought they were now at as great an elevation as they should be able to accomplish in the course of the voyage. At this elevation M. Beaufoy could not divest himself of the idea that he heard sounds as of persons cheering from the

earth, though it was not possible that it could arise from any such cause, as the balloon was still above the clouds, and the travellers could not distinguish anything but the dense white clouds, which now appeared precisely like a thick October fog. The air felt damp and chilly, and the rain still continued, though less violently than before. The breath was particularly visible, and from the circumstance of having been without a hat during the whole of the excursion, it is most probable that the sounds M. Beaufoy heard, were merely a ringing in the ears, the effect of the damp; he tried the experiment repeatedly of looking towards the earth, and shouting as loudly as possible, to ascertain whether the sound would be returned by echo or reflection from below, but no such effect followed. Got into a clear atmosphere, the white clouds remaining as before beneath, but on looking upwards, there was a mixture of blue and white clouds, though with a great preponderance of blue, just as is usual in a moderately clear day below.

The blue sky seemed to be of a dark and clearer blue than he had generally seen. M. Sadler now proposed descending into a clearer atmosphere, for the sake of getting a view of the earth, it being still concealed from the view by the dense white clouds below. This was in consequence of the observers noticing that 22 minutes before four the wind had reverted to the old point, and M. Sadler's experience led him to conclude that the balloon could not be now far distant from the sea ; and judging from the rate at which they had traversed over the country, as long as objects were distinguishable. Turned off a pigeon, which would not leave the car, but continued to look about as if frightened, and then turned its head inward without attempting to escape. When pushed off the side of the car, it fluttered and used the most violent exertions to regain the car, but as notwithstanding all its exertions it continued to sink rapidly below the car, it at length extended its wings, keeping them apparently immoveable, and darted towards the earth, at an angle considerably inclined, with the rapidity of a hawk making his swoop. It was very remarkable, that almost at the same moment, a common house fly, apparently much benumbed, and scarcely competent to common exertion, crawled from beneath the seat of the observer, and without any difficulty, flew with facility upwards, and settled on the lower part of the net of the balloon, a good deal above the heads of the travellers. It appears curious, that so small an insect, and that too partly incapacitated, should be able to fly up to the balloon with the same rapidity as usual, when a far more powerful animal should have sunk from the car, almost like a piece of wood

thrown overboard. M. Sadler now pulled the string of the valve, the gas rushed out with somewhat less noise and violence than before, but the balloon was evidently rapidly sinking; it was a sinking perfectly sensible to the feelings even had they not been informed by the constant reference to the barometer.

At this time M. Beaufoy felt a trifling pressure in the ear, and some little deafness, and this most probably was increased by the damp atmosphere, and being without a hat, which is by the bye a great inconvenience in such situations on account of the ropes.*

As soon as the balloon descended into a region, from which the earth was perceptible, M. Sadler's conjectures proved just; as the travellers saw, apparently at no great distance from them, the wide expanse of the Northern Ocean. The sensation of deafness did not go off for more than a quarter of an hour afterwards, even notwithstanding the balloon had greatly decreased in point of elevation. Until this trifling deafness, there did not appear to be the smallest difference between the intensity of sound, at the greatest elevation, and at the surface of the earth. The travellers conversed in their usual tone of voice, and any casual operation, such as drawing the cork of the champaigne, &c. was heard just as usual. If anything the universal stillness invited rather a lower tone of voice than ordinary.

Released a pigeon, and placed it on the edge of the car, and like the former did not attempt to escape till pushed off from the car.

At four o'clock, M. Sadler cautioned his companion that the instruments must be removed: and directed that they should be taken in the lap of the observer. He told him likewise to be prepared on his giving the word, to heave overboard everything that would admit of it, with a view of breaking the force of the descent. M. Sadler and his companion were also to place their feet against the corners of the opposite seat, and then raise themselves as much as possible with their hands by clinging to the ropes, taking care to raise their hands as high as possible above their heads.

At ten minutes past four they descended in the parish of East Thorpe, near Colchester.

It does not appear, says M. Henry Beaufoy, that the vertical rotation experienced in the course of this voyage, when the balloon encountered the storm and current of air, had been mentioned by any former travellers, with the

* It appears to me that on this as on most other occasions the affection of the ear producing temporary deafness is not felt till the balloon begins to descend.

exception of Count Zambeccari, who made an ascent with Admiral Sir Edward Vernon, at London, 23d March, 1785.

Nicholson's Journal, Vols. 10 and 11, will be found, on reference, to contain several exceedingly interesting reports on aërostation. Those made by Robertson, Sacharoff, and Guy Lussac, contain the greatest variety of information.*

About the year 1811, but I have not the exact date, Madame Blanchard ascended to an enormous height from Paris; she remained the whole night and for fourteen hours in the air, during which she fainted from the altitude of the balloon, but came to, and at length descended in safety.

Tuesday, Oct. 1, 1811, M. Giard ascended from Florence in an air balloon to the height of near 15000 feet, where he became numb from cold and almost frozen. After having been over the sea for a considerable time, he descended at two o'clock in the morning at St. Gasciano.

Monday, Oct. 7, 1811, M. Sadler and another gentleman ascended from Birmingham, and the wind being strong, he travelled to the astonishing distance of 112 miles in an hour and a half, which is more than a mile a minute, and consequently exceeds the speed of the racehorse Flying Childers; notwithstanding the various currents which the balloon may have met with in the air. A medal was struck at Birmingham to commemorate this voyage, which has his head on one side and the car of the balloon containing the travellers on the other. The inscription on this coin represents it as M. Sadler's 35th voyage. It would be impossible to give the minute detail of every ascent: suffice it to say therefore that in this instance they passed successively over Litchfield, Tamworth, Leicester, and near Spalding, and landed at last near Boston in Lincolnshire, after having sustained some bruises.

Monday, Dec. 23, 1811, Madame Blanchard made another ascent at Rome and descended at Tagliacozza.

Monday, Sept. 21, 1812, Sig. Zambeccari and Sig.

* I have extracted this account from the one published at the time, but there is extant a very able and scientific paper on the subject by M. Beaufoy himself, to which I would fain refer the reader.

Bonoga ascended at Bologna in Italy: on descending the balloon caught in some high trees and took fire; to avoid being burnt, both parties leaped down, when Zambeccari was killed, and his companion had several bones broken.

The same year, a mechanic named Bittorf ascended at Manheim on the Rhine, when the machine took fire, and descending rapily, dashed him to death against a house.

F. Albert a Saxon Augustinian inflated rarefied air bags as early as the 14th century, *but did not send up the fire.*

Thursday, Oct. 1, 1812, M. Sadler ascended at Dublin in hopes to cross over to Liverpool; but when near thereto, he got into an opposite current, and deemed it prudent to descend into the sea: from whence he escaped by getting the crew of a ship to run her bowsprit through his balloon, exhausting the air, and then taking him on board.

Friday, July 15, 1814, St. Swithin's Day, M. Sadler and one of his sons ascended from Burlington Gardens, London, and fell at Great Warley Franks, near Ockendon, in Essex. During this voyage, and at a great elevation above the clouds, M. Sadler felt much pain in his ears, which his son soon afterwards felt also, but in a less degree. M. Sadler mentioned that he and M. Windham, M.P. had both felt this pain in the ears when they ascended together, above thirty years before. He observes as follows:—

After the balloon had cleared the east wing of Burlington House, our ascent was slow, and only evidenced by the apparent receding of objects; for it was not we who seemed to rise, but every thing beneath us to retire; in a few minutes we were perpendicular with Leicester-square, and our prospect was at once grand and awful; the whole of London and its magnificent buildings lay below us, with its surrounding fields, canals, and parks; the beautiful serpentine form of the River, with its rich shipping, docks, and bridges. We enjoyed this scenery for about 15 minutes, and, at a quarter before four o'clock, entered a dense cloud, which completely shut us out from all sight of the earth; at this time we could sensibly perceive the balloon to be rising. When we had soared through this cloud, my son observed

to me, that, from the variegated colours reflected and refracted from the multitudinous congregation of vapours around us, and the effulgence of different lights, he could scarcely see to any great distance, or make any distinct observations on the numberless forms around us; although, from the shadow of the balloon on the more opaque clouds, I could easily discover that we had already altered our course towards the south east. From the intense cold, and a most violent pain in my ears, which I never experienced before, our height could not be less, in my calculation, than five miles. The late Right Hon. M. Windham, about thirty years ago, indeed, experienced a similar attack in his ears, though we had not then ascended above two miles and a half; but, from my best observations, calculated upon former experience, we must have been about that height. My son soon after found the same effect, though in a much slighter degree.

By the various currents of air, and the renewed motion of the machine, I judged we were approaching the sea; and requesting my son to open the valve, we perceived ourselves rapidly descending. The clouds were so near the earth, that, after lowering for the space of a quarter of a hour, though we distinctly heard the lowing of the cattle, we could not discover *terra firma;* but shortly after the clouds opened themselves beneath us, and displayed the variegated fields and the river Thames; and informed us that we had again altered our direction, and were returning from the south east to the north west; and, sailing over the Lower Hope and East Tilbury, we had a distinct view of the mouth of the river, Sheerness, Margate, Ramsgate, &c. with their coasts and shipping; but the clouds collecting and rolling over each other, again inclosed us in visible invisibility. After again descending below the clouds, we saw an inviting hay field at a considerable distance, and opening the valve again, a sufficient quantity of gas escaped for us to reach the proposed spot; and, after throwing out the grappling iron, which immediately took effect, we came to the ground without any unpleasant convulsion.

Friday, July 29, 1814, M. Sadler, jun. ascended again from Burlington Gardens, accompanied by another person; they remained forty eight minutes in the air, and fell at Coggeshall, in Essex.

Monday, August 1, 1814, another M. Sadler, jun. went up again from the Green Park, London; and in this voyage he with difficulty saved his life; for not only did the valve of the balloon freeze, so that he was unable to check the ascent

of the balloon, but the net burst at the top, and he perceived the balloon gradually protruding itself through it; so that he expected every moment to be precipitated to the earth. He saved himself, however, by tying the long silken neck of the balloon round his body, and after being carried to a tremendous height into a cold air, wherein he was almost frozen, he at length came down into Mucking Marshes, opposite Gravesend. This was on the afternoon of the great fête given in the Park, in celebration of the Battle of Paris.

Sunday, August 14, 1814, I ascended to the summit of Cader Idris, and there made a series of observations, which are otherwhere recorded and need not therefore be repeated here. On descending to nearly the base of the mountain I perceived a fullness about the ears and slight deafness, which increased as I approached the town of Dolgelly, and did not go quite off till near eight o'clock in the evening.

Friday, June 29, 1815, M. Sadler, jun. ascended from Norwich, and was very near getting blown out to sea, but managing at length to get into and to keep in a current blowing towards land, he came down safely near to where he went up.

Friday, June 13, 1823, M. Green, and a young man named Sparrow, ascended from Oxford, and descended near Henley; the car, according to the Gentleman's Magazine, was dashed to pieces by the concussion in coming to the earth: in rising too they struck against a chimney.

Tuesday, May 25, 1824, M. Harris, who had sometime ago ascended with M. Graham, made a voyage from the Eagle Tavern, City Road, in which he lost his life, under very remarkable circumstances. A female, named Stocks, ascended with him, a girl only eighteen years of age. The balloon mounted with great rapidity and was soon lost in a cloud. When near two miles high it seems that M. Harris opened the valve, in order to descend, and it is supposed that owing to some accident it did not close

again in time to prevent the escape of too much gas. The balloon, however, collapsed, and fell with great rapidity to the earth, very near the park of a person named Gee, near Beddington, in Surrey, where M. Harris was found dead, but Miss Stocks, though much injured, and quite faint, after a time recovered. This accident shows how dangerous it is to have the valve at the top of the balloon. M. Garnerin adopted the safer plan of having it on one side.

Soon after this accident M. Graham made two very fine ascents; in the first he was accompanied by his wife, from White Conduit Gardens; in the latter he was accompanied by M. Beaufoy, as hereunder described:—

Thursday, June 17, 1824, at five minutes past six in the evening, (says M. Beaufoy) the balloon rose from the gardens of White Conduit House, Islington; the barometer being then 29·80 inches, the thermometer 66°, and the hygrometer 17° dry. Wind very nearly from the north.

I felt no motion whatever! All objects seemed to sink from the car; and in a short time quite lost their altitude.

At eight minutes past six, the barometer was 27·40 inches, or 2257 feet, thermometer 46°, hygrometer 15° dry, when everything was perfectly distinct, but flat like a military map; and at twelve minutes past six, barometer 25·50 inches, or 4235 feet, thermometer 45°, we passed through some thin mist. The balloon soon after entered a different current of air, which caused it to make about half a revolution, slowly; occasioning a slight sensation of sickness, that went off in one or two seconds, when the machine became steady.

At sixteen minutes past six, barometer was 23·3 inches, or 6605 feet, thermometer 39°, hygrometer 20° dry, when the machine became enveloped in clouds; which were by no means dark, nor had the approach to them been gratifying. Soon after a disagreeable sensation of singing in the ears was felt by M. Graham and myself, and continued the whole voyage; the application of cotton not removing it.

Until this moment, every thing had been distinctly visible from the balloon; trees, houses, and ships, had length and breadth, but no height. Roads seemed like footpaths of an orange colour, fields of corn as if ruled with lines of vivid green; the hedges looked thicker and darker.

On rising above the clouds, a most magnificent sight met the eye! One vast expanse of frozen snow, with enormous masses towering above the rest like mountains,

having every summit burnished by the rays of the sun, which shone most brilliantly from a sky of a deep blue colour.

At twenty minutes past six, barometer 21·60 inches, or 8608 feet, we heard the report of a cannon, but no reverberation after it; and the balloon again revolved gently.

At twenty six minutes past six, when the barometer was 20·2 inches, or 10,416 feet, another gun was heard; and the clouds below rolled over each other into the most fantastic shapes, while between their fissures the earth was clearly discernible.

At thirty one minutes past six, barometer 19·50 inches, or 11,298 feet, thermometer 32°, hygrometer 25° dry, I let loose a pigeon, which flew away with ease and rapidity, its wings making a great noise from the perfect stillness around. After one or two circles, it darted through an opening in the clouds; and I was assured by the owner that it reached its nest in the City road, at twenty minutes past seven o'clock the same evening.

At twenty minutes to seven, barometer 19·20 inches, or 11,711 feet, thermometer 32°, hygrometer 31° dry, M. Graham judged we were as high as we could ascend without throwing out ballast; and as we were far above every object interesting to the eye, the cord of the valve was slightly pulled and we commenced an extremely gradual descent. The balloon seemed to be over Kennington, and I found nothing disagreeable in looking about, except at objects perpendicularly under the car.

At eighteen minutes to seven, our descent was so imperceptible, that it could only be ascertained by throwing out very little bits of silver paper; and I in vain endeavoured to find out from the compass the direction the balloon was taking; as though the needle pointed north, it could not tell whether we floated to or from that point.

At nine minutes to seven, the barometer was 22·3 inches, or 7784 feet, thermometer 38°, and hygrometer 23°, when we approached the clouds; which had a most beautiful effect from the masses of vapour seeming to rise up in eddies to meet us.

At five minutes to seven, barometer 24 inches, or 5822 feet, the machine was quite enveloped in a thick mist, which, at four miutes to seven, barometer 24·50 inches, or 5263 feet, became dark; and gave rise to an unpleasant feeling, of floating in space without any defined object to rest the eye on. The voice also appeared much weaker and lower than at any other period of the voyage; but I did not feel any oppression at the chest, as I coughed two or three times on purpose to ascertain whether it pained me.

At seven o'clock, barometer 25 inches, or 4714 feet, we emerged from the clouds; and getting into a new current of air, the balloon turned round again. At three minutes past seven, barometer 26·5 inches, or 3130 feet, every object on the earth became perfectly distinct; and M. Graham let down his grappling iron, at the end of a cord 160 yards long.

At seven minutes past seven, barometer 28·30 inches, or 1385 feet, thermometer 50°, hygrometer 22° dry, the height of houses and trees became apparent; and one minute afterwards, the grapple having caught in the boughs of an oak, brought the car to the ground with considerable violence; and after rebounding two or three times, M. Graham and myself stepped out without any difficulty into a field near Godstone.

In this aërial excursion, I was much surprised to find the atmosphere become drier as we ascended, except only at the height of 2257 feet. *After our descent, I had occasion to use my handkerchief, when the sound in my ears was like the report of a pistol.*

The balloon was 63 feet high, by 37½ in diameter, which lemon shaped figure contains 46388 solid feet; and as each cubical foot of common air equals 1¼ oz. the whole weighed 3479 lbs.

In addition to the above, some further observations are recorded in the public prints of the day. Among others M. Beaufoy describes the temporary deafness which he felt after descending, and compares the sound which he heard in his ears every time he blew his nose, to the going off of a pistol. Many other persons who have ascended have described the same.

Tuesday, May 19, 1829, wind easterly and strong, M. Green ascended from Chelmsford, and fell at Hornsey, in Middlesex. I did not witness this ascent, having set off the day before on a tour on the Continent.

Sect VI.—*Aërial Voyage of Dr. Forster (the Author) and M. Green—Observations on the above and on Aërostation.*

I shall now proceed in the order of these annals to give an account of my voyage on the 30th of April, 1831, with M. George Green, with his inflammable air balloon, the dimensions of which were very considerable, being above 50 feet high by 35 in horizontal diameter, and having, when

inflated, the shape of a pear: it was made of the best gummed silk, in gores alternately of red and of yellowish colour.

As I had long determined to make some further observations on the clouds, in addition to those recorded in former Alpine excursions, and likewise to try the effect of a descent from the higher regions of the air, with a balloon, on the organs of hearing, I readily accepted of the proposal made to me to accompany M. Green in his voyage, and I was provided with a number of electrical instruments for the occasion; but the morning appearing unfavorable, and fearing that in so small a car they might be damaged if we should have bad weather to encounter, I left them at home; and though the evening turned out fair, it was too late to go back for them. I contented myself, therefore, with making such accurate observations as laid within my power, both on the clouds, and on the sensations produced in the animal machine by the rapidity of descent; thus putting to the test of experiment the accounts of other aërial voyageurs.

On the day previous to our ascent, the balloon was placed in the ancient garden of the Dominican Friars, at Moulsham near Chelmsford, and the process of filling was begun from the manufactory of carbonated hydrogen; by next day it was sufficiently inflated. Having left my wife in possession of a powerful telescope at Boreham, to watch the motion of the balloon, I proceeded to the ground, when M. Green and myself made the voyage, of which the following particulars were chiefly drawn up at the time, and published in the *Chelmsford Chronicle*:—

Saturday, *April* 30, 1831, about six o'clock in the evening, the barometer standing at 29·20, the thermometer about 63° wind gentle from E.S.E. the balloon was disengaged from its fastenings, and we ascended slowly into a soft and serene atmosphere, amidst the shouts of numerous spectators and the sound of a band of military music, taking a direction towards Writtle, and passing by a very gentle ascent over the green and fresh valley of the Chelmer. The rotatory oscillation of the machine, being as it were the compound motion produced vertically by the power of ascent and

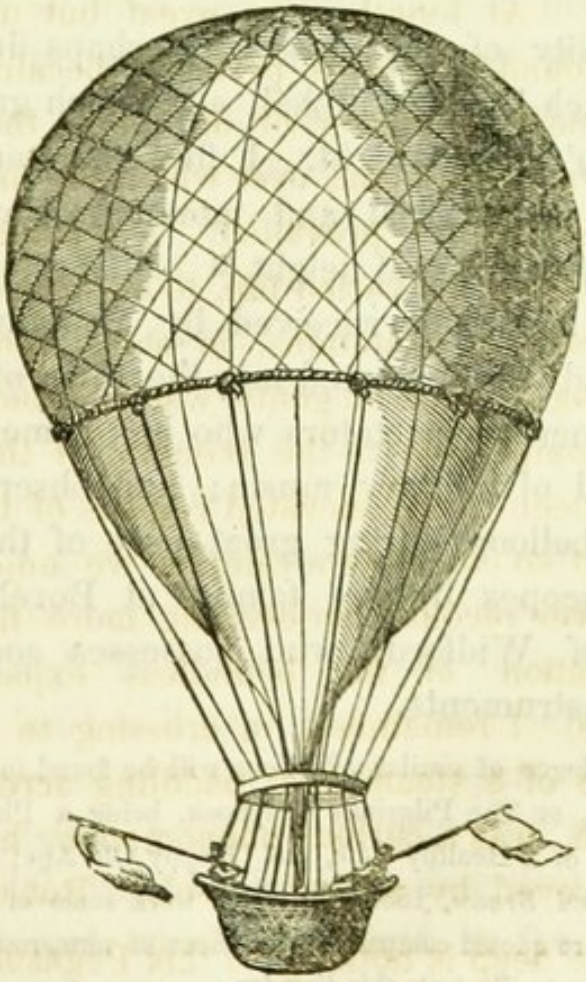
horizontally by the wind, was from right to left, or in the order of the signs; but it was so gentle as not to produce any annoyance worth speaking of.

The sensation produced by rising was both astonishing and delightful; the deception of vision, whereby the earth seems to sink instead of the balloon appearing to rise, was, to me at least, lost in a moment; indeed I can hardly say that I was conscious of it at all, although most aëronauts have described it. We rose rather slowly, and with the consciousness of mounting, as we distanced the crowd and the scenery below, no motion was felt in the little wicker basket in which we sat, which is called the car of the balloon. In less than a minute we were above the trees and all the buildings, the tops of which, as well as the gardens, were filled with spectators. As we were wafted by the light breeze over the valley, I could see the gentle motion of the leaves of the trees which grow along the burn; but in a few minutes more this could no longer be discerned, from our increased altitude; and as the motion of the balloon, when rising, turned us slowly round, I could not easily notice the degree of rapidity with which the angle subtended by any prominent object was diminished; for the scene was constantly changing, as we turned in succession towards every part of the prospect. My companion now observed to me, that we had the main ocean in view, and, indeed, we distinctly saw both the Thames and the sea beyond the Nore. As we were by this time elevated much above the reach of the highest objects, it was deemed advisable to let out the grapple, as we had but little room in the car. I began now to speculate on the forms of the clouds, some of which seemed charged with the electric fluid. In the direction of the Maldon river, and hovering over its marshy lands, we saw what had evidently been a cumulus now subsiding into a stratus or white evening mist, stretching in such a manner over the ground in its descent, that we at first took it for smoke. Higher up there were cumuli in the air, much nimbiform

haze still more elevated, and some waneclouds. The beauty and extent of prospect now increased, and the fields, here and there coloured with the bright yellow of the flowering colewort, green with the young wheat, or richly brown from fallows, chequered with rows of trees whose new light foliage and blossoms enlivened the darker hue of their boughs, and the whole country intersected with rivers, roads, and villages, had a most enchanting effect. All earthly sounds ceased as soon as we had got above the breeze which swept the surface of the ground, where in a region comparatively calm, and lighter than it was below, we were conscious of no motion whatever. I presently felt a slight movement, and heard the great buoyant balloon above us make a noise, as if touched by the wind. On adverting to the cause, we found that we had got into another current, and being at length nearly perpendicular to the village of Writtle, we were gently wafted back again, till we came almost over the northern end of Chelmsford, where, at a very great altitude, probably near 5000 feet, we still noticed the variation of objects as we moved round with the oscillating machine. The white buildings of the Shire Hall, the Church, the avenues and long canal between them at Boreham House, New Hall, and some other prominent objects were still distinguishable; and the plan of the gasworks, the gaol, and other extensive buildings could still be made out. I noticed also a windmill, and the general masses and lines of trees intersecting the fields, while the more distant horizon, softened into a delightful blue, was lost in immensity of distance and seemed to meet the skies by an almost undistinguishable line of demarkation. The hanging my head over the basket, and so looking down, was by much the least agreeable mode of surveying the surface of our mother earth, from whose leading strings we seemed to have burst; and would have made persons who were less accustomed than myself to be on high precipices, very giddy—a circumstance which might have been attended with much danger. I felt, however, no sort of unpleasant sensation, notwith-

standing our great altitude; for the consciousness of insulation in the air makes one feel more like a part of the balloon above us than of the world below. About this time I experienced a sensation of uneasiness about the tympanum of the ear, accompanied by a snapping noise, very like what other aëronauts have described, and which I had before experienced in a greater degree, while descending high hills in Switzerland, as will be found described elsewhere: it was also followed, as will hereafter be seen, by a transitory deafness after we had begun rapidly to descend; but not by that sense of fullness which I have found so disagreeable after coming down from terrestrial elevations: it is probably similar to what Lunardi, Garnerin, Charles and Robert, and all the early aërial travellers who mounted very high, have described, with the exception of M. Blanchard, who does not seem to have been liable to this affection. We were still throwing out ballast, and the balloon, taking a sort of crescent course while mounting, must, as I have since become convinced, have been slowly ascending in an irregular spiral. At length, at a great but unascertained elevation, we found ourselves perfectly becalmed, and so remained, for near a quarter of an hour, the motionless spectators of a vast panorama, over which the most profound and indescribable silence prevailed. Accustomed as I had been, in the course of my varied life, to all sorts of situations, in travelling over high mountains, in ships upon the rough waves, or floating in boats on gentle water, I had as yet seen nothing at all comparable to the scenery of this situation; nor had I ever been in the elevated regions of the air under circumstances of so complete a calm as we enjoyed at this moment. I never recollect an evening more fitted for the quiet contemplation of the boundless expanse of surrounding nature. I remember, in crossing to France, the first experience of a steam boat paddling across the level brine like a fish, was a curious phenomenon, having before been only conveyed by sailing vessels. But this newborn Leviathan of the deep is nothing to this Pegasus of the air;

neither is the sensation produced by a balloon in motion at all comparable to that of a balloon at rest. Picture to yourself, reader, two persons suspended in a small basket slung under an inflated bag of huge dimensions buoyant in the air, immediately beneath a canopy of mist, and in the elevated plane of evaporating and coloured clouds, whose grotesque forms are gradually becoming lost amid the shadows of greyhooded evening, in perfect stillness, without any perceivable motion, and looking down upon a great and apparently concave amphitheatre, divided like a map, and made up of objects rendered too diminutive by their distance to be well defined, and which appear to have no altitude at the great height from which we view them ;—and you may get some idea of the sensation produced by a view from a becalmed balloon. One seems, as it were, to have been divested of all terrestrial connexions, and, raised above the smoke and stir of that dim spot which men call earth, to be breathing, in delicious tranquillity, the pure ether of the celestial regions.



We found at about half past six o'clock that the balloon was still gently ascending; and at this time I became conscious again of increased altitude by a loud snapping in the ears. At length we thought it time to prepare for our descent, and the valve being opened by pulling the string, we began to sink down very rapidly, and soon got into a faint breath of wind, probably only some stray eddy from the interstices of clouds, or the replenishing breeze of one of those slight electrical vacuums which I believe often take place in variable weather. Perceiving that we had again descended into the current of air which blew next the earth, I proposed to my companion to throw out a little ballast, and thus to fly along in the breeze over a large extent of country; but he, fearing that damage might be done to the machine, should the horsemen attempt to pursue us, advised an immediate descent: so I gave way to his suggestions, and the valve being again pulled, we were soon floating over the pine trees near Broomfield Lodge, where we got down, and landed shortly after in a field of oats, after a voyage of about an hour.

The rapidity of the descent perhaps increased the deafness to which I have alluded, and which gradually went off before ten o'clock at night. I find the same sensation mentioned by most aërial and mountain travellers, who have ascended to any great height.*

We were hospitably received by M. James Christy of Broomfield, and were escorted into the town of Chelmsford at night by numerous spectators who had come out to meet us with a band of military music; and observations were made on the balloon during great part of the voyage by means of telescopes by my family at Boreham, and by M. Warner of Widford, who possesses some excellent astronomical instruments.

* A long Catalogue of similar affections will be found in a work, entitled "Medicina Simplex, or The Pilgrim's Waybook, being a Philosophic Enquiry into the Conditions of a Healthy Life, and Happy Old Age; by a Physician." London: *Keating and Brown*, 1832. In which work some of the particulars of my aërial voyage are quoted compared with those of numerous other aëronauts, with a particular view to illustrate this disorder.

I shall now record, for the benefit of my philosophical readers, such observations made during the aërial voyage, as have not been recorded elsewhere. And, firstly, with respect to the organ of hearing and the propagation of sound, I must observe, that at a very moderate elevation all the sounds below us, loud as they were and consisting of a full band of music and the acclamations of the crowd, became inaudible; although it is well known that a lark on the wing above our heads on a spring morning is as distinctly heard to sing, when almost out of sight from elevation, as when he is near the ground: hence I admit the probability that sounds descend better than they rise. Yet I do not know how to reconcile this circumstance with what is related by others, who have distinctly heard sounds on the earth when they have been at prodigious elevations: perhaps it depends on the state of the air at the time, or on the sort of sound: for mere noise is not always sound. The distant ringing of bells is best heard before rain, but their elevated position on a high steeple causes them to be heard farther off. Cannon made of brass are heard farther than those made of iron, but the sound of both is most widely extended when they are fired from hills. I remarked that up to a certain height noises were heard very plain, as of carriages on the roads, and that on descending again to within the same distance they were again audible. I could not hear M. Green speak so plain, during the latter part of the voyage, as before; but this was after a rapid descent, and the effect must be referred to the cause which will be discussed in the next Chapter.

When at a great height the prospect below seemed concave, the horizon being elevated all round like the ridge of a bowl, although in reality it must have been a slight convexity—at least so it appeared to me. On a mountain, the conical figure of our terrestrial support, and the peaks of other mountains, probably destroy this effect. I saw nothing at all like what M. Baldwin described in his account of his voyage, and which is figured in the *Encyclopædia*

Britannica. Neither was I conscious of the least sensation of giddiness, which others have described. However, the vast chasm beneath us when viewed by looking downward from the car gives an idea of concave space of so great an extent, that I can easily conceive it capable of producing some degree of vertigo and of alarm to persons who are not accustomed to precipices.

Of the dangers to be guarded against in aërostation something ought to be said. The balloon may burst from rushing up too high, and the aëronaut not being able to get the valve open. The reverse of this accident was probably what caused the death of M. Harris, whose balloon came down rapidly, owing to the valve being opened hastily, and not closing again.

The getting into an electrical cloud, or the vacuum left by a fulmination in storms, is also an accident to be avoided with due care. The manner in which balloons have suddenly expanded on some occasions must have been owing to electrical causes.

M. Garnerin thought that lightning might strike the gilded parts of balloons, and fire the gas, but I feel doubts as to the probability of this accident.

The being blown out to sea and drenched, or what seems more frightful, being lodged on inaccessible cliffs and crags, or catching on the spires of buildings, are also accidents which the aëronaut should be on his guard against; as is likewise the concussion in landing, and other accidents in windy weather, when the balloon is less manageable.

Besides the above, some persons, owing to varieties in the compound action of organs which phrenology has not explained, have a propensity when on heights to fling themselves down into the gulph below; others feel this with respect to great waterfalls. These and other dangers are all but guarded against by that habitual presence of mind which belongs to a true philosopher, and without which nothing is to be done well, nor any arduous enterprize undertaken with safety.

As balloons are liable to be carried out to sea, from whence a contrary wind might prevent them from returning, preparation should be made for such an accident. As cars are commonly constructed, the aëronauts would be drowned by being dragged through the water. But they might be made of a form capable of floating in the ocean with safety, the balloon acting as a sail. I propose to make numerous experiments, to ascertain this, on the best forms for floats.

Where instruments are taken up into the air, they should be placed in a circular wicker basket fixed round the car horizontally. I hope in time to try some plans of this kind.

With regard to preparatives against danger, there is not much to be said. I advise parachutes of good size to be carried up in the car; as in case the balloon should burst or take fire by accident, they might break the fall of the aëronaut. I think parachutes made light and with baskets slung under them, might be made use of to let children and others out of windows, when houses are on fire: the best machines for this purpose in present use are the firescapes, invented by the late M. John Maseres; but the parachute is, in my opinion, far preferable.

Among the things recommended to be carried up in balloons, I am surprised to find Cavallo enumerating refreshments; the most absurd of all sorts of provisions; for unless in cases where a philosopher intends to remain twenty four hours in the air, nothing can be so idle as the idea of eating and drinking amidst interesting experiments and novel scenes. I never would take any eatables up with me; but I find that many aëronauts have done so: indeed there are persons in this age of luxury who cannot cross the channel in a boat, nor even get into a stage, without the folly of carrying something to eat about them.

Sect. VII.—*Supplementary Additions to the above Annals.*

I propose to give here some account of a few voyages accidentally omitted in the above annals, and of others which

are recorded in the journals of the day, but to the particular detail of which I do not attach implicit credit.

St. Catherine's Day, Nov. 25, 1783, Count Zambeccari launched a gilded silk air balloon from the Artillery Ground at *one* o'clock, and it fell at Petworth, at half past three.

In June, 1786, M. Testa ascended from Paris with a balloon 28 feet in diameter, and he pretended to change its course by means of his wings. When only 2900 feet high the balloon expanded, when, alarmed at his situation, he opened the valve and descended into a field of corn, in the plain of Montmorency, and there took in some ballast, as he pretends, though I suspect that he threw some out in order to rise again ; for I feel certain he never descended by the mechanical effect of his wings. However, while preparing to mount again, his balloon was seized by the owner of the field, to pay for damage done to the standing corn by the crowd, and though buoyant and pressing upwards to ascend, it was carried by a cord three yards long into the village ; on entering which he suddenly cut the cord and mounted again into the air, to the astonishment of the spectators. He now rose to a great height and encountered a thunderstorm, to the imminent danger of his life. At this time he says he saw the electric rays of a positive electricity on the point of an iron rod which he had with him, and soon afterwards saw it changed for the electric stars of the negative electricity. Not daring to let out any of the gas during the presence of the stormy clouds, he was forced to stay up all night; the air then became clear, and after having enjoyed a fine view of the rising sun and floated twelve hours in the air, he came down at Campremi, 75 miles from Paris. They report that on his descending his clothes had a sulphureous smell like that which is perceived in gardens after the first fall of an electric shower in dry weather.

In June, 1794, M. Coutet ascended in a balloon, named the Entreprenant, in order to reconnoitre the enemy's force at the battle of Fleurus ; he was accompanied by a general and adjutant. They remained four hours in the air, and

communicated signals to general Jourdan by which he was enabled to gain the victory. The enemy fired in vain at the balloon.

About the 21*st of Oct.* 1797, M. Garnerin, who had tried several experiments with a parachute, came down in one at Paris, and though it oscillated like a pendulum all the way down, he reached the earth in safety.

Monday, August 22, 1808, M. Andreoli and M. Biot ascended in a balloon from the gardens of the Conservatoire at Paris: they reached the height of 13000 feet and came down 45 miles from Paris. The second and famous ascent of Gay Lussac alone is recorded above, in the order of the annals.

In May and June, 1806, Dr. Jungius, the first German aëronaut, made several successful voyages at Berlin, but of these I have no authenticated particulars to offer to the public. Aërostation does not appear to have been a favourite science among the Germans.

About this time Madame Blanchard ascended from Bordeaux.

Monday, August 27, 1804, M. Gay Lussac and Brioschi ascended at Padua, and rose rapidly to a considerable height. When the barometer had fallen to 15·00 inches, M. Brioschi felt a violent palpitation at the heart; but when the barometer had fallen to 12 inches, he fell into a state of torpor. M. Andreoli alone could observe the balloon, which rose till the mercury sank to 9 inches, when he observed it fully inflated, and found that he could not use his left arm. Soon after this, barometer at 8 inches, the balloon is said to have burst with a loud report; and then they all came down rapidly with safety near the place of Patriarch's tomb. I cannot help doubting the accuracy of this account; for it seems to me that the escape of the air would have caused a precipitate descent of the whole machine and the death of the aëronauts.

Friday, August 25, 1815, Dr. Spurzheim and myself being on a tour from Caernarvon to Capel Cürig, we

ascended Mount Snowden; on the summit of which we sat some time enjoying a most magnificent prospect. On this occasion the descent produced no deafness or unpleasant feeling of any kind; but the barometer was sinking and showers coming on, and we descended slowly by a rugged path which occupied much time.

Friday, Sept. 1, 1815, M. Sadler, jun. ascended from Newcastle and came down at Whitby after a voyage of twenty minutes. He soon after went up from Glasgow and also at Edinburgh, where he made a second ascent on the 4th of November, but the balloon progressing towards the sea he pulled the valve and soon came down.

Sunday, April 28, 1816, Madame Garnerin, who was called the heroine of parachutes, ascended in a balloon from Paris and descended in a parachute in the Bois de Boulogne, two miles from Paris.

Sunday, May 19, 1816, I ascended Skiddaw in company with Dr. Spurzheim, and on coming down was attacked with fulness about the ears and deafness, which gradually went off.

Wednesday, August 5, 1818, M. Malreski, a Pole, and 11 guides, ascended Mont Blanc, reached the summit on the 6th, and on the 7th returned.

Wednesday, July 6, 1819. A fatal accident befel Madame Blanchard this evening, by an ascent in an illuminated air balloon, from the gardens of Tivoli, at Paris. A grand fête had been announced for the occasion, and a great multitude was assembled. Madame Blanchard ascended, dressed in a white robe with a white hat and feathers, and placed amidst her rows of Bengal lights; she had a very imposing appearance in the car. By some accident or other some of the gas escaped, the whole took fire, and an appalling blaze in the air proved to the distressed spectators that some fearful combustion had taken place. The gens d'armes galloped to the place where she was supposed to have fallen, and soon found her in the Rue de Provence, in her car, and enveloped in the network of the balloon; she

had previously struck on the roof of a house, the inhabitants of which heard a dreadful cry, nor was she quite dead when found after a second fall from the roof into the street. However, a few moments ended her earthly existence, and her remains were interred in the Cimetière du Père la Chaise. Although in general so courageous, she was on the occasion of this ascent very nervous, and expressed to some friends that she had presentiments of evil, and had not been comfortable all that day.

Monday, July 11, 1819, Dr. Howard, Dr. Van Rosselaer, and guides, ascended Mont Blanc and reached the summit on the 12th, returning on the 13th. When on the peak of the mountain I noticed wane clouds at the same elevation as ourselves, while the cumulus formed about the summit and even below us. We had a most extended and enchanting prospect.

Saturday, August 25, 1821, M. Green ascended from Portsea, surpassed the clouds, and after a difficult voyage landed at Langstone.

Monday, July 29, 1822, having slept on the Jura at Champagnolle, I proceeded, accompanied by my wife, over the mountain to Gex in Switzerland: on beginning to descend we beheld one of the finest views of Alpine scenery which the world can exhibit, mountain after mountain rising in lofty and snowclad cones, forming that vast barrier of Swiss and Savoyard Alps which divide Italy from France, crowned by the lofty Mont Blanc, whose cloudcapped summit seems to meet the skies. The sun was going down, and breaking out between divided clouds cast all varieties of beautiful colours on the mountain peaks; while the diversified modifications of the clouds which precede the gathering of a tempest, threw their partial shadows on the scene: between us and this fine background of mountains inhabited by the chamois and the marmot, and in which imagination might add the chaste Diana and the Oreades, lay the beautiful and widely expanded mirror of the Lake of Geneva, encompassed all about with villages whose spires

were reflected in the glassy waters, with vineyards, orchards, and flowering fields rising in gentle subalpine hills. As we descended, the sudden change of manners, from the gay French to the romantic people of Swizzerland and the Savoy, with their varied and peculiar costumes and new language, added to the effect. The temporary deafness which I experienced was of short duration. We stayed an hour at Gex during the storm; and travelling afterwards to Nyon by the side of the lake, we had an opportunity of witnessing one of those formidable but interesting storms,* which, in such a situation, naturally brings to mind Virgil's lines:—

Armorum sonitum toto Germania cœlo
Audiit insolitis tremuerunt motibus Alpes.

The sun had set, and the darkness of the evening came on very suddenly owing to the gathering of the clouds, which appeared highly charged with electric fluid, and hung about the rugged surface of the mountains. We were travelling in a small calèche, of which the curtains were very bad; when the storm began, the rain fell in torrents and entered the carriage; the lightning darted down in forked and zigzag streams on all sides, but particularly towards the lake, and the thunder rolled almost without intermission and louder from the mountain echoes than I had ever heard it before. I noticed in the storms two distinct kinds, and I cannot help referring one to the discharge of the spark, and the other to some combustion of gases: the echo was tremendous, the very ground seemed to shake under us, and I might almost have written notes from the ceaseless glare of the lightning, which was of various colours, but the bright blueish white prevailed. We began to be very wet, but we could not help laughing at our ridiculous situation, being forced to hold up the curtains of the vehicle against the shower. By the time we had got to Nyon the tempest had

* Some exceedingly curious particulars relating to this storm and its extent will be found in my Researches about Atmospheric Phenomena. London, &c. 1829.

abated; but it was followed next day by a series of showers of larger hail than was ever recollected before in that romantic country, and which destroyed several fine vineyards near Vevai. The thermometer rose to 80°. at Lausanne in the intervals of the showers.

Friday, June 13, 1823, M. Green and another gentleman ascended from Oxford and came down at Henley.

Tuesday, May 26, 1829, M. Green ascended from the Friars Gardens, Moulsham, about a quarter before seven o'clock in the evening; the balloon rose well and was seen for a long time rapidly waving towards the W.S.W. The breeze was rather strong and the balloon came down in safety at Hornsey, a distance of thirty miles, and lodged first on the top of a cottage. This voyage has been misrepresented in a former page, as having taken place on the 19th instead of the 26th.

Thursday, July 2, 1829, M. Green and another person ascended in the evening from the Bowling Green of the Golden Eye, Mile End Road: it was his 71st ascent. He descended at about a mile from Ilford, in Essex.

In Autumn 1829, M. Green ascended from Colchester.

Friday, August 12, 1825, M. Graham with another gentleman attempted to ascend in his balloon from Chelmsford. He failed however to make an ascent, and his companion getting into the car alone, it rose to an inconsiderable height, and came down at Chelmsford, catching on the bell on the top of the gaol. After the adventurous traveller was dislodged, the balloon broke away and ascended with great velocity into the air, where it expanded and burst, and soon came down at Purleigh, about nine miles distant.

Sir George Cailly has lately made some very curious observations on aërial navigation, which are to be found in the *Philosophical Magazine;* and I understand that the Earl of Minto is prosecuting some ingenious researches into the temperature of different regions of the air by means of balloons.

Wednesday, Sept. 29, 1824, M. Windham Sadler met with a fatal accident with a balloon to day, and it is the

second which happened this year. He had gone up, accompanied by one of his men, from Bolton: when nearly over a place called Church, near Blackburn, they prepared to descend, and coming down rather too rapidly, and with too much wind, the balloon brushed against a tree, which threw Sadler out of his car, to which he hung by one leg, the balloon moving on, while the aëronaut was suspended in this dreadful situation with his head downwards, struck again on a chimney, against which it dashed poor Sadler's head with so much violence that he was knocked down with his skull and several bones fractured, and died early the next day. It is said that he had evil forebodings of the fate of the day, and was rather nervous on going up. The balloon, after this accident, rushed up with great violence into the air, with the man who was left in the car, and who had been probably too much alarmed to assist his master; after reaching a great height it descended again, and striking violently against some rails near Whalley, when the man leaped out, fractured his left arm, and received some other injuries.*

Saturday, June 24, 1826, M. Corneillot, accompanied by a gentleman named Joliffe, ascended in an air balloon, from a place near Wood Farm. The aëronaut had promised to navigate the balloon, and to move it horizontally, but this did not appear to succeed, and after a few minutes passed in horizontal motion, the balloon was carried away by the wind. They then rose with fearful rapidity to the height of near 10,500 feet, passed the clouds, and observed the brilliant appearance of their mountainous superstructures rolling beneath the balloon, and appearing as it were nicely balanced in the air. M. Corneillot took up some birds with him, and observed that they could not fly when above

* It is astonishing in what a number of cases persons who have died suddenly by accidents, have had some presentiment of it on the fatal day. I have sometimes endeavoured to account for this, by supposing that the very same nervous agitation which might accompany the evil foreboding might also disqualify the parties from assisting themselves under the necessary dangers of their situation; but the thing occurs too often to be referred to such a cause, and we must leave it among the many remarkable coincidences which human life affords.

the clouds. The aëronauts themselves were sensible of much inconvenience, and though, as they observed, the structure of bright and wavy clouds beneath them concealed the chasm below and prevented giddiness, yet the blood-vessels swelled and the ears tingled, and were in pain. The balloon shortly afterwards came down at Combe Bank, in Kent.

Sect. VIII.—*Additional Experiments and Observations.*

Ascent of a Horse.—*Saturday, August* 16, 1828, M. C. Green* ascended in an air balloon from London, in company with a pony; the novelty of making so dangerous an experiment, in company with so refractory an animal, drew much company to the spot, and excited a great deal of mirth. On first mounting into the air the little horse seemed alarmed as the spectators shouted horribly loud; but on getting into a more tranquil region he became very quiet and began eating some beans out of M. Green's hand, who dismounted in order to pat his sides and quiet him, and fed him to keep him quiet: the balloon rose to a considerable height and got into a shower of fine snow like silver dust; but at length having crossed the Thames came down, and safely landed the passengers at Beckenham, in Kent, after a voyage of half an hour.

I am not aware that any equestrian voyage to the clouds had ever been made before this: the elephant that is said to have ascended at Paris was an inflated effigy of that huge animal.

Thursday, May 12, 1831, M. Green ascended again from Chelmsford, in company with the two Demoiselles Kennett, and descended soon afterwards at Baddow, distant about two miles. It was a very calm and clear evening, and they had a fortunate voyage.

* I believe M. George Green, this gentleman's brother, has made more voyages than any other aëronaut, having ascended near 100 times into the air; whereas neither M. Garnerin nor M. Blanchard made more than 50 voyages each.

The last balloon ascent which might be described, was made by one of the Messieurs Green, in the presence of the King, on the occasion of opening London Bridge.

AN OBSERVATION OF M. GARNERIN ON M. MOSMENT'S VOYAGE.—The ninth and fatal voyage of M. Mosment at Lisle, recorded above on the 7th April of this year, produced from M. Garnerin some curious observations on the dangers to which aëronauts are exposed, and he dates them all, but in my opinion erroneously, to carelessness or want of presence of mind. He also represents the danger of ascending with gilded and silvered balloons, as Zambeccari used to do, as very hazardous, on account of the electricity of clouds which might be attracted by the metallic coating. M. Blanchard on the contrary asserted that he had passed through clouds frequently with gilded balloons in perfect safety.

There are some curious particulars connected with M. Mosment's fatal voyage: when at a great height over the city of Lisle, his flag was observed to drop and was picked up: soon after this, the spectators saw the balloon rise very rapidly to an enormous height so as to be quite lost, just as if much ballast had been thrown out; but they did not see M. Mosment fall; although his body was picked up soon afterwards close by the city. The balloon fell the same day at the distance of above 70 miles from the place of ascent.

DISPATCHES.—*March* 24, 1807, a curious experiment was made at Woolwich; small balloons being sent up with dispatches intended to be dropped at given distances, by means of touchstring set on fire and calculated to burn a given time, so as to drop the letters where it was desired. The experiment required too much accuracy to succeed.

BLANCHARD'S DOG.—*August* 26, 1787, M. Blanchard ascended from Strasburg, and let down, as he thought, a dog in a parachute; the animal however in his descent got into a whirlwind, which carried him up with great rapidity to a height in the air exceeding that of the balloon; as the whirl-

wind subsided the parachute descended again, and in passing the balloon the dog recognised his master and began to bark: just as he was stretching out to seize it, another whirlwind carried the dog up again; and M. Blanchard, descending near Zell, actually got down before his dog. Of this account I say *credat Judæus Apella*, but it is probable that making allowance for some exaggeration the outline of the story is true. M. Blanchard made several experiments with parachutes, and let up dogs in small balloons with parachutes attached to them by means of touch string, which came down safely to the ground.

PARACHUTE.—Soon after this M. Blanchard himself made the first descent in a parachute from a balloon, and broke one of his legs in the fall.

GUIDING BALLOONS.—In 1786, M. l'abbé Edgeworth made some experiments to show that balloons may be guided in the air, which, as they are not at all satisfactory to me, I shall not relate. He supposed that by alternately elevating and depressing the course of a balloon a direction might be given to it, and observes that Dean Swift, in his famous Chateau dans l'esprit, called Laputa, pretended to manage this flying machine in a similar manner. M. Edgeworth it appears afterwards in 1802 showed his invention to M. Montgolfier at Paris, who in turn showed him his Hydraulic Ram.

Qui vigilat inveniet.

CHAPTER II.

MISCELLANEOUS PARTICULARS.

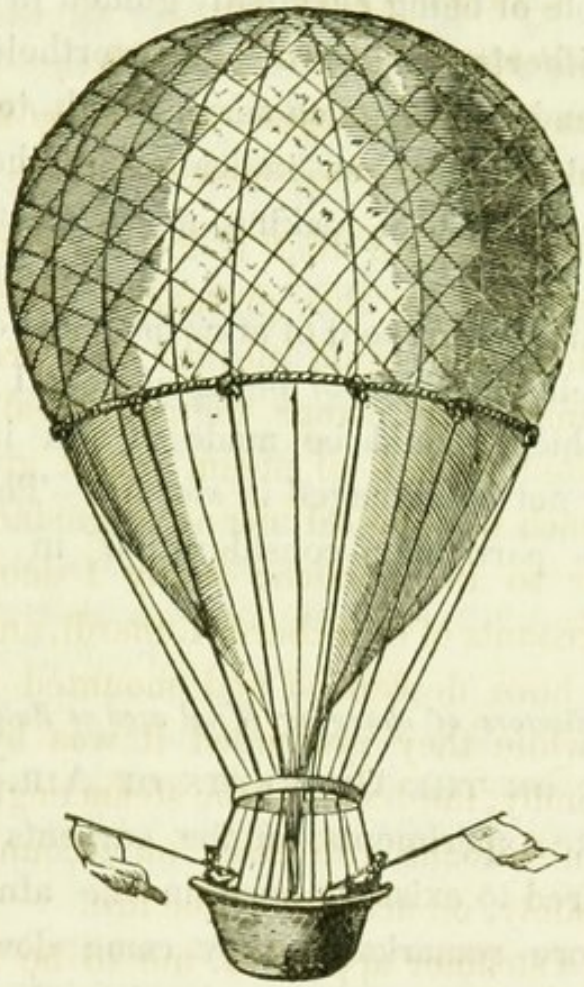
SECT. I.—*On the Notion of guiding Balloons—the Power of Steam, as a Means of directing Boats, inapplicable to Balloons.*

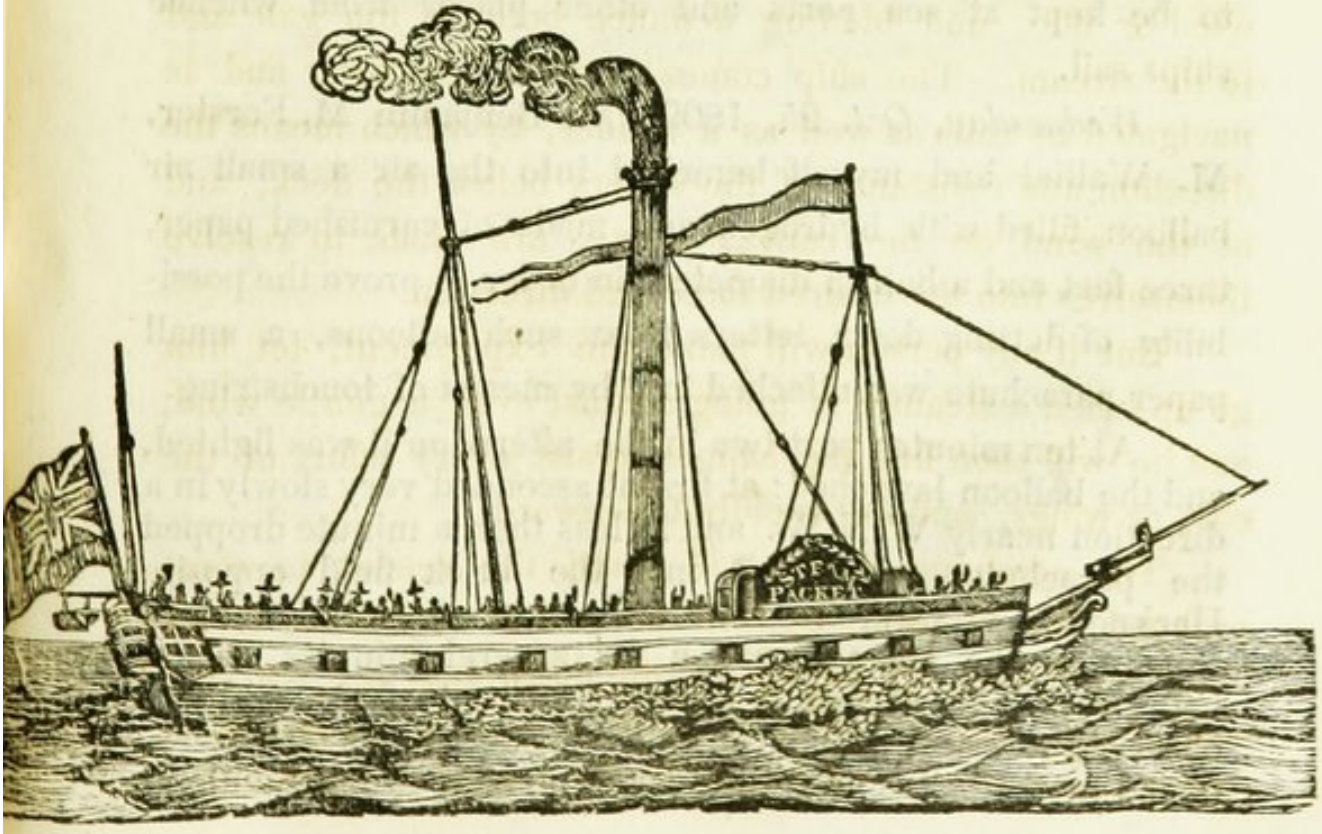
IT has been often urged that if the early aëronauts could move their balloons, as they pretended, horizontally against a slight wind, and could elevate or depress them at pleasure, by means of oars, wings, the gouvernail, and so on, the newly invented powers of steam might give great force and effect to such mechanical means of guidance: but it does not appear so in practice: firstly I doubt of the correctness of the accounts of Blanchard, Lunardi, and others, who seem often to have descended and mounted again by the aid of ballast, while they pretended it was by means of their wings; secondly, the boiler of the steam engine could not be carried up in balloons with ease, on account of the weight; nor with safety, on account of the fire.

A balloon and a steamer appear to me to be the very opposites to each other; the balloon going invariably with the wind alone, and setting mechanism at defiance; the steamer being propelled mechanically without the aid of wind or tide, and bidding defiance both to the gale and to the stream. The ship comes between the two, and is navigated by sails as well as a rudder, by which means the direction and resistance of the waters below the deck, and of the wind on the canvas above, are made to resolve themselves into the desired force and direction.

But if any person will make the experiment, let him go up when a steamer is going against even a gentle wind, and he will soon find the balloon resist every effort of the oars or wings, and sag rapidly to leeward.

The adjoining figure will assist the reader to comprehend the subject: besides the above objection, if we observe a balloon in the air sinking down into the sea, we shall almost always observe, by the bulge and slight inclinati on that it has a different current from the vessels in the water.





The balloon being afloat in one element only seems to me not to be capable of being effectually guided in its course by any means hitherto discovered. Nevertheless small balloons may be rendered of much service both to nautical and meteorological science, as indicators of the coming wind, and as the means of making many electrical experiments.

Another familiar instrument of atmospherical electricity occurs to me as being capable of being of use, I mean the electrical kite, which should be made of silk instead of paper, that it may not be damaged in storms. This subject however deserves particular consideration in the next section.

SECT. II.—*Indicators of changing Wind used as Balloons.*

EXPERIMENT ON THE CURRENTS OF AIR.—I began very early to make experiments on the currents of air, of which many appeared to exist at once in the atmosphere; and what was more remarkable they came down to the surface of the earth in succession, showing thereby that small balloons may be made use of, in order to determine the direction of the coming wind, and ought for this reason to be kept at sea ports and other places from whence ships sail.

Wednesday, Oct. 25, 1809, M. Benjamin M. Forster, M. Wallis, and myself launched into the air a small air balloon filled with hydrogen and made of varnished paper, three feet and a half in diameter: in order to prove the possibility of letting down letters from such balloons, a small paper parachute was attached to it by means of touchstring.

At ten minutes past two in the afternoon it was lighted, and the balloon launched: at first it ascended very slowly in a direction nearly W.N.W. and in less than a minute dropped the parachute, which fell into the brick field opposite Hackney New Church. The balloon now ascended more rapidly in the same direction for several minutes, when, being very high, it met a different current of air, and was observed to travel nearly towards the South: this was ascertained by the balloon's getting much more southward without

increasing or diminishing in apparent magnitude, which it would have done, if it had taken a course either much to the East or the West of the South. In a few minutes more its course was again altered by a third current of air, which carried it in a direction apparently NE. when it passed again over the northern part of the parish of Hackney, and was distinctly seen from the place of its ascent. At about twenty minutes before three, it was blown by a fourth current nearly NNW. by N. Thus there appear to have been four different currents of air above one another, namely, ESE., N., SW., and SSE. by S. It very soon became invisible to the naked eye, but was discerned through a telescope till about ten minutes before three, when we observed it to sink very rapidly, after which it was no more seen. The balloon fell the same day at five o'clock at Wilbraham in Cambridgeshire.

A small balloon let off the same day went uniformly in one current of air.

One very curious way of exploring currents would be to send up a long string of small balloons, one above another, the highest having the greatest ascendant power: their varied directions and counteractions would be very curious, as the whole chain would present a shifting figure as it mounted.

One of the most useful purposes to which the science of Meteorology can be applied, is that of enabling shepherds, farmers, and mariners to ascertain the ensuing changes of the weather. To this part of the subject I have always paid particular attention; and with a view of furthering so useful an object, I am induced to insert the following observations, founded on personal experience.

The most important part of our atmospherical experiments, particularly when considered with reference to nautical science, relates to the causes and indications of the changes of the wind; to foresee which has always been deemed a desirable object. I have of late made numerous experiments, the result of which points out clearly a very easy method of prognosticating such changes. For I have found that the changes of the wind usually begin first in the higher regions of the air, and subsequently descend to the surface of the earth. In the year 1809 and 1811 I sent up a vast number of small balloons, and again in 1824 and 1825, I made experiments on wind nearly every Sunday evening for several months at a time, by means of kites raised to a great height in the air, and frequently sent up small balloons for the same purpose. By accurately noticing the successive directions of the balloons, I ascertained what currents were blowing aloft, and even the

kites, three or four of which I sent up tied to each other so as to form a long series, frequently indicated different draughts of air. In at least nine cases out of ten the currents came down and blew next to the earth in the same order in which they appeared above: so that the higher of the crossing currents came down the last in the order of succession. The same experiments have been made in France, and with the same results.

During a recent aërial voyage I had a striking instance of this fact. The three successive directions of the balloon, which I accurately noticed the whole time I was up, came down next day, and was indicated by the weathercock. But the most remarkable circumstance noticed by me during the aërial voyage to which I allude, was that when we reached an altitude of near five thousand feet, the balloon had a sort of spiral course, as was accurately determined by observers who were watching us from below. This fact I at first took to be accidental and of no importance; but subsequently looking over a very able paper on the hurricanes of the West Indies by an American philosopher, I find a series of observations which prove that all those fearful tempests are large whirlwinds. The author is likewise of opinion that the most violent gales are circumvolvent, instead of being rectilinear as is vulgarly supposed. This may possibly be the case, and certainly demands further enquiry: for the periphery of the circles in which they move, may be so large as to render their circular figure imperceptible from below. I have noticed circumstances, in crossing over the high mountains of the Alps, which seem to favour the above hypothesis. But as I propose to repeat my experiments in aërostation and meteorology, I may before long have something further to communicate on this subject. The facilities for experiment are unfortunately not so great in Britain as in France, nor is the interest taken in science so great in this country.

Sect. III.—*Of Kites and other Flying Instruments of Meteorology.*

Something ought to be said of the means of turning that beautiful plaything the kite into a philosophic instrument. Kites may, by tying one to the back of another, be made to go quite as high, if not higher, than any balloon tied to a string, and would be preferable thereto, as a means of bringing down and thus demonstrating the electricity of the air and clouds.

CHAPTER III.

ON THE AFFECTIONS OF THE ORGANS OF HEARING OCCASIONED BY AERIAL JOURNEYS.

As the investigation of the fluctuating affections of the organs of the external senses may lead to a more perfect knowledge of their more permanent disorders, so should we be justified in bestowing thereon a very particular attention, even if natural curiosity itself did not prompt us to this enquiry.

The particular affection of the Organs of Hearing, which first called my attention to their physiology, is that transitory deafness which is experienced immediately after aërial and mountain voyages, by certain individuals, while others are comparatively exempt from it; being frequently liable to some other disorder in its stead. I shall first describe the effect, and then proceed to examine the cause.

After ascending to any great height in the atmosphere, a snapping noise is usually heard in the ears, as if it were produced by the tympanum; and on swallowing anything, instead of the usual almost imperceptible crackling sound in that organ, the aërial voyageur hears a louder and very unpleasant sound: but there is as yet no deafness. On descending again, however, the hearing becomes somewhat difficult, and this is accompanied by more or less of a sense of fullness and pressure about the internal parts of the ears, which is worse as he gets lower down, and does not wholly subside for some hours afterwards. So that it cannot be said that the altitude, in the air, produces the deafness and pressure; but it causes an affection as we rise, of which, as we descend, the deafness is the counterpart. If we attend to this sensation, we shall find that it is likewise attended by both sorts of *Tinnitus Aurium*, or what are called roaring and singing of the ears. When the affection has been violent, it is longer going off: in some cases it may be compared almost to the effects produced, by loud explosions, on the ears

of those unaccustomed to them. I have been the subject of this annoyance during most of my ascents to the summits of mountains, as well as in the air; and if the reader will take the trouble to examine the foregoing annals, he will find that almost all other aëronauts have complained of it, as following, during the descent, those painful affections which often occur at great altitudes, but which subside as the patient gets down again into an atmosphere to whose elasticity and pressure he is more accustomed. This annoyance may seem trifling, from its fugitive nature; but as analogy would point to the same or similar conditions of the organs as capable of producing more lasting infirmities, so ought we to take advantage of these transient effects in order to develope their causes, and to avoid both their temporary and permanent recurrence whenever it be possible.

Sect. I. *Structure and Physiology of the Auditory Apparatus.*

When certain things are perfect in the ear, then as Mr. Abernethy used to express it, hearing is present; when these things are absent, so are likewise the functions of the auditory organs. It will be proper therefore to begin our enquiry with the anatomy of the ears. With the external meatus and the cartilaginous expansion or pinna of the ear we have nothing to do in this enquiry: therefore I shall proceed to the internal parts which demand particular attention.

The *Internal Ear* is enclosed within the petrous portion of the temporal bone; it is divided into the tympanum, the mastoid cells, and the labyrinth.

The tympanum is a roundish cavity, covered by a muscular membrane just as a drum is by its parchment, and for this reason it is called the tympanum: it contains four delicate bones, the *malleus*, *incus*, *stapes*, and *os orbiculare*, and muscles belonging to some of them; the *chorda tympani* otherwise the membrana tympani. It is everywhere lined with a vascular membrane.

The mastoid cells belong to the temporal cavities in the bone.

The labyrinth is a cavity within the ear which, from the different form of its parts, is divided into the cochlea,

vestibulum, and semicircular canals. The soft parts which are formed within, which form the organ of hearing, are—The membranous semicircular canals, which are situated within the bony semicircular canals, are loosely connected to the periosteum by a cellular membrane, a quantity of fluid being interposed, which circulates through the labyrinth. Each of these membranaceous semicircular canals proceeds from the vestibule, and at its commencement swells into the oval ampulla; now all these oval ampullæ originate from a membranaceous sacculus within the vestibulum, which is termed the alveus communis. This sacculus, the ampullæ, and membranaceous canals, therefore, occupy the vestibulum and osseous semircular canals; and it is by means of the alveus communis that the membranous canals all communicate with one another, they being, as it were, tubes growing from the sacculus. They are distended by the very limpid fluid of the labyrinth. The internal ear or tympanum has an opening for the admission of air into the mouth, by means of the Eustachian tubes.

The blood vessels of the labyrinth arise from the vertebral arteries. The auditory nerves arise from the medullary streaks on the surface of the fourth ventricle of the brain, and they increase into small greyish and rather prominent bands laid transversely on the corpus retiforme, which band is proportionate to the bigness of the auditory nerve, and consequently to the acuteness and power of the faculty of hearing in different species. The auditory nerves taking their origin near to that of the convolutions of the brain which are the organs of the musical faculty, explains why persons, who are beginning to be deaf from nervous irritation, often feel a particular disposition to sing. These nerves are eventually spread out on the sides of the alveus, and ampullæ and on the zona mollis of the cochlea, like a fan, in a manner somewhat analogous to the way in which the optic nerves are expanded in the retina. So that the out-spreading of this nervous substance, on the internal parts of the ear, may be said to be a contrivance for receiving, and communicating to the brain, the impressions of sound, which are specifically modified vibrations of air, caused principally by sonorous bodies, and received and concentrated by the external meatus so as to agitate the tympanum. This drum then is said to communicate its vibrations to the malleus, the muscles of which transmit them to the incus, to the os orbiculare, to the stapes, and thence to the water of the labyrinth: so that on the peculiar agitation of this fluid, transmitted through the nerves, depend the numberless varieties of sound, which, when perceived and adjusted by means of the organ of music, constitute all that the mind

perceives of the melody and harmony and other varieties of sound. The rest belongs to the sentient capacity or mind itself. This is all that need be said, for our present purpose at least, of the structure and physiology of the ears.

SECT. II.—*Pathology of the Organs of Hearing—Cause of the Deafness—Curious Facts and Queries.*

Besides inflammation and other affections which the external ear is so liable to, in common with other parts, the internal ear is subject to its peculiar disorder, deafness, or a defect in its proper functions. This may be either transitory, or lasting, according to the time that its essential causes continue in operation ; and the proximate causes may be divided into two classes, viz :—1st. Obstruction in the accessary apparatus ; and 2nd. Loss of vital power or tone in its necessary nervous system. I propose here to enquire into the cause of that transient affection produced by changes in the altitude of the patient ; and in so doing the first question is whether the nerves themselves are, for the time, paralyzed by some electrical effect, or whether the deafness be from obstruction ? I think both causes are probably in operation, for I have made this very remarkable observation, that after descending from mountains the most tiresome sensation is that of pressure and fullness about the tympanum, with very little loss of hearing ; whereas after descending from balloon voyages the greatest annoyance is from the difficulty of hearing, from the weak impression of sounds, whereas the sense of obstructive fullness is very little !

My first notion of this affection was that it arose from the rarefaction of the air in the higher parts of the atmosphere, whereby the air in the tympanum expanded and pushed out the membrane ; as a bladder is swelled in an air pump ; and then as we descended again the membrane having been stretched did not vibrate so well as before, and required some time to recover its proper tone ; just as the parchment of a drum which had been stretched by overbracing would not sound well : at the same time, I thought the feeling of fullness might be occasioned by a rush of blood to the head, produced perhaps mechanically by descending ; which might be worse in coming down a mountain, from the jolting and fatigue. But in order to render this explanation valid we must suppose the Eustachian tubes to be closed up ; which would, according to received opinion, have caused deafness of itself ; since they act, like the hole in the sides of a drum, to let air into the tympanum. I am not however

quite certain that the partial obstruction of these tubes would actually cause deafness, I cannot help regarding them as constituting a provision of Nature against the effects of changes in the pressure of the atmosphere, by affording a passage for communication, and thus preserving the equilibrium between the air within and that without the tympanum. According to this view of the subject, the obstruction of an imperfect passage through the tubes, to which we know many persons are subject, would not of itself be a cause of deafness, but would render persons liable to become deaf for a time whenever their own altitude, or the barometrical pressure of the atmosphere, should be changed. That some persons are and some are not subject to this fugitive deafness may arise from the degree in which their tubes are permeable. For I have observed a great variety in this respect. I have myself suffered this affection on the sudden rising of the barometer, while I remained stationary in the house; on other occasions I have come down from high mountains without feeling it at all. There may be also adjunct causes arising from the electric properties of the air; and this may account for the different effects on different occasions. We know that change of weather will produce pains in many parts of the body, that bad teeth and injured bones ache before rain, that the first coming of east wind causes irritability and headache, that the Lunar conjunction and opposition bring on the paroxysms of madness, and numberless other affections in the animal system which, reasoning from analogy, we should ascribe to some of the modified operations of this principle on the earth's inhabitants, through the medium of its atmosphere. The subject deserves further enquiry, to assist which I submit to the reader's notice the following facts and questions:—

Deafness has been rendered worse on some occasions, and cured in others, by subjecting the ears to the galvanic sparks! Can the fluid of the labyrinth be changed in quality by becoming the conducting medium of atmospherical electricity? Are the bloodvessels expanded?

Deafness in descents from great heights is attended with Tinnitus Aurium: change of weather also produces this in nervous people. Besides the singing in the ears which resembles a tea kettle, and which comes sometimes with a louder ringing from the rush of blood to the head, there is a sort of roaring more internal accompanying deafness; and also a knocking, to which nervous people are subject, which a friend of mine ascribes to the malleus and incus. The roaring comes on at particular times of day and night, and most in hot weather! I want to know what varieties of these affections are found to accompany the deafness owing

to descents from balloons and mountains, to which this chapter relates?

Persons who go down in a diving bell are said to be deaf; now agreeably to the explanation which I have offered, the increased weight of the air transmitted to them when they were below the waters would make them deaf at the bottom, whereas they would be relieved on rising! Is this always the case?

It seems to me that the makers of musical instruments, and teachers of the art of singing, ought to be consulted on the subject of varieties, in the modes of partial deafness, not that the musical faculty depends on the ears alone, for it has appropriate organs in the brain.

There are marine animals capable, with impunity to themselves, of dragging men down so deep in the sea as to cause the head and other organs to burst, and to force in the water.

That huge bird the condor of the Andes darts down on its prey in a straight and rapid course of several thousand feet in a few seconds! What is the structure of its brain and ears different from those of other birds?

Insects are said not to inhabit the higher peaks of mountains, and yet we do not find that parasitical insects are destroyed by the highest aërial flights of migratory birds on whom they live. I have seen the ravens above the peak of Cader Idris. The albatros is said to fly still higher. eagles soar till out of sight, and cranes, storks, and even wild geese fly high in their migrations. Swifts and swallows also ascend very lofty! What is the greatest altitude to which, according to geometrical observation, birds have attained?

The migrations of the swallows and other annual visitants constitute one of the most curious subjects in natural history, and I should much like to have tables of the periods of birds made out for each latitude and longitude of the habitable globe.

These reflections lead me to conclude this work, with inviting the attention of philosophers to the flight and power of wing possessed by birds.

P.S. While at press, I learn that M. Green, jun. has ascended again at Cambridge, accompanied by two persons, on Wednesday, 16th of the present May, 1832, attained the height of 9000 feet. and descended at Foulmire.

CHAPTER IV.

ON THE FLIGHT AND MIGRATION OF BIRDS.

The subject of mechanical movements in the air, which has been alluded to above, naturally brings us to the questions, by what means birds and winged insects become buoyant?—what are their greatest powers of motion through the atmosphere?—and by what instinct and means those vast migrations are effected, which annually take place among the volatile inhabitants of the globe, and which in many cases mark the distinctive seasons of the year with so great a regularity as to her appointed time, and the Turtle, and the Crane, and the Swallow, observe the time of their coming. It appears to me that make the ancient writers say, Yea, the Stork in the Heavens knoweth all animals, including man, are impelled to action by the operation of external agents on peculiar organizations, so that the life and character of every created being is, in effect, the result of two principal causes—native instinct, which seems to result from the particular organs of the brain, and education, which comprehends the sum of all the external impressions: the whole chain of effects which act reciprocally on causes being referred to a final cause. A similar observation may be extended to every phenomena of the universe; all creations being maintained in their particular functions by the pervading power of the Creator. Thus then should man also be studied, with a view to his natural history. We should begin with his organization and proceed to his physiology, and then to the effect of accident, of education, and of those peculiarities of position in society, which varying in every age and clime, according to some universal principle of change, make up the diversified features of society, of which the chequered tablet of history is the record. Next to the brain and nervous system by which we demonstrate the conditions of the character, we should examine the organs necessary to its developement, as the limbs, the nutritive organs, and so on; and in birds, the wings and air cells; in fishes, the fins; and in man, the numerous mechanical and philosophical inventions, which are, as it were, adjutant limbs added by the inventive powers of a more perfect organization. Viewing the actions of men and of animals in this light, I am adverse to the hypotheses of those theorists who assert that we have learned to swim from waterfowls; to construct houses from the Beaver or the nestmaking bird; the instincts of the human as well those of the mere animal being are the springs of their respective actions. But as I have already observed that each is

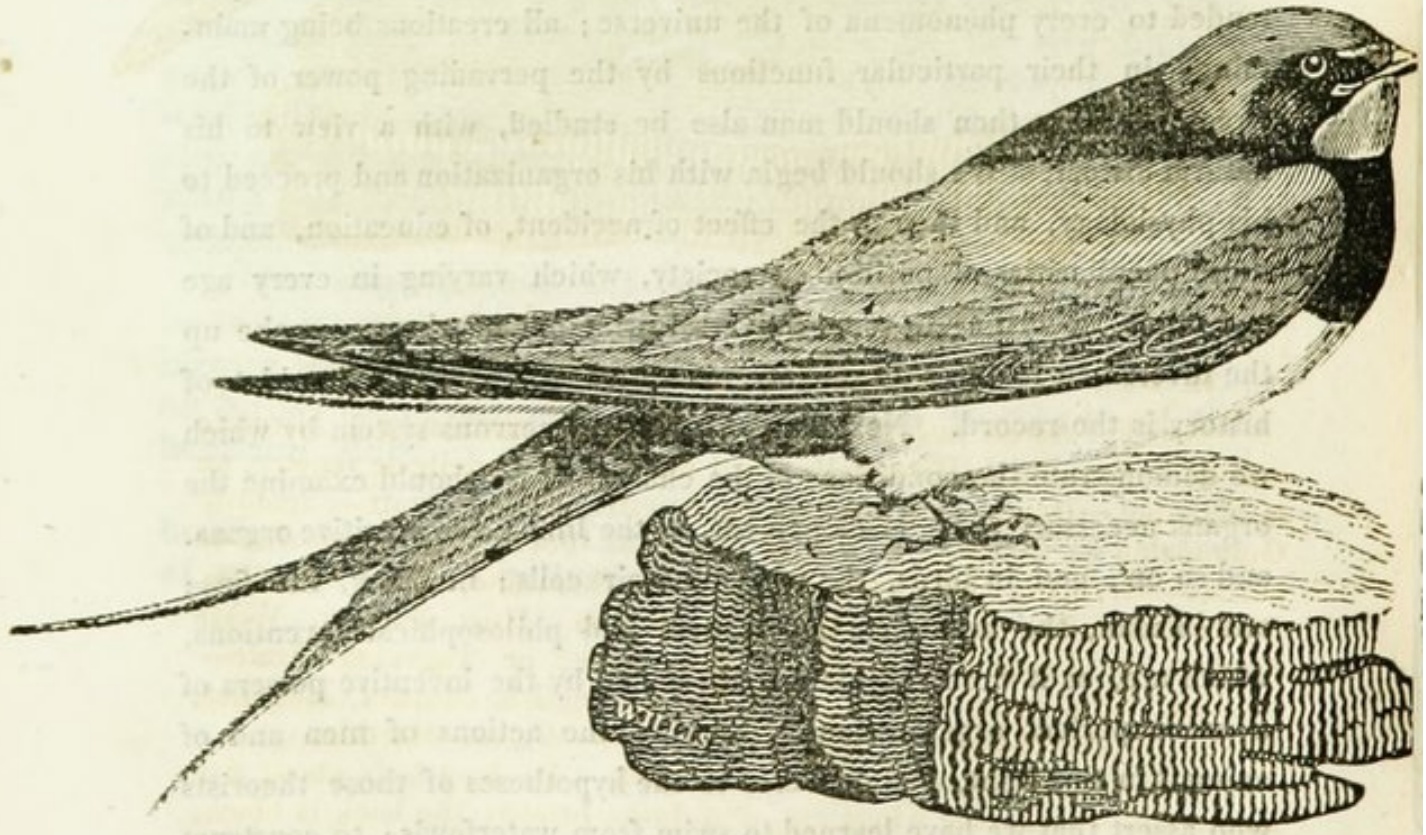
aided by the power to imitate the rest,—so many of the mechanical arts enjoyed by man may be improved by writing accurately what mechanisms Nature has employed in the construction and use of the necessary organs of other creatures. Hence I propose to philosophers to enquire more particularly into the power of birds and winged animals in general; to excite them to do which the following anecdotes and remarks on the migration and power of flight in birds are subjoined.

Sect. I.—*On Migratory Birds.*

I propose in particular that accurate notes should be made by voyageurs of the arrival and departure of birds in the countries in which they may travel, *distinguishing always the species.* For example, it would be interesting to know how long the swallows are in going from hence to Senegal, where it appears they arrive in autumn, soon after they leave us.*

The engravings in the subjoined pages will enable the reader to distinguish the several species. The same observation applies to Woodcocks, Quails, Cranes, Storks, and other migratory fowls. By multiplying such observations we shall acquire a more accurate knowledge of the space traversed by birds in a given time, and shall be able the better to estimate their mechanical powers.

The following are the distinguishing marks of the four species of Swallow which visit France, England, and other temperate parts of Europe; and I have subjoined the European names for each sort.



HIRUNDO RUSTICA.

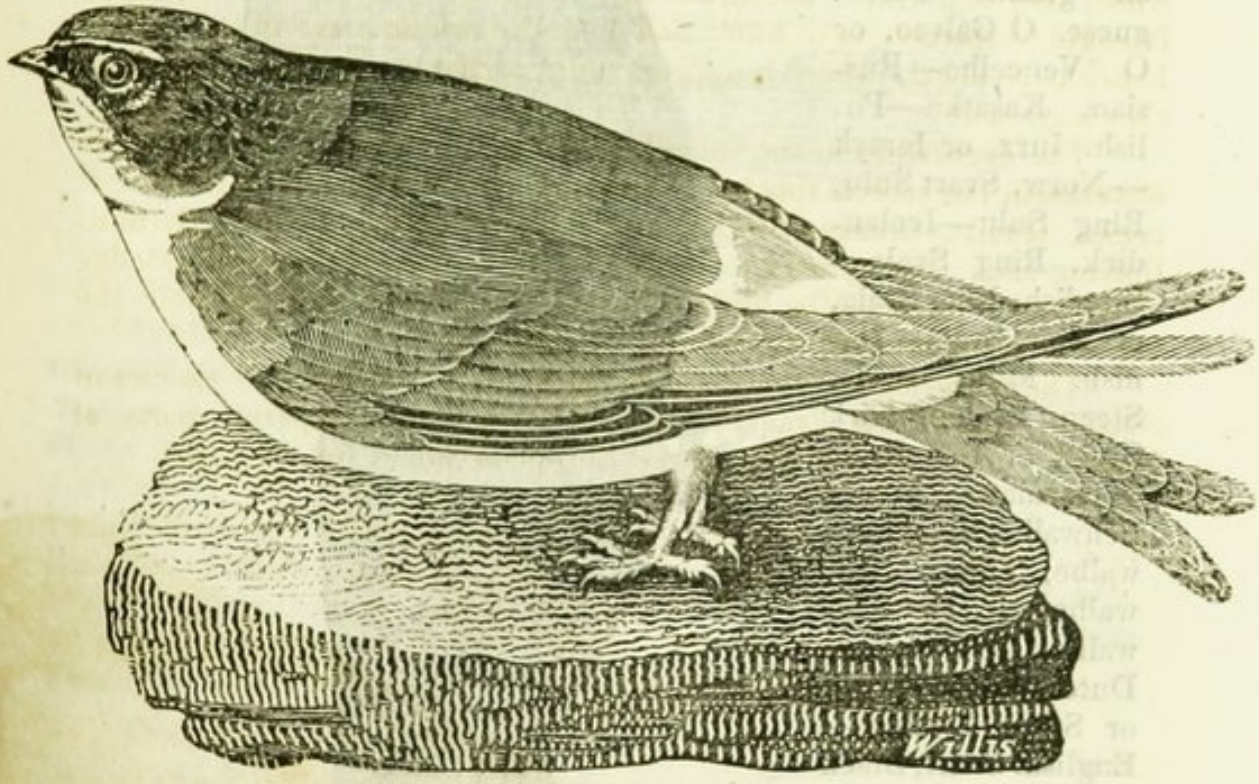
H. Domestica.—H. Caminicola.

Latin. Hirundo domestica—French. L'Hirondelle domestique, or

* See my Tract "On the Brumal Retreat of the Swallow."—London, 1807

l'Hirondelle de Cheminée—Italian. La Rondine Camino—Portuguese. A Andorinha de Chamminé—Spanish. La Golondrina de Chimenea—German. Rauch Schwalbe, Feuer Schwalbe, Küchen Schwalbe, Bauren Schwalbe, or Bauern Schwalbe—Swedish. Ladu Swala—English. House Swallow, or Chimney Swallow—Gaelic. Gobhlangaoithe—Danish. Mark Svale, or Forstue Svale—Dutch. Boeren Zwaluw.

The length of this species is about six inches, breadth from tip to tip of the extended wings about twelve; the head, breast, and upper parts of its body and wings black; the back is of a very shining blueish black colour; the forehead and chin marked with a reddish spot; the tail much forked.



HIRUNDO VRBICA.

H. Rustica.—H. Domestica.—H. Agrestis.—H. Fenestrala.

Greek. Ἄπους χυψελος—Latin. Hirundo rustica, vel Hirundo agrestis—French. L'Hirondelle à cul blanc, l'Hirondelle de fenêtre, ou la Martinet—Italian. La Rondine da fenestra, or il Tartaro—Spanish. Golondrina de ventana, or Albion pequeno—Portuguese. Andorina de janella—German. Haus Schwalbe, Fenster Schwalbe, Mehl Schwalbe, Kirch Schwalbe, or Berg Schwalbe—Dutch. Huis Zwaluw, Wilde Zwaluw, or Lentebode—Danish. Bye Svale, or Tagskiæg Svale—Swedish. Hus Swala—Norw. Huus Sulu—English. Martlet, Martinet, Martin, House Martin, or Window Swallow—Welch. Marthin.

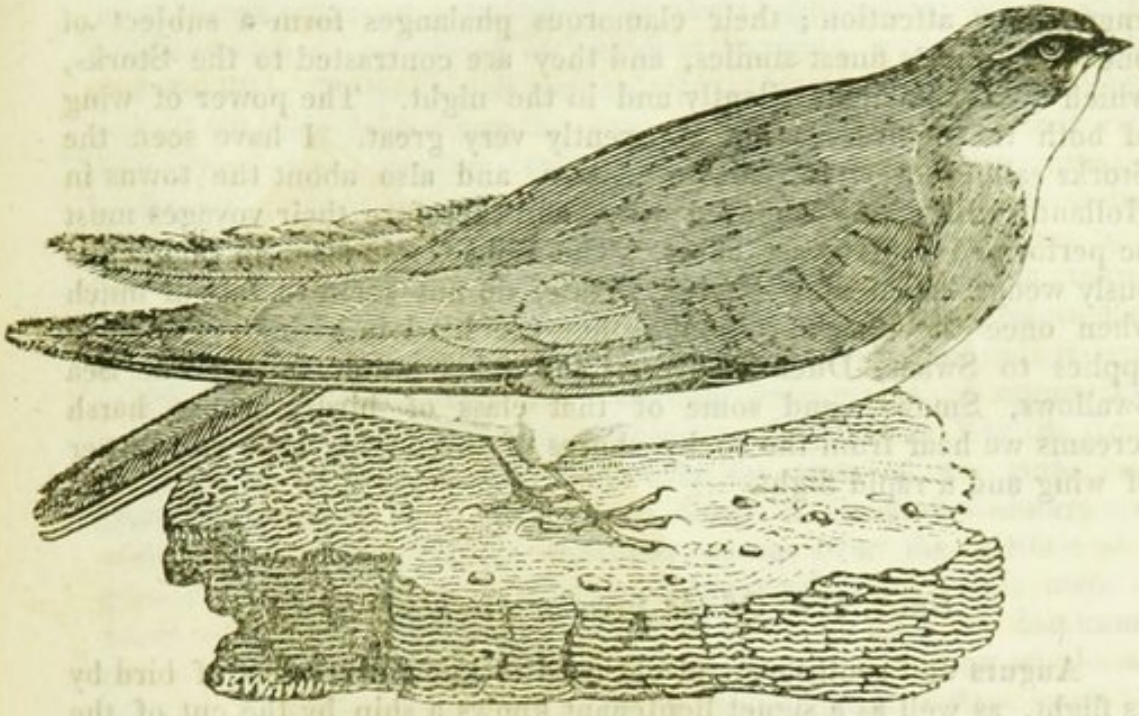
The martin is less than the swallow. Its length is about five inches and a half; the wings are of a dusky brown; the back is black, glossed with blue; all the under parts of the body, from the chin to the tail, are white; as is likewise a part above the tail, which is brownish, like the wings. This bird is distinguishable at first sight by the bright white colour of all the under parts of the body.

HIRUNDO APUS.

H. Apus major.—Cypselus niger.—H. Cypselus major.—Cypselus, apus.

Greek. Ἄψ—Latin. Cypselus major—French. Le Martinet noir, Moutardier, or le Juif—Italian. Rondone nero, il Rondone, or il Rondinone—Spanish. El Veniejo, Aorejaque, or el Avion grande—Portuguese. O Gaivao, or O Vencelho—Russian. Kasatka—Polish. Iurz, or Iersyk—Norw. Svart Sulu, Ring Sulu—Icelandick. Ring Svala—Swedish. Ring Svala, or Spir Svala—Danish. Muur Svale, Steen Svale, Kirk Svale, or Söe Svale—German. Mauer Schwalbe, Stein Schwalbe, Thurm Schwalbe, Kirch Schwalbe, or Speyer—Dutch. Gier Zwaluw, or Steen Zwaluw—English. Swift, Black Martin, Black Swallow, Squeaker, Screamer, Deviling, or Shriek Owl.

The swift is the largest of the genus, being seven inches in length, and nearly eighteen in breadth when its wings are extended. Ruy says of this bird: *Ob alarum longitudinem et brevitatem pedum humo aegrè se tollere potest.* Raii Synop. p 72. It is of a sooty black colour, with a whitish spot on its breast.



HIRUNDO RIPARIA.

H. Arenaria.

Anglo Saxon. Stœth Swalewe—Welch. Gwennol y glennydd, or Gwennol y dwr—Gaelic. Gobhlan gainbhich—German. Ufer Schwalbe, Wasser Schwalbe, Strand Schwalbe, or Rhein Schwalbe—Dutch. Oever Zwaluw, Aard Zwaluw, or Zand Zwaluw—Danish. Dig Svale, Jord Svale, Klint Svale, or Solbakke—Norw. Sandrönne, Dig Sulu, Strand Sulu, or Sand Sulu—Swedish. Strand Svala, or Back Svala—Russian. Strisch, or Granatotshka—Polish. Grzebielucha—French. L'Hirondelle de rivage—Italian. Rondine riparia—Spanish. Golondrina de ribera—English. Sand Martin, Sand Swallow, Bank Martin, or Shore Bird—Armen. Choll.

The sand martin is the smallest of the genus, being about four inches and three quarters in length, and is of a dusky brown colour above, and whitish beneath. It builds its nest in holes, which it bores in banks of sand.

Some persons have affected to disbelieve in the migrations of the Swallows, and pretend that they pass the winter in holes of trees, in and over and under water, among reeds. I have, however, refuted this notion in my "Natural History and Brumal Retreat of Swallows." Their migrations are, in fact, established beyond all doubt; but the particular places whither they go, and how long they are in going there, are questions which remain to be solved, and on which I will not state my conjectures, because my object is to promote enquiry and ascertain facts.

I have collected numerous passages from Aristotle, Pliny, Oppian, Virgil, and other writers, to prove how general an interest was taken of this question by the ancients, and on comparing all the accounts, ancient and modern, I find the evidence for their migration to be irresistible.

The astonishing migration of the Cranes, whose marshalled flights through the air have attracted the notice of the poets, ought also to

engage our attention; their clamorous phalanges form a subject of one of Homer's finest similes, and they are contrasted to the Storks, which take their flight silently and in the night. The power of wing of both these birds is not apparently very great. I have seen the Storks sailing over the plains of Alsase, and also about the towns in Holland, with a very laboured wing, and therefore their voyages must be performed with a vast effort. The Wild Geese also, in their curiously wedgeshaped and lettered flights, do not seem to labour much when once they get up, though they are hard in rising: the same applies to Swans, Ducks, Divers, and other water fowl. The Sea Swallows, Smews, and some of that class of birds, whose harsh screams we hear from the rocky shores of the ocean, have vast power of wing and a rapid flight.

Sect. II.—*Of the peculiar Flight of Birds.*

Augurs and soothsayers of old used to know every sort of bird by its flight, as well as a signet lieutenant knows a ship by the cut of the gib, or the pennant flying in a distant breeze. Every sort of flight, the mode of swimming, and various songs, sounds, and noise of birds, were known to them. Superstition has had its rise in the Sciences, and Augury did for Ornithology, what Astrology did for Astronomy, or Alchemy for Chemistry: by connecting fancied interests with particular flights of birds, it by degrees brought science to perfection.

Mr. White, of Selborne, has the following curious notes on the flight and movement of birds.

"Thus Kites and Buzzards sail round in circles and wings expanded and motionless; and it is from their gliding manner that the former are still called in the north of England Gleads, from the Saxon verb Glidan, to glide. The Kestrel, or Windhover, has a peculiar mode of hanging in the air in one place, his wings all the while being briskly agitated. Henharriers fly low over heaths or fields of corn, and beat the ground regularly like a pointer or setting dog. Owls move in a buoyant manner, as if lighter than the air; they seem to want ballast. There is a peculiarity belonging to Ravens that must draw the attention even of the most incurious—they spend all their leisure time in striking and cuffing each other on the wing in a kind of playful skirmish; and, when they move from one place to another, frequently turn on their backs with a loud croak, and seem to be falling to the ground. When this odd gesture betides them, they are scratching themselves with one foot, and thus lose the center of gravity. Rooks sometimes dive and tumble in a frolicksome manner; Crows and Daws swagger in their walk; Woodpeckers fly volatu undoso, opening and closing their wings at every stroke, and so are always rising or falling in curves. All of this genus use their tails, which incline downward, as a support while they run up trees. Parrots, like all other hooked-clawed birds, walk aukwardly, and make use of their bill as a third foot, climbing and descending with ridiculous caution. All the Gallinæ parade and walk gracefully, and run nimbly; but fly with difficulty, with an impetuous whirring, and in a straight line. Magpies and Jays flutter with powerless wings, and make no dispatch; Herons seem

incumbered with too much sail for their light bodies; but these vast hollow wings are necessary in carrying burdens, such as large fishes; and the like; Pigeons, and particularly the sort called Smiters, have a way of clashing their wings the one against the other over their backs with a loud snap; another variety called Tumblers turn themselves over in the air. Some birds have movements peculiar to the season of love: thus Ringdoves, though strong and rapid at other times, yet in the Spring hang about on the wing, in a toying and playful manner; thus the Cock Snipe, while breeding, forgetting his former flight, fans the air like the Windhover; and the Greenfinch in particular exhibits such languishing and faltering gestures as to appear like a wounded and dying bird; the Kingfisher darts along like an arrow; Goatsuckers glance in the dusk over the tops of the trees like a meteor: Starlings as it were swim along, while Misselthrushes use a wild and desultory flight; Swallows sweep over the surface of the ground and water, and distinguish themselves by rapid turns and quick evolutions; Swifts dash round in circles; and the Bankmartin moves with frequent vacillations like a butterfly. Most of the small birds fly by jerks, rising and falling as they advance. Most small birds hop; but Wagtails and Larks walk, moving their legs alternately. Skylarks rise and fall perpendicularly as they sing; Woodlarks hang poised in the air; and Titlarks rise and fall in large curves, singing in their descent. The Whitethroat uses odd jerks and gesticulations over the tops of the hedges and bushes. All the Duck kind waddle; Divers and Auks walk as if fettered, and stand erect on their tails: these are the Compedes of Linnæus. Geese and Cranes, and most wild fowls, move in figured flights, often changing their position. The secondary Remiges of Tringæ, Wild Ducks, and some others, are very long, and give their wings, when in motion, an hooked appearance. Dabchicks, Moorhens, and Coots, fly erect, with their legs hanging down, and hardly make any dispatch; the reason is plain, their wings are placed too forward out of the true centre of gravity; as the legs of Auks and Divers are situated too backward."

Sect. III.—*Of the Instinct to Travel.*

The organs of space giving to some animals and people a great knowledge of country, they find their way about with astonishing facility.

I shall conclude these remarks with some authentic extracts on the subject of carrier pigeons, who afford the most extraordinary example of this instinct. And I really think they might be made of more general use in conveying speedy intelligence.

They were trained to this method in Turkey and Persia, and were carried first, while young, short flights of half a mile, and afterwards more, till at length they would return from the farthest part of the kingdom. Every bashaw had a basket of these pigeons, bred at the seraglio, which, upon any emergent occasions, as an insurrection, or the like, he dispatched with letters, braced under their wings, to the seraglio, only sending out more than one, for fear of accidents. Lightow assures us, that one of these birds would carry a letter from

Babylon to Aleppo, which is thirty days journey, in forty-eight hours. This pigeon was employed, in former times, by the English factory, to convey intelligence from Scanderoon, of the arrival of the Company's ships in that port, the name of the ship, the hour of her arrival, and whatever else could be comprised in a small compass, being written on a slip of paper, which was secured in such a manner under the pigeon's wing as not to impede its flight; and her feet were bathed in vinegar, with a view to keep them cool, and prevent her being tempted by the sight of water to alight, by which the journey might have been prolonged, or the billet lost. The pigeons performed this journey in $2\frac{1}{2}$ hours. The messenger had a young brood at Aleppo, and was sent down in an uncovered cage to Scanderoon, from whence, as soon as set at liberty, she returned with all possible expedition to her nest. At the season of the arrival of the annual ships, it was usual to send pigeons to be ready at the port. Some have asserted that the pigeon was at once sent down to Scanderoon in a cage; but others with greater probability affirm, that she was taught by degrees to fly from shorter distances on the Scanderoon road. It is also said, that the pigeons, when let fly from Scanderoon, instead of bending their course towards the high mountains surrounding the plain, mounted at once directly up, soaring still almost perpendicularly till out of sight, as if to surmount at once the obstacles intercepting their view of the place of their destination.

The custom of carrying on a correspondence between Aleppo and Scanderoon by means of pigeons was common in M. D'Arvieux's time Mem. T. v. p. 496. Maillet, in his "Description de l'Egypt," vol. ii. p. 271, has given a very circumstantial account of this mode of conveying intelligence; and he also relates a story of a pigeon dispatched from Aleppo to Scanderoon, which, mistaking its way, was absent for three days, and in that time had made an excursion to the island of Ceylon; a circumstance then deduced from finding green cloves in the bird's stomach, and credited at Aleppo. Baumgarten mentions the flying of pigeons in his time (1504) in Egypt. Sir John Mandeville also mentions it in his travels. In the time of the holy war, certain Saracen Ambassadors who came to Godfrey of Antioch from a neighbouring Prince, sent intelligence to their master of the success of their embassy, by means of pigeons, fixing the billet to the bird's tail. Bochart has collected numerous authorities for the antiquity of this custom both in Syria and Greece, (vol. ii. p. 15,) and more respecting its antiquity may be found in Pennant's British Zoology. Hirtius and Brutus, at the siege of Modena, held a correspondence with one another by means of pigeons. And Ovid tells us, that Taurosthenes, by a pigeon stained with purple, gave notice to his father of his victory at the Olympic games, sending it to him at Ægina. Ælian. Var. Hist. lib. ix. cap. 2. Pliny, lib. x. cap. 24. Anacreon tells us, that he conveyed a billetdoux to his beautiful Bathyllis, by a dove.

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