A

NEW SYSTEM

OF

METEOROLOGY,

DESIGNED FOR

SCHOOLS AND PRIVATE STUDENTS.

DESCRIPTIVE AND EXPLANATORY OF ALL THE FACTS, AND DEMONSTRATIVE OF ALL THE CAUSES AND LAWS

OF

ATMOSPHERIC PHENOMENA.

VOLUME I.

BY

JOHN H. TICE.

Perched upon that giddy height,
Whence and whither, wanderer, say?
Whence? from out the realms of night;
Wither? toward the realm of day.

ST. LOUIS:
PUBLISHED BY TICE & LILLINGSTON.
1878.

R. B. CROSSMAN, printer.

INDEX.

PREFACE.

The fearful nature and awful grandeur of clouds, rain, hail, snow, whirlwinds, tornadoes, thunder and lightning, forcibly impressed me from my earliest childhood. Before attaining the age of four years, I inquired for their cause. My parents resolved these phenomena into the Ultimate Cause, God. Accepting this solution, I wished to know how he did it, and why he did it? Not receiving satisfactory answers to these questions, they became life problems to me. They had, and ever will have, such a fascination for me as to engross my entire attention when I am in their presence.

While a lad of tender years, no cloud appeared above the horizon without my scrutiny as to its aspects, and noting the changes in its form and color. After night, no thunder cloud loomed up in the sky without my watching, while in sight, the play of the lightning in its folds, and studying its structure in its strata and convolutions.

At a very early age, I distinguished the rain clouds from the "wind clouds," and could point out clouds that were in a transition state from the "dry" to the "wet." I then also discovered that in every rain storm there are two disk clouds, an upper and a lower, and that a cloud column connects the two. I perceived that at times this connecting cloud had the shape of an hour-glass, in which sheet lightning only was seen playing to and fro, between the disks. All the facts I observed by day or night, I treasured up, with a vague idea that when I knew all the facts, I would not be long without knowing their causes too.

I had an abiding faith in those whom the world esteemed learned men. I believed them high priests of Science, and thought that they held in their hands the key that unlocked all the mysteries of Nature. In short, I had a veneration for them. I was persuaded that all that was required to attain to their empyrean height, was

to have a mind well stored with physical facts. I imagined that all that was necessary to enjoy with them the transporting view of the boundless domain of Nature so elevated a lookout must afford, was to have an intellect well versed and trained in the Physical Laws that govern this wide domain. I supposed that to anyone so qualified, known facts would suggest possible facts that would be found by looking for them, and when found they would unfold new laws and new facts; and that gradually the Unknown would be conquered by approaches through the Known.

Unaided, except by the dim light afforded by text books, I had mastered the principles of Arithmetic. Rising above the rule by knowing the reason for it, I could solve its problems rationally, without being necessitated to follow the *dictum* of the author mechanically and blindly without a *why* and a *wherefore*.

I had no difficulty in acquiring a knowledge of the Pure Sciences of Arithmetic, Algebra, Geometry, and Trigonometry. All that was necessary, was only to look long enough and steady enough at the elementary principles until all became Light, as their quantities, forms, symbols, lines, planes and axioms filed in long array before and past me.

As I advanced, I felt confident that I was upon firm and solid ground, namely upon demonstrated, and therefore immutable, Truth. In the Physical Sciences, Botany, for example, I found the facts of the vegetable kingdom exhaustively and harmoniously set forth in orders, families, classes, genera and species, and systematically and harmoniously arranged into a Science. Hence I inferred that nothing was dignified with the name of Science, except what was established, verified and demonstrated Truth.

I was aware that none of the Physical Sciences were hoary with age, many of them were new, and that some of them not even numbered as many years as myself. Yet I was under the impression that the list of the Physical Sciences had been exhausted, and that Physicists like "the Macedonian madman" were sighing for new worlds to conquer. A little investigation convinced me that I was sadly mistaken.

When I undertook the investigation of my favorite Science, Meteorology, I found Humboldt to declare that it really had not

taken a step in advance since the time of Aristotle, and that he despaired of it ever taking a step in the right of direction, which was indispensible to make it a useful Science, namely to foretell the future. I found Lockyer pointing out to his Meteorological friend the fact that the Meteorology of the schools was a failure, because it had no physical basis, and advised him as a first step to find a physical basis for it, even if he had to search the world over to attain it.

I found the most eminent of botanists, Prof. A. de Candolle, in the Society of Physical and Natural Sciences of Geneva, express his "regret that the method of averaging by which meteorologists establish the mean of their observations, renders the results of their labor nearly useless". The late Prof. Nichol, of Glasgow, declared what we call Meteorology, consists of incongruous theories, and a mass of physical knowledge not yet reduced to a science. To the same effect MM. Regnault and Biot might be quoted in the celebrated discussion before the French Academy of Science.

Everyone qualified to undertake the investigation of the fundamental principles of Meteorology must have perspicacity sufficient to at once perceive that Electricity underlies all the facts and phenomena comprehended in the Science. Impressed with this factas a preliminary step to qualify me to undertake the investigation, I applied myself to mastering the laws and modes of Electricity, and the relation and reciprocal action between Electricity and its invariable concomitant, Magnetism. To show how deficient some authors are, I found in the "Thirty-third edition, rewritten and enlarged" of a text book on Physical Science by a leading professor in one of the leading colleges of the Republic, the following statement:

"When a wire carrying an electric current is brought over a magnetic needle, if the current flow north, then the north end of the needle is deflected *East*; if it flow south, then it is deflected *West*." Now, a mere tyro in Electric Science should know that this statement is exactly the *reverse of the facts*. What shall we think of an author-professor as a guide in our investigations who commits such a blunder; and of college professors as shining lights

in Science who use up thirty-three editions of a text book containing such a blunder without detecting it?

Again as regards the electric laws discovered and demonstrated by Ampere, namely, (1) "Two parallel currents of Electricity flowing in opposite directions, *repel* each other;" and (2) "Two parallel currents of Electricity flowing in the same direction *attract* each other;" five of seven text books in my possession state the reverse of what the laws are, Dr. Lardner and Prof. Tate being the two authors giving the laws correctly. Palpable errors like these and others equally as egregious, which cannot be specified here, made me lose much of the respect I had entertained towards scholastics, and all confidence in their statements until verified.

Such was the outlook as regards Meteorology when I undertook its investigation. No author knowing what he affirmed; and consequently no text book that could be relied upon as authority, either for physical facts or physical laws, except one, and that had passed into desuetude and was no longer studied, namely: The Great Book of Nature. It speaks by authority. Every fact it utters is a "thus saith the Lord". Its utterances are so distinct, and so explicit are their purport, that with proper attention there can be no difficulty in understanding their meaning.

Necessity compelled me to study this book; but from inclination and habit it was a delightful, pleasing task. The facts observed; the causes I assign for these facts; the laws applied for explaining them, the inductions to which they led me, the deductions I have made from them, the conclusions arrived at, in fine, the translation I have made, and the proposed interpretations given to one chapter in this Great Book, are in part embodied in the present volume.

I do not claim to have exhausted the facts recorded in this Great Volume of the Universe, nor that I know all the causes and laws recorded in it or taught by it. Neither do I claim exemption from error in the translation I have made of it, nor infallibility for the interpretation I have given to it. As the store of facts increases, as our knowledge of physical laws enlarges, my shortcomings will be revealed and manifested, and my errors corrected. I claim nothing except a sincere effort to take a first step in the right

direction in which, not only Meteorology, but every dynamical branch of Physical Science must be pursued. If this first step will be justified by the revelations of the Future, as it is warranted by the facts and disclosures of the Past, it will lead to a New Departure in Physical Science, to a larger and wider range of thought that will enlarge and remodel them all. It will do more. It will put Nature and Science for once in harmony.

As to the manner in treating the subject, a word by way of apology may be necessary. From the nature of the matter treated I had to discuss it from the electric standpoint. Two modes of treatment were optional to me: (1) to proceed upon the assumption that the general laws of Electricity were understood by the public; or (2) to assume that the public had no practical knowledge of them whatever. With the facts confronting me already stated, that either from the carelessness of authors, or the ignorance of compilers of text books, even what little is known of electric laws, is so perverted as to inculcate the very opposite of the truth, I chose the alternative that the public know practically nothing of Physical laws, and proceeded accordingly. To many readers this no doubt is superfluous, and much of the discussion will be irksome to them; yet to the great majority of readers it is indispensible. Without it, a discussion and explanation of physical phenomena would be unintelligible to them and therefore unprofitable. This is the apology I offer for dwelling so long at certain points in the discussion upon elementary principles.

The reader as he sees my facts, and follows my course of reasoning, perceives I treat of a *dynamic* instead of a *mechanical* Universe. I speak of a Universe stored with Energy to last it for all time. A portion of this Energy constantly flowing in from Space upon and through suns and planets; and after performing its office, it is thrown off, and flows back into Space for renewal. Hence, Energy is never wasting away, and therefore never needs replenishing. Not so with the mechanical Universe of the scholastics, which has a limitted stock of Energy by which motion is enforced upon suns and planets, but which is expended in the act. When Energy—as it finally must upon this hypothe-this—becomes exhausted, the Universe must stand still and crumble.

to pieces. The Universe, according to the mechanical theorists, hence has the seeds of its own dissolution sown in its constitution.

In the language employed in treating the subject, I had to choose between extremes. I had either to use common and ordinary terms, or had to use conventional or technical words and phrases, which would be only intelligible to the initiated, that is, to a coterie termed professionals. If I used only commonplace terms, it would have confined me to a very narrow range of thought, such as is pursued by the untrained mind. Science cannot be brought down to the level of the unthinking, but they must be trained to think, and brought up to the level of Science. For in its nature and essence, Science is elevating and enobling.

Science is not the exclusive property of the gods, nor of the privileged few, but like Mind it is the common property and heritage of the Race. He who snatches Science from the cloister, and from the grasp of the haughty, proud and arrogant that believe themselves gods because they have a monopoly of it, and brings it out and down to the whole Human Race as a common gift and heritage, acts as nobly, philanthropically, and beneficiently, and is as great a benefactor to the Human Race as Prometheus was when he snatched fire from Heaven and brought it down to men. I have endeavored to imitate him, and bring down Science, the fire of the Immortals, from Heaven, to warm and enlighten Mortals on Earth. In order to do so, I have used as plain and pointed language as I could command, and avoided as much as possible technical terms; using them only when unavoidable, and then not without explaining them.

But let no one be self-deceived. The precious boon of knowledge comes not unbidden, unsought, nor without strenuous effort and careful preparatory training. When Ptolemy inquired of Euclid if there was not some mode of learning Geometry less laborious, less barbarous, and requiring less mental discipline and training than the ordinary one, Euclid replied: "There is no royal road to Geometry."

Science can bless man by giving him large mental vision, and boundless range of thought that will carry him to the verge of the Universe, where all its wonders are revealed to him,

only upon condition that he is so charmed by her as to woo, win and wed her. Science is composed of facts, of causes, of laws, of elementary principles, of ideas, both absolute and relative, whose dependence and relations must be traced out by patient thought until perceived and grasped by the mind. It must be developed in the mind by fixed and absorbed attention, earnest thought and deep reflection. As it develops and assumes form and shape in the mind, the intellectual faculties expand and develop with it. By this means those of very ordinary natural capacity have grown to be intellectual giants, and have received the homage of Mankind.

But something more is necessary. To partake of the fruit of the tree of Knowledge, it is indispensible that the pupil, as he comes and takes a seat at the feet of Nature, should be of a tractable disposition, and of a docile mind. Everything inculcated, whether by schools or books must be as nothing to him, and he must consider it blotted from the memory, unless confirmed and verified by the teachings of Nature.

As for myself, I do not wish to be regarded as an oracle. I only express my own convictions and conclusions, giving however, the facts and reasons that forced these convictions and conclusions upon me. Others are to judge whether these results are warranted by the premises or not. I write in the interest of no school, class or coterie, but in the interest of Truth and Humanity for public edification. I address no one's prejudices, but everyone's judgment. I supply the physical facts and laws upon which my opinions are founded, so that all can judge understandingly of the validity and accuracy of my conclusions. I ask of no reader to surrender "the doctrines of the Fathers," unless convinced that those *dogmas* are untenable; nor do I demand the sacrifice of a single tradition, notion or doctrine, unless the reader is convinced of its unsoundness. I invite the closest scrutiny of all classes. If they cannot invalidate my facts, nor convict me of a misstatement of physical laws, or a violation of the rules of Logic, then as honest men and women they must either concur in my deductions, and accept my conclusions, or they must show that different de-

ductions and conclusions are warranted by the facts, which are more rational than mine.

In the Sequel, all other meteorogical phenomena will be discussed, and where necessary the physical laws applicable to them will be developed and applied. The following phenomena will receive special attention: the mode by which clouds, rain and dew are formed; the nature, character, causes and laws of cyclones, and the causes, laws and modes by which men, animals, houses, trees, cars and locomotives are lifted and transported on land, and by which the stupendous volume and weight of water in the waterspout is raised and carried away at sea. The causes and laws of that intense cold in the clouds by which hail is produced will be demonstrated; the causes of St. Elmo's fire or electric light, and the conditions under which it always appears, will be intelligibly set forth. In conclusion, a full statement will be given of the principles of Meteorognosy, that is, the Science of precalculating the weather, which since its announcement nearly four years ago has excited so much attention and amazement at the wonderful precision with which calculations have been verified.

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St. Louis, Mo., June 10th, 1878.

METEOROLOGY.

CHAPTER I.

INTRODUCTORY.

The object of Science is "to know"; and we know things only (1) through primary conceptions, as in the Mathematics; and (2) through the observation of primary phenomena, as in Physical Science. The Mathematics are Pure Sciences, and consist of self-evident truths and of inductions and deductions from them arranged into order and systematised. The Physical Sciences are, in Logic, called exact Sciences, because they depend upon and require the greatest exactness of observation. They are founded upon the testimony of observations made upon primary phenomena, hence the Physical Sciences cannot be exact, except the facts upon which they are based are exact.

Every department of Human Knowledge is divisible into branches according to the topics it treats of or discusses. Take for instance the Exact Sciences which are purely physical; one treats of the primary phenomena of the Atmosphere, another, of those above the Atmosphere, a third, of the structure of the Earth, a fourth, of the structure and varieties of vegetable life, etc. These Sciences are called, according to the topic discussed, Meteorology, Uranology, Geology, Botany, etc.

Meteorology is derived from the Greek *Meteoros*, elevated, and *logos*, a discussion, description or conversation. *Meteoros*—from which our word meteor is derived—in Greek is applied to anything that is aloft, elevated above the Earth, and detached from it, hence we apply the word meteor to

shooting stars and fireballs, because they are detached from the Earth, appearing aloft in the Atmosphere. The meaning of the word Meteorology, therefore is a description of meteors.

But in Science the term meteor is not restricted to shooting stars and fireballs, but it is applied to every phenomenon that is seen, or that manifests its presence in the Atmosphere. The auroras that appear in the circumpolar skies in both hemispheres; the oscillations of atmospheric pressure, called in default of more appropriate terms, the high and low barometers; clouds, thunder, lightning, rain, hail, snow, winds, whirlwinds, tornadoes, hurricanes, and waterspouts, are all, in the language of Science, meteors. Clouds, rain, hail, snow and cyclones, are called hydro-meteors, from the Greek *hydron*, water, that is, water meteors, because they are inseparable from one or the other form of water, as a solid in hail and snow, a liquid in rain, or vapor in clouds. All these phenomena fall within the scope of Meteorology, but they do not fill its measure; for besides them it treats of all aerial modifications and changes, as variations in temperature, in moisture, in electric tension, etc. Moreover it takes cognizance of all aerial movements, and accounts for the translation of phenomena in definite, or even indefinite directions across the surface of the Earth.

Since many telluric phenomena are synchronous with aerial ones: for instance, the temporary ebbs and flows of springs; the rise of water in lakes under an electric cloud, and its fall under a clear sky; the electric disturbances in the Earth as manifested in the variation in energy and change in direction of Earth currents; the variation of magnetic intensity; the sudden appearance of earthquakes, volcanic eruptions, etc., and since they always are synchronous with peculiar atmospheric conditions, therefore they must originate from the same agencies that cause so invariably the iden-

tically contemporaneous atmospheric phenomena. Hence it likewise falls within the scope of Meteorology to take cognizance of the phenomena on and in the Earth, as well as those of its gaseous envelope the Atmosphere, and likewise to explain them by demonstrating their causes, and the laws that direct and control them.

From the definition we have given to the word Meteorology, it is evident that the Science it designates is founded upon a mass of peculiar physical facts pertinent to its scope. It therefore cannot be constructed until the facts are at hand. The first step therefore, is the collection of the facts, in doing which we from necessity, must either accept the facts upon the credibility of the testimony of those who have experienced and observed them, or we must acquire them by personal experience and observation.

But we must not fall into the delusion that we have attained to Science, when we have at command a large and ample collection of facts. Phenomena may have been exhaustively observed, and every variation in energy, form, shade and color noted and recorded; but they are still not in such a shape that they can be utilized for the construction of the Science of Meteorology.

Phenomena are not uniform in their characteristics. They differ not only in kind but in degree. Besides this, some are simple, others are compound, and many are complex.

The object in collecting the facts is for the purpose of constructing the Science of Meteorology upon a physical basis. When we therefore undertake the task of construction, we assume that none but meteorological facts have been collected, that the phenomena have been observed with the utmost care and exactness, so that they are not only complete as a collection, but are invested with innate integrity, and virgin purity. If such be the case, and these phenomena and their characteristic facts be judiciously and prop-

erly handled, the Temple of Science must rapidly rise in majestic form, imposing grandeur, harmonious in proportion, faultless in symmetry, beautiful in design, and perfect in finish.

There is a class-distinction in meteorological facts and phenomena as well as in other physical facts. Since they are all meteorological phenomena, therefore they agree in *essentials;* but differing in kind, they are, according to differences, classified into *genera.* When the facts in each genus are critically examined, they are found not only to differ in degree, but in form, aspects and other individual characteristics. Each genus is therefore subdivided according to individual differences, and classified into species according to individual agreement.

Not everyone is a good observer, hence the task of classification cannot be confided to everyone, for the best observers are in general good classifiers. To be both a good observer, and a judicious and accurate classifier, requires a well trained and practical eye, acute perceptive faculties, a discerning mind, and deep insight, and penetrating intuition.

Classification depends upon the following principles:

The genus is based upon the general property called the *essential* which belongs to the whole class in common. The species is founded upon the difference between individuals of the same genus. It is called the *particular.*

The *essential* can be predicated of the genus, and consequently of every individual included in the genus. Examples: The genus *homo* or man includes the whole Human Family; the essential of which is a man or a human being. The essential human being, or man, can be predicated of every individual and of every race of Man.

The particular can only be predicated of the individual or of the entire class that constitute the species to which the individual belongs. Example: Black skin, crisped hair,

etc., can be predicated of the whole African race or species of Man, and of every individual of the species.

From these examples it is evident that the more general the class of objects is, the more general but indefinite is the conception we have of it, and the qualities we can predicate of it; and the more individualized the class is, the more definite and particular are the conceptions we have of it, and the qualities we can predicate of them individually and collectively. This is the object in making classifications into *genera*, *species* and *varieties* of the same species. It is the only possible method by which we can study them in all their relations and inter-dependence as a whole or as individuals, and consequently the only way to determine the general and special causes and laws of physical phenomena.

Applying these principles to meteorological facts and phenomena, the more general and comprehensive the classes we have formed of them are, the more vague our ideas must remain of them, and the more indefinite must be whatever we can predicate of them. Our object in examining and studying them is to learn what they were intended to teach us and to ascertain what they mean. But they can only teach us directly what is plainly and palpably manifested by them, that is, their nature and character. Behind the phenomenal there is the causal, which lies beyond the sphere of the sensibility, which can only be apprehended by the Intelligence. From the phenomena we have to ascend by Induction to their causes and laws. From general phenomena of course we can only attain to a knowledge of general causes and general laws. From special phenomena, and the more individualized the better, we attain to a definite knowledge of particular causes and laws.

Though in some countries meteorological phenomena have been regularly observed for over a century, yet the form—averages—in which they have been preserved makes them

of little, we might justly say, of no value in the construction of the Science to which they belong. They give us the amplitude of the range of the barometer and thermometer, of the declination of the needle, of the rainfalls, etc. They give us not only the extremes of all these, but their annual averages, and so far they have increased the stock of curious, and in some respects interesting but not generally useful knowledge. For practical purposes, the results of all this toil and care, are too indefinite to be useful as guides, and for scientific purposes they are nullities on account of ambiguity and vagueness.

Notwithstanding the aimless character of these observations, they have incidentally disclosed the following important facts: (1.) That in some sections of the globe certain phenomena are practically constant, that is, they are continuous, and have but little variation. (2.) In other sections they are interrupted, and subject to sudden and extreme oscillations. (3.) That extreme oscillations regularly recur at fixed periods. (4.) That periods of violent commotion are followed by periods of comparative repose.

Though physicists are in general accord as to the first two propositions, yet so inexact, or rather aimless, have the phenomena observed been in other respects, that they do not agree within months and even years, as to the periodicity of the phenomena in question. For example the length of the cyclonal period by some has been estimated to be under ten years, and by others all the way up to thirteen years. The same discrepancies between them exist as to the lengths of the auroral, the sunspot and the rainy periods. The same may be said of the lengths of the periods of electric tension in the Atmosphere, and the variations in the force and direction of Telluric Magnetism.

No one can dispassionately examine the facts relating to each and all of them without coming to the conclusion that

each and all of these phenomena move in cycles, and that they are synchronous in their recurrence. The failure in determining definitely the lengths of the cycles is an inevitable result from the form in which the observations have been preserved. The date of a phenomenon was considered of no importance. Its only value as estimated was as a factor in the annual averages. Hence the individual fact with all it was capable of teaching us, was irrevocably swamped and lost in the Dead Sea of Averages.

We have said the length of the *cycles*, for no one can look at the discordant results of averages, without coming to the conclusion that the only way out of the difficulty, discord and confusion created by the averages, is to conceive the existence of several, if not many, cycles having different periodicities. Physicists have erred in considering that there was but one cycle. Their aim has hence been to determine its length by their averages. These averages were stark, rigid and cold in death. All that had been vital in their component parts died when they were merged in the general average. Failure, most disheartening failure, was the inevitable result, from the nature of the defective *data*. In this case the *data* do not contain what is sought, hence it can not be deduced from them.

But a more promising era of physical observation has dawned, from which more propitious results can be expected to follow. The cause of this change was incidental. Many individual phenomena that were observed, were of such extraordinary character, as to be sensational. These were deemed worthy of a full record, not for scientific purposes, but to gratify the morbid taste for the curious, the wonderful and sensational. These individual phenomena have however, subserved a better purpose than was contemplated when they were placed upon record, and thus accidentally preserved. They have revealed causes and laws, both general and par-

ticular, which, but for them, would have remained concealed and unsuspected. They have led even the dullest plodders in routine observation to suspect that all physical phenomena whatever their naturc, character and kind, originate in one and the same source, and that they are bound together in the bond of indissoluble unity. But where to look for, and how to search for this primary source from which they all emanate, and how to find the links of the chain that connects them and binds them together in a bond of indissoluble Unity, they neither know, nor have they the genius to devise the means to consummate the object so devoutly wished for. They are in the category of those to whom Plato addressed the inquiry, "How can ye expect to find, unless ye know what ye are looking for".

Why do we observe physical phenomena? Because we know and feel that the Great Phenomenal World is yet a sealed book. We are conscious that absolutely nothing is known of the causes that operate in the Physical World, nor of the laws that sway its phenomena. We have an intuitive notion that phenomena have a great deal to teach us, and that they will impart it to us, if we only become more familiar with them. We know that they can and will reveal the secrets concealed within their laws and causes, and consequently those of the Physical World, if we only cultivate their acquaintance. It is for these purposes that we observe, note and record them.

But do observers really know what they are looking for? They know nothing of causes, and consequently cannot know anything about the laws of the causes. They are scholastics, and as scholastics they look upon the motion of the heavenly bodies as being due to a primary impulse without inquiring into the cause of the primary impulse. They imagine the Universe to be a mechanism, and consequently as controlled and governed by mechanical laws. The Sun

they regard as a huge fire whose energy is kept up by meteors poured into it as fuel from Space; or equally as visionary, they regard him as a great Magazine of Force stored to its utmost capacity at the Beginning to furnish him a supply of energy for running the Solar System for a definite time. Since he must be constantly expending this Energy, therefore when it becomes exhausted, the Sun himself will die out. The same result must inevitably follow the grosser mechanical conception of meteors. When the meteoric fuel gives out, the fire of the Sun will become extinguished, and he will remain a huge mass of dead cinders. These are the notions entertained by scholastics of the causes and laws operating in the Physical World, and this is our warrant for saying, they do not know what they are looking for; and hence they will not find what they seek until they have more just and rational conceptions of the structure of the Universe, of the laws that govern it, and of the causes that produce all its living, moving phenomena.

What are the causes that underlie the phenomena of the Physical World? They are the Physical Forces; and they are so few that they can be counted upon the ends of our fingers, namely: Light, Heat, Electricity, and Constitutism*. A knowledge of these Physical Forces is indispensably requisite to enable us to understand the principles upon which the Universe is founded, and to qualify us to unravel the mysteries of its phenomena. But how are we to acquire this knowledge? Books and the authors of them are not even agreed as to their number, each contradicting the others, and every one inconsistent and self-contradictory in his postulates. They have not risen to the conception that each one of these Forces has its peculiar function in the Economy of Nature,

* Scholastics have applied to this Force the absurd and self-contradictory term Latent Heat;—about as appropriate a term as Latent Thunder would be for Electricity. I call it Constitutism from its functions, as will be shown hereafter.

and therefore has its proper place in the Universe, where it is invariably found when needed there.

There is but one Book that is authority upon this subject, wherein all is written for Man to read, or inscribed in so plain and significent characters that he can decipher it, and that is the book of Nature. These letters and these hieroglyphics are physical facts and phenomena. Hence by observing, noting and recording the facts and phenomena constantly manifesting themselves to us by the Physical World we can attain to a knowledge of the nature, character and functions of the Physical Forces. When we once have attained to this standpoint in Science, then we are qualified to undertake an explication of the facts of the Physical World, and not till then.

Contemplation of, and meditation upon the collected facts and phenomena will furnish us with many suggestions. These suggestions must be followed up until they develop into well defined propositions; and then the propositions must be subjected to the test of comparison with facts, and if they fall within the scope of experiment, they must be tested by it also. Only when they have stood the ordeal of every possible test and have been verified, are we warranted in accepting them as Truth.

When we know the number, nature, character and functions of the Physical Forces, then by induction we rise to the conception that all phenomena that occur on or in the Earth, in the Atmosphere, in the Solar System or in the remote regions of Space, are caused by one or the other of the Physical Forces. If this inference be true, then we hold in our hands the keys that unlock the mysteries of the Universe. When we have verified this grand conception, we have established a great fundamental principle in Science. We have then arrived at the primary source of all physical phenomena, the bond of their indissoluble Unity. We will

then know what we are looking for, and know also the precise method we must adopt and pursue to find it.

CHAPTER II.

WHAT OCEANIC CURRENTS TEACH.

When we survey the number, character, variety and grandeur of atmospheric phenomena, and when we consider—as our intelligence suggests—that the Earth cannot remain quiescent while these stupendous events in contact with its surface are taking place, we then form a faint conception of the greatness of the task, and the difficulty in its execution of arranging these facts into order and constructing them into a system. These facts all come within the scope of Meteorology. But we have no such Science as Meteorology, for what now passes current for Meteorolgy is a libel upon all Science. The task to arrange into order, to systematize and harmonize this vast array of facts is no less than to construct the Science to which they pertain.

First let us consider that in its narrowest scope Meteorology takes cognizance of all the phenomena of the Atmosphere: hence to treat of it intelligibly and understandingly, it is necessary to know what is going on in the Atmosphere. We must know what movements are taking place there, in what direction they take place, and why there are any movements at all in it. Until we know this, we cannot attain to a knowledge of the causes of these movements nor are we qualified to undertake to deduce the laws of physical motion.

Physical Science is demonstrated truth arranged into a system. It is based upon phenomena and facts; but facts

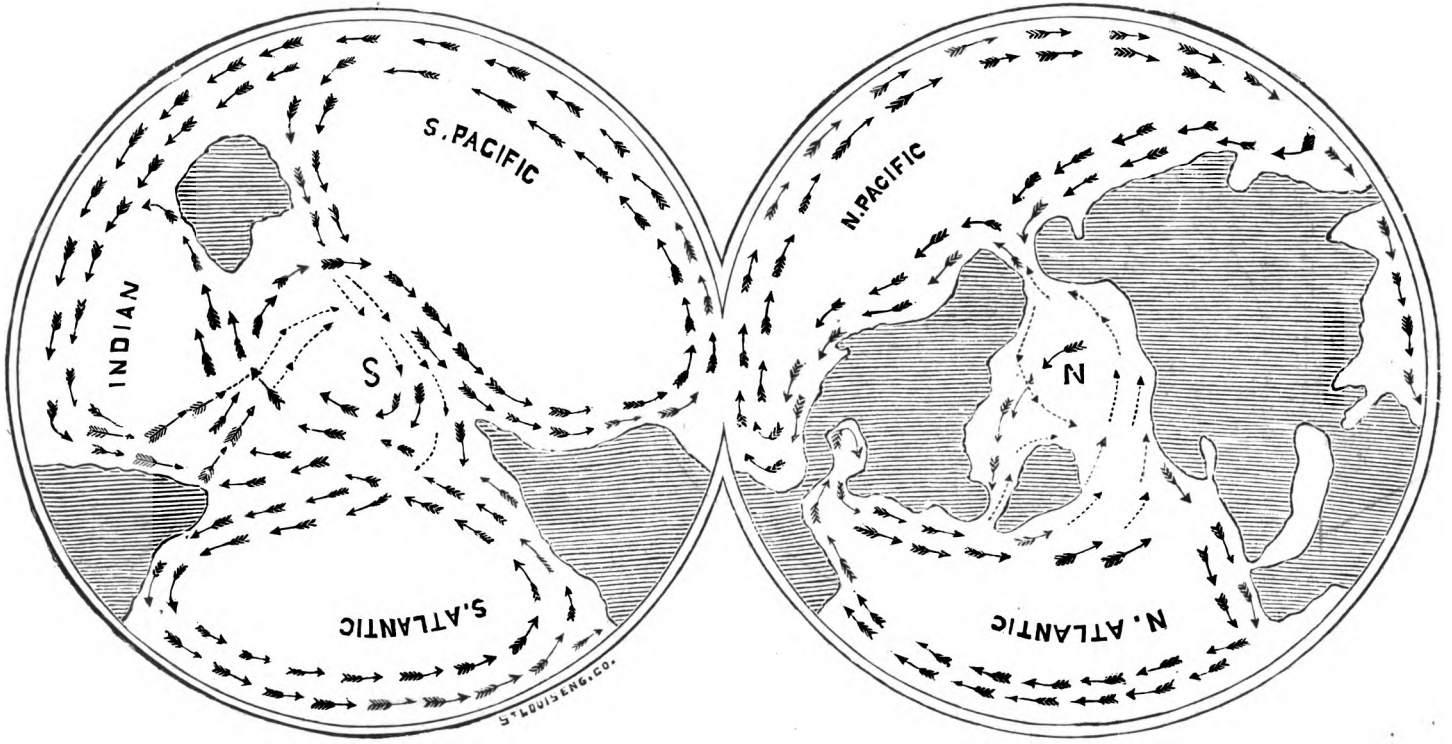
and phenomena are sequences of physical causes and laws. The first step hence is to deduce the causes and laws from the facts themselves and then verifying the deductions by testing and comparing them with all pertinent facts known to us.

But since telluric phenomena also come within the scope of Meteorology, a like comprehensive knowledge is necessary of the causes in operation upon and in the Earth, and of the laws in conformity to which these causes act. Thus qualified, we can undertake the interpretation of what is so legibly written in letters of living Light all over the Earth and Sky for the instruction and edification of the Human Race.

It is step by step we must ascend to that elevated standpoint where we can survey the whole field of physical phenomena and pass under review the whole army of facts subdivided in corps, brigades, regiments, battalions and companies, and assign to each subdivision its proper place on the field. It is not the Present alone that we then can survey and comprehend, but also the Past. We then understand and can tell exactly the physical conditions that prevailed when those imposing and extraordinary phenomena occurred which were deemed worthy of a place in history. The causes of the great variety of physical facts and their great modification in energy, form and character will then be plain and palpable to us, and not dark and mysterous as now.

Meteorology investigates the nature and character of atmospheric phenomena, in order to determine their causes, and to unravel their mysteries. It is hence necessary to commence by ascertaining what the normal condition of the Atmosphere is. Perpetual unrest undeniably is its normal condition, for it is always in motion, and never at rest. A calm is not even an exception; for a limited area of calm only occurs (1) where motion has been temporarily arrested by

OCEANIC CURRENTS IN THE POLAR HEMISPHERES.



MAP No. 1.

an interposed obstacle, or (2) by the meeting of opposite currents converging to the same point. What therefore is the nature and character of Atmospheric movements, and what are the form and direction of its currents?

The Atmosphere is composed of two invisible gases, oxygen and nitrogen; hence its movements do not fall within the scope of vision nor within that of any other of the corporeal senses, excepting that our sensibility is affected by the surface winds. In order therefore to form a clear conception of these movements, it is necessary to resort to analogy, by referring to movements that are palpable to our senses.

Some time since a writer on Physics asserted that all the motions of Matter, whether it be an atom, or a mass like a planet, when simply obeying the impulse of natural force, are identical in every respect. Without being considered as either accepting or rejecting this theory, I avail myself of the analogy it suggests, to illustrate atmospheric movements of invisible gases, by directing attention to movements that are visible, namely the currents of the Ocean, which give us a clear idea of what atmospheric movements are.

When we survey the movements of the water of the Ocean, the first remarkable fact that arrests attention is, that along the west coast of all continents and in both hemispheres currents issuing from the opposite Polar seas, flow towards the Equator, where their waters unite and form the great Equatorial currents that flow from East to West across all Oceans, as will appear from the accompanying map of the opposite hemispheres.

It will be perceived that along the west coast of Europe, a current issuing from the Arctic Ocean flows towards the Equator, where it is met by a similar current issuing from the Antarctic Ocean and flowing from the Cape of Good Hope along the west coast of Africa. Their united waters form the current flowing from East to West across the Atlantic, along the Equator. When this Equatorial current strikes the South American Continent it divides. One of these divisions flows along the east coast of South America down to Cape Horn, and thence southeastward where it is lost sight of from sinking under the outflowing current from the Antarctic Ocean which strikes the Cape of Good Hope. The other division of the Equatorial Current enters the Carribean Sea, thence it flows into the Gulf of Mexico, from which it issues through the straits of Florida, as the Gulf Stream, flowing along the east coast of North America to the Arctic Circle where, and notheastward towards Northern Europe, it sinks under the cold outflowing waters of the Arctic Ocean.

In all respects similar movements are observed in the Pacific Ocean. Along the west coast of North America a cold current of water issuing from the Arctic Ocean through Behring's Straits flows towards the Equator, where it is joined by a similar current coming from Cape Horn along the west coast of South America. Their united waters form the Great Equatorial Current that flows from East to West across the Pacific Ocean. The southern portion of this current striking New Guinea and Australia is intercepted and diverted, so that it flows down along the east coast of Australia, and thence southeastward, disappearing under the Great Antarctic Drift, that flows northeastward to the southmost point of South America. The main portion of the Equatorial Current, however, continues westward. The northern portion successively striking some of the islands

that constitute the East Indies; and finally the peninsula of Malacca, by which it is deflected into the Chinese Sea, whence it issues as the Kuru Sivo, the Gulf Stream of the Asiatic coast. The Kuru Sivo flows northward and northeastward into Behring's Sea, where it sinks under the outflowing waters from the Arctic Ocean through Behring's Straits. In the Japanese language Kuru Sivo signifies the Black Stream, so called because its waters when viewed obliquely at a distance appear black. The same is the case with the Gulf Stream. As it is approached from the Sea, it appears like a river of ink flowing through the Ocean, though its waters when examined, are really transparent. The blackness is owing to the electric condition of the water which either extinguishes the rays of Light, or refracts them in such a manner that they do not reach the eye. Darkness, or rather blackness, is associated with many electric phenomena as will appear hereafter. I give the phenomenon as I find it; and since I find it invariably when it manifests itself associated with high electric tension in the medium of manifestation, hence I infer it to be an electric effect. The section of the Oceans traversed by the Kuru Sivo and the Gulf Stream are noted for their electric phenomena, and especially for the violence and destructiveness of the storms that infest them—the Gulf stream for its hurricanes, and the Kuru Sivo for its typhoons—the Asiatic name for hurricane. The phenomenon of blackness, and the cause of it, is a subject of the highest scientific interest, and deserves a thorough investigation, in order to determine its cause. Perhaps this blackness may simply be owing to the same cause as the ultramarine blue seen in keroscene under a proper angle of refraction. Transparent vapor over the sea, is transformed into fog over the shore. When cloud formation takes place over a mountain, invisible vapor becomes fog over the mountain.

In the *Rocky Mountains* I have seen a double transformation. Fog clouds hanging over the Parks, dashing headlong towards the mountains, vanish before they touch them, but reappear under the cloud, as if they issued from an invisible smokestack. In what is called the weather glass, the chemical solution becomes turbid under a low barometer, and transparent again under a high barometer. In the electric egg, and in its improvement, the Geissler tubes, the intervals between the meniscii are pitch black. In the aurora, the luminous arch is often seen to span what seems to be a black cloud, yet through which the stars are shining. In daytime meteoric stones have come from what seemed to be a jet black cloud. The hailstorm is always enveloped in a greenish black cloud and often the tornado also. But the latter is more generally in a copper-colored cloud, shading to orange and buff. The colors of these electric phenomena have a secret to disclose and we ought to question them closely.

The central portion of the Equatorial current after entering the Indian Ocean, flows westward until arrested by Africa, along the east coast of which Continent it flows south to the Cape of Good Hope, thence southeastward, where it sinks under the current that flows out of the Antarctic Ocean, northeastwardly to the southern point of Australia, thence along the west coast of Australia till it joins the Equatorial current.

The inspection of map No. 1, reveals the fact that three well-defined currents flow from the Antarctic Ocean, and invariably northeastwardly in direct lines to the southern points of continents, namely: South America, Africa and Australia. Thence they skirt the west coast of those continents to the Equator. This general fact suggests a general cause for these currents. Why should they flow out of the Antarctic ocean in curves from left to right, and invariably

to the southern point of a continent? We infer that the continents and the waters of the Polar Sea are in opposite electric states; hence they mutually attract each other, and such mutual attraction is the cause of the current.

All continents in shape are rudely formed cones, with their bases towards the north, and their apexes toward the south. No such projecting continental points being presented to the Arctic sea, as towards the Antarctic, the course of the currents issuing from the North Pole is not so well defined as those from the South.

The Arctic Polar Sea in fact is land locked. Polar currents however, are known to issue from the North Pole, flowing southeastwardly to the bases of the continents, and thence eastwardly along those bases to straits or openings into the Pacific or Atlantic oceans. Through these straits, as Behring's and Davis' straits, and the open sea east of Greenland, they issue into the great oceans. Hence the same fact in a modified form, exists in the sea around the North Pole as around that of the South Pole, with this difference: the curves described by the outflowing waters, are from right to left, or in the opposite direction of those coming from the South Pole.

It is very probable that the waters coming from the opposite poles, which meet and form the Equatorial currents, cross the Equator, and hence exchange hemispheres. If this be the case, then each volume of water from the time it leaves either pole until it returns thither, describes a duplex figure 8, thus:

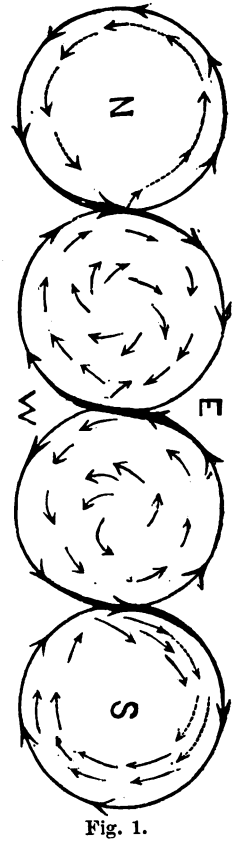


Fig. 1.

The circle around N represents the Arctic Circle; consequently the enclosed space, the Arctic Ocean. The circle around S represents the Antarctic Circle, and consequently the enclosed space the Antarctic Ocean. The circle from the Arctic Ocean to E & W, represents both the North Atlantic and the North Pacific Oceans, from the Equator to the Arctic circle; and the circle from E & W to the Antarctic Ocean, represents both the South Atlantic and the South Pacific Oceans, and likewise the Indian Ocean from the Equator to the Antarctic Circle. E & W indicate respectively the cardinal points East and West. A line drawn from E to W will represent the Equator. The arrows from the Arctic Circle to E indicate the direction of oceanic currents in the North Atlantic or North Pacific Oceans along the west coast of continents in the Northern Hemisphere. Those from the Antarctic circle to E, indicate the direction of currents in the S. Atlantic, S. Pacific and Indian Oceans along the west coast of continents in the Southern Hemisphere. The arrows from W to the Arctic and Antarctic circles indicate respectively the direction of currents in either the N. Atlantic or N. Pacific along the east coast of continents, coming from the Equator to the Arctic Ocean, or in the S. Atlantic or S. Pacific, along the east coasts of continents, from the Equator to the Antarctic Ocean.

In the Indian Ocean the waters in their route from the

South Pole to the Equator and return, describe simply the figure 8.

It is an interesting, and, if accidental, a curious fact, that in Mathematics, the figure 8 is the sign of infinity, and in Philosophy, the symbol of endless continuity. Did those who independently adopted this symbol, receive the expressive suggestion from Physical motion? If so, then these movements must have been known to them. On the ancient pottery found in Missouri—supposed to be that of the Mound-builders—this same figure is found painted in parallel lines, as represented by Fgure 2.

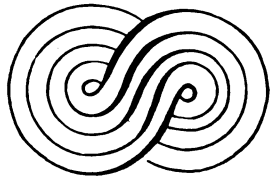


Fig. 2.

It is likewise a significant fact that the nervous system in animals, and the circulation of the blood describe the same figure. A still more significant fact is that the movements of the protoplasm—now sometimes called bioplasm—in both the vegetable and animal cell, describe the same figure.

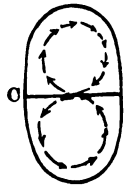


Fig. 3.

Let figure 3 represent a living cell, and the line C the cytoblast that divides the cell into two compartments. The cell is filled with a translucent viscid substance called proto-

plasm, or by some biologists, bioplasm. Suppose that above the cytoblast, the movements of the protoplasm be direct as shown by the arrows—then below the cytoblast the movements will be retrograde.* The combined movement is perceived to be the figure 8. The key that unlocks the mystery of all these movements is electric and magnetic.

Let A, figure 4 ,represent the rear of an electric current circulating through a wire bent in a circle; and B the front of the same current. If this current were visible and viewed

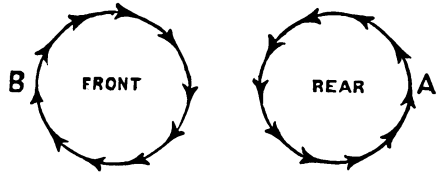


Fig. 4.

from the front, the forward motion would appear to be direct; when this same current were viewed from the rear—then the forward motion would appear to be retrograde. If a short piece of iron or steel is placed in the centre of the circular current, the end pointing towards the front of the current, becomes a *boreal* magnetic pole; and the end of the wire pointing to the rear, an *austral* magnetic pole. Hence a circular current of electricity produces in its front, that is, on the side on which the motion is direct—*boreal* magnetism and in its rear—that is, the side where the motion is retrograde, *austral* magnetism.

If oceanic currents and the protoplasmic currents in living cells are electric currents—which they are, if they be caused by Electricity—then on that side of the compartment of a cell where the current is seen to be direct, *boreal* magnetism

* The terms *direct* and *retrograde* are astronomical. In this treatise the term *direct* is used to designate motion in the same direction that the hands of a watch are seen to move, and retrograde motion contrary to the hands of a watch.

is produced, and on the side of the adjacent compartment where the current is retrograde, *austral* magnetism is produced. Since a boreal and an austral pole mutually attract each other, hence the animal or vegetable tissue, built up by the action of cells, having the two opposite magnetic poles superimposed, is a stable equilibrium. In the Arctic Ocean the currents of water, if electric, will—since the current presents its front to the bottom of the Ocean—produce boreal magnetism there and austral magnetism on the surface of the Ocean, since the rear of the current is presented by the surface. In the Antarctic Ocean the conditions being reversed, the effect must be reversed. In both the North Atlantic and North Pacific Oceans, the rear of the current being presented to the bottoms of these Oceans will produce austral magnetism at the bottoms, and boreal magnetism at the surfaces which present the front of the current. Again in both the South Pacific and South Atlantic Oceans, these conditions being reversed, as will be perceived by inspection of figure 1—the boreal pole is produced at the bottoms of both, and the austral pole on their surfaces. Hence in the water areas the opposite magnetic poles are alternately located at the surfaces and at the bottoms of the Oceans. At the proper time additional facts of the same nature and character will be adduced by citing aerial phenomena in order to demonstrate and verify the deduction that all these remarkable facts are due to electric action.

We have already presented the fact that all the currents issuing from the Equator and flowing towards the poles, along the east coasts of continents in both hemispheres, sink under the cold currents issuing from the Polar Seas. The cause of this sinking is probably owing mainly to the difference in density between waters near and nearest the freezing point. Nevertheless the fact should not be ignored that these cur-

rents having flowed around one magnetic pole for thousands of miles may be so affected by it as to be attracted by the opposite magnetic pole which is at the bottom of the Ocean near the poles. Magnetic influence, hence may be inferred to assist in this sinking of waters near the Polar circles. Fresh water attains its greatest density at the temperature of 38.80.° Hence it sinks, and water nearer the freezing point, having less density, rises to the surface. To this fact it is owing that ice is not formed on the bottoms of rivers and lakes, which would be destructive to fish and all other aquatic animals. So with the sea water. It is not yet however a settled point at what temperature sea water attains its greatest density. The temperatures ranging from 34° down to 29° have all been named. It is generally conceded that sea water freezes at a temperature of nearly 28°.

The currents of warm water from the Equator that flow over layers of cold water along the east coast of continents towards the poles, gradually lose heat. When they reach the Polar circles, if not sooner, they meet outflowing cold waters from the Polar seas. It may be that now having greater density they sink to the bottom of the ocean, while the colder polar currents being nearer the freezing point, consequently having less density, and therefore more buoyancy, overflow them. The overflowing of the warm by the cold current issuing from the Antarctic Ocean is a fact without any exception. But both the Kuru Sivo and the Gulf Stream overflow the currents issuing from the Arctic Ocean, yet both are lost sight of by sinking near the Arctic Circle. The outflowing cold streams however, flow at no great depth beneath the Gulf Stream, for icebergs are carried at right angles southeastward across the Gulf Stream.

That the currents coming from the Equator sink, or are poured down to the bottom of the Ocean near the Polor circles, admits of no doubt—it is an inevitable deductiou from the

facts. Wherever the Polar Seas have been explored, currents are found to flow out from the poles, but at no point has a current been found to flow towards the poles. The polar currents are perennial, hence their outflowing waters must be supplied by perennial sources. Since no such sources can be conceived to exist, unless it be the currents that after a course of thousands of miles return towards the poles, and disappear by sinking under these outflowing currents from the poles; hence those currents that have disappeared under the outflowing waters, must be the sources whence the perennial supply comes that sustains this constant outflow.

On the map I have traced in dotted lines the supposed course of these currents along the bottom of the Ocean, until they rise to the surface near the poles, in consequence of having less density, now having attained nearly to the temperature of the freezing point of sea water.

In what is called the Sargasso Sea, in the North Atlantic, there is an upwelling or upheaval of sea-water. Another such upheaval occurs in the South Atlantic, on the polar side of the Tropic of Capricorn. Similar upheavals of sea-water exist in both the North and South Pacific, on the polar sides of both Tropics. Besides these, there is an anomalous upwelling of fresh water in the Carribean Sea, as though a river discharged itself through an orifice in the bottom of the Ocean. In this upheaval the *maniti* and other fresh water animals abound. These upheavals or uppours of water —excepting the latter—are delineated and the direction of their outflowing waters shown in figure 1.

The movements of the water in the Ocean are hence horizontal currents on the surface, and horizontal currents at the bottom; vertical downpours from the surface to the bottom near the Polar circles, and vertical uppours from the bottom of the Ocean to its surface near the poles, and on the

polar sides of the Tropics in both the Atlantic and Pacific. Horizontal currents on the surface of the Ocean flow from an uppour to a downpour; and those at its botton flow from a downpour to an uppour. If oceanic movements are types of aerial ones, then the analogy between them furnishes us so clear a conception of their nature, character and form, that we will have no difficulty in unraveling their mysteries and explaining their laws and causes.

CHAPTER III.

THE ATMOSPHERE AN AERIAL OCEAN.

The Atmosphere is an aerial Ocean covering the Earth to a depth of at least sixty miles. The surface of the Earth is the bottom of this aerial Ocean. Clouds float in it over the land and the sea. From them fall rain, hail and snow; and from them also bursts the tornado and hurricane with such gigantic energy and devastating fury that Man stands aghast with wonder, amazement, fear and consternation at the fearful phenomenon.

The Air, like the Sea, has its wonders and its mysteries. Both stand ready to reveal great and wondrous things, only kept secret from the Beginning, because Man in a proper manner has not approached and asked in a docile spirit and inquiring frame of mind for their disclosures.

On the surface of this aerial Ocean there are whirlpools into which the air rushes and is poured down upon the surface of the Earth. On the bottom—the surface of the Earth—there are vortices into which the air rushes from all points, is engorged, and spurted up to the surface of the Atmos-

phere. From uppcurs, the air flows out on all sides into the vortices of adjacent downpours. From the points where these downpours strike the surface of the Earth, the air, in diverging currents, flows out on all sides into the vortices of the adjacent uppours. These outflows from downpours and inflows into uppours are the winds, the standing riddle that the inexorable Sphinx has persistently propounded through all ages, and which man has hitherto totally failed to solve.

Wherever there is a downpour of air upon the surface of the Earth, there the readings of the barometer are high. The readings there do not indicate the weight of the Atmosphere alone, but in addition the force of the descending current. All the area struck by a descending current of air, is under a *high barometer*, as high atmospheric pressure is now called.

When the readings of the barometer indicate that the atmosphere presses upon the surface of the Earth, with a weight equal to a layer of Mercury thirty inches in depth and upwards, then the phenomena is called a high barometer. Atmospheric pressure below thirty inches is called a low barometer.

Wherever the air pours up from the surface of the Earth, there the readings of the barometer are low, because they do not indicate the weight of the Atmosphere, but only the residue of weight after deducting the force of the ascending current. Hence the area on the Earth's surface underlying an ascending current of air is under a Low barometer.

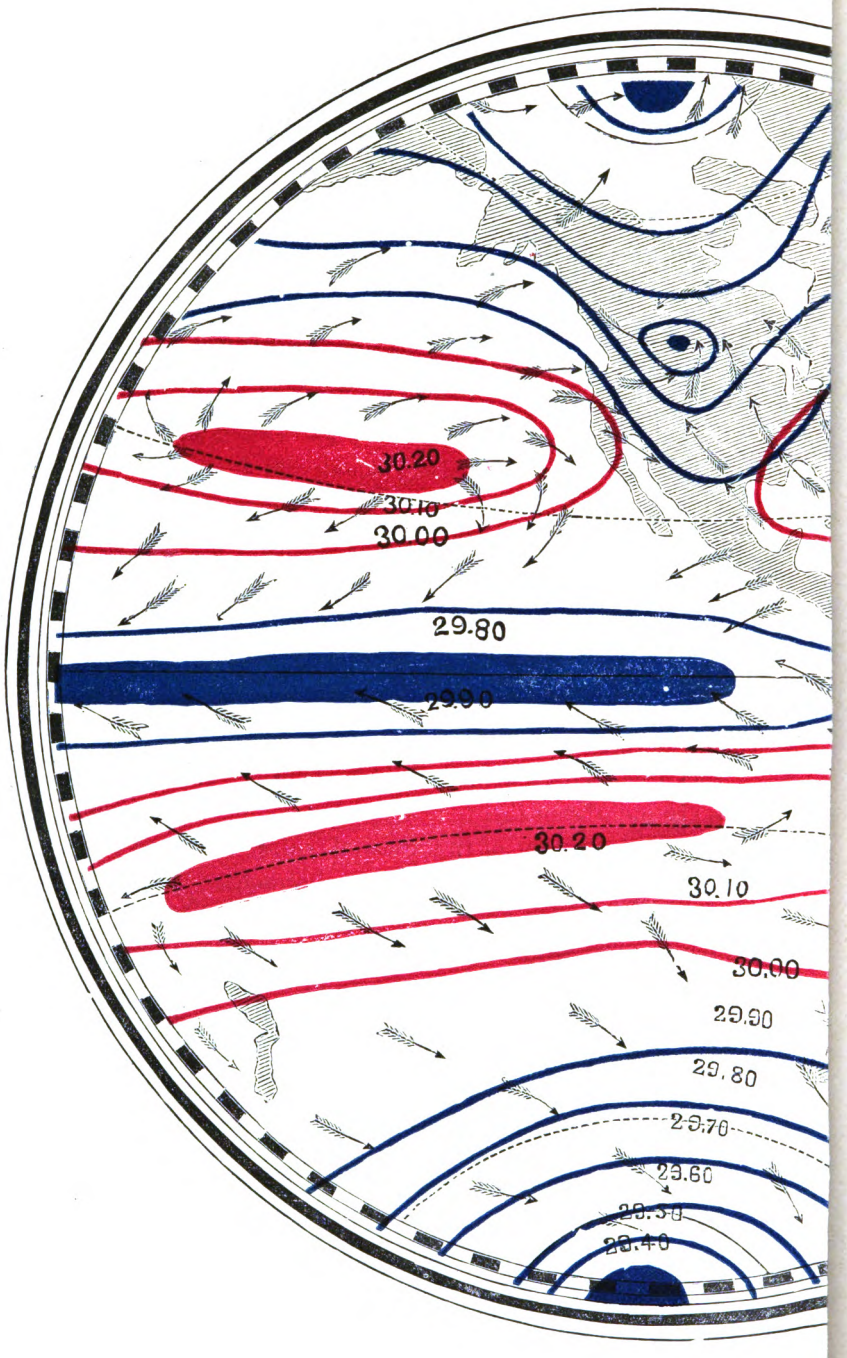
If a High barometer is caused by a downpour of air upon the Earth, and a Low barometer by an uppour from it, then there must be facts that prove it.

Francis Galton, an English Meteorologist, about twenty-five years ago first discovered that in the centre of every High barometer there is always a *large* area of calm; and likewise

that in the centre of every Low barometer, there is always a *small* area of calm. In connection with these facts, he also discovered: (1) that from the area of calm in the centre of a High barometer, on all sides the air flows *out;* and (2) that on all sides the air flows *into* the calm center of the Low barometer.

Both of these facts were contested by other Meteorologists, when Galton first announced his discovery. But all observations made since, and the daily observations of the Signal Service, confirm the truth of his discovery. Since it is a fact no one disputes, and which no one can dispute that from every area of High barometer on all sides the air flows out, therefore whence comes the supply of air that sustains this constant outflow? Flowing out on all sides, there is no other direction whence it can come than from the Zenith; and since it comes from the Zenith, it proves there is a descending current, a downpour of air upon the surface of the Earth under a High barometer. It is the force of this descending current that causes the high readings of the barometer. The great elevation whence the descending current comes is the cause that the air in Summer is always cool and bracing under a High barometer, and often intensely cold in Winter. The facts show conclusively that a high barometer is a downpour of air upon the surface of the Earth.

What are the facts in regard to the Low barometer? I have already shown that all observations made since Galton announced his discovery, and the daily observation of the Signal office, show incontestibly, that on all sides the air flows into an area of Low barometer. Hence whither does the air thus poured into the calm centre go? The conditions as shown by the facts are such that it cannot go in any other direction than towards the Zenith, and since it goes towards the Zenith, there is an ascending current, an uppour of air


30.20
30.10
30.00
29.80
29.90
30.20
30.10
30.00
29.90
29.80
29.70
29.60
29.50
29.40

from the surface of the Earth. The facts prove undeniably and conclusively that the low barometer is an uppour of air from the surface of the Earth.

Chart No. 1 exhibits the average atmospheric pressure over the Globe for six months, from the first of April to the first of October, or during the Summer of the Northern Hemisphere, consequently the Winter of the Southern Hemisphere. The areas that during these six months show an average high barometer are colored red in the centre to indicate the extent of the areas of calm, with red lines drawn around these centres to indicate the extent and limits of the high barometer. These lines drawn around the centres, are called *isobars*, a word derived from the Greek *isos*, equal, and *baros*, weight. Isobar, hence, means the line along which equal atmospheric pressure prevails. The outer red line is the Isobar of 30, the dividing line between the high and the low barometer.

It will be perceived that during these six months four constant high barometers prevail, located as follows: two north of the Equator, in both the Atlantic and Pacific Ocean, and centrally near the Tropic of Cancer; and two south of the Equator on both oceans, centrally near the Tropic of Capricorn. The areas where average low barometers prevail during these six months of the year are colored blue in the centre to indicate the extent of the areas of calm with blue isobars around these centres. In the low barometer, pressure is lowest at the centre and *increases* outwards; under the high barometer, pressure is greatest at the centre and *decreases* outwards. In other words, pressure increases from the centre of the low barometer to the centre of the high barometer, and hence decreases from the centre of the high barometer to the centre of the low. It will be perceived that during these six months there are seven areas, whereupon average low barometers prevail, namely: one centrally over each pole; one along the Equator on both Oceans; one over

the Aleutian Isles; one over Iceland; one in Central Asia; and one in the Rocky Mountains in the British Province of Western Manitoba, (pronounced Man'e-to-baw').

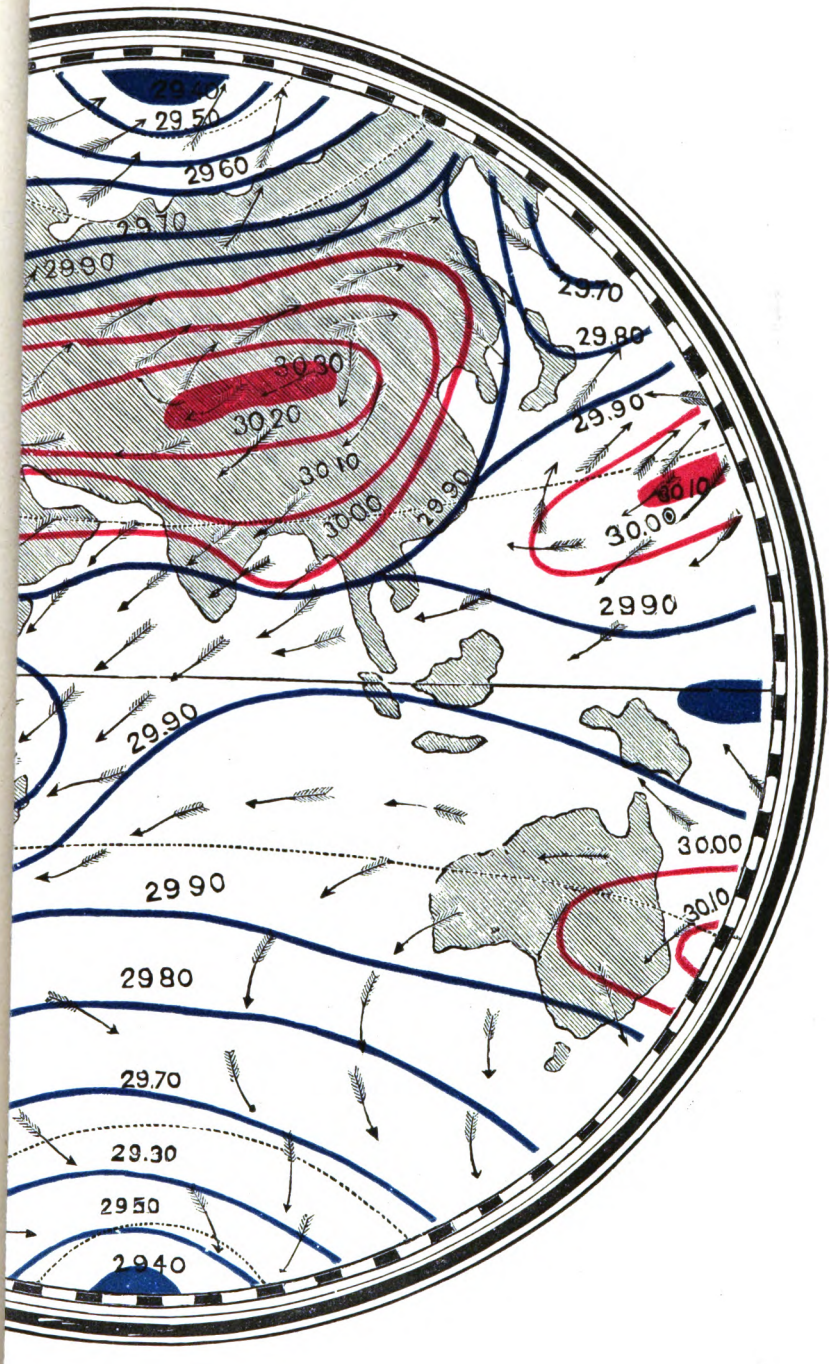
Chart No. II, exhibits the average atmospheric pressure during the remaining six months of the year, namely: from the first of October to the first of April, or during the Winter of the Northern Hemisphere, and consequently the Summer of the Southern. The same areas in both the Atlantic and Pacific are perceived to be covered by high barometers, as in Chart No. I; and an additional area of high barometer is seen to be in Central Asia. The areas in the South Pacific and North Atlantic, are however both enlarged; while those in the South Atlantic and North Pacific are much diminished. The same low barometers as in Chart I, likewise appear with two additional ones, namely: one over South Africa, and the other over South America. The areas of low barometer near the Arctic Circle, one over Behring's Sea, and the other over Iceland, are much enlarged.

If these charts be superimposed, then the localities along the polar sides of both Tropics on the Oceans will show an average high barometer throughout the year, because one chart represents these phenomena for one half of the year, and the other chart for the other half. These high barometers hence are fixed as to locality, and constant as to duration.

It is also perceived that the same areas along the Equator on both Oceans, and over both poles show low barometers for the whole year. These low barometers, therefore, likewise are fixed and constant.

In Meteorology as in every branch of Physical Science, the same method of division and subdivision, and classification of facts and phenomena into *genera* and *species* must be pursued until individual facts and phenomena are attained. It is only then that we can understand them and interpret their meaning. The phenomena of atmospheric pressure is divided

PRIL 1, OR NORTHERN WINTER.



into two *genera*, namely: the High Barometer and Low Barometer. Our discussion has already disclosed one species of both *genera*, that is, there are some of both high and low barometers that are fixed as to locality, and which persist throughout all the year. These we will consider a species, and class them as *constant* high and constant low barometers.

But the charts disclose another species of both, that interchange places about the time the Sun crosses the Equator. For instance, when the Sun crosses to the North side of the Equator, the high barometer in Central Asia in the Northern Hemisphere lifts, and a low barometer takes its place. At the same time, the low barometer in South Africa, in the Southern Hemisphere lifts, and a high barometer takes its place. When the Sun in Autumn recrosses the Equator, they again interchange places; and so on forever. Though during the time they continue, they are fixed as to locality, yet as they at fixed periods interchange localities, and since the length of these periods is six months, they are classed as *periodical* high and periodical low barometers.

There is another species of high and low barometer, which are not shown upon the charts, because these charts only show average phenomena for alternate six months, or in other words, the charts show only such high and low barometers as persist constantly in definite localities throughout the year, and such as persist it certain localities only for six months during the year. These other species are neither fixed as to locality, nor have they a fixed period for either their appearance or their duration. They first show themselves on the west coasts of all continents, and traverse them from West to East, occupying on an average from two to four days in the transit, according to the width of the continent. Their average rate of translation eastward, is about twenty-five miles an hour. But from causes which will be demonstrated at the proper time, there is sometimes accel-

leration and sometimes retardation. When accellerating causes prevail, they may attain a velocity of from fifty to seventy miles an hour; and when causes of retardation, their rate of velocity may be reduced to only from six to eight miles an hour. They may not only be retarded, but they may be entirely arrested. When arrested, their behavior will, according to circumstances, be: (1) Standing temporarily still: (2) deflected in curves by way of the North or of the South, that is, along the line that offers the least resistance at the time; or, (3) on rare occasions, when overpowered by obstructions on their front and flanks, they may be driven back westwardly whence they came, and wait until the obstructing cause has removed, when they will resume their eastward course. The nature and cause of these obstructions, and likewise the cause of all directions in which they move, will be shown hereafter. It should, however, be borne in mind that the normal course of neither high nor low barometer is due East. The normal course of a high barometer—that is, when it is not influenced by a low barometer either on its flanks, front or rear—is from Northwest to Southeast; and the normal direction of a low barometer, when uninfluenced by an adjacent high barometer, is from Southwest to Northeast;—that is, their normal paths are at right angles to each other.

In North America, the low barometers that appear on the West and Northwest coast of the Continent are offshoots or spurs from the Aleutian constant low barometer. In Europe, the low barometers that come from the Ocean, are offshoots from the Icelandic constant low barometer. Most of the low barometers that traverse the American Continent are formed on the Northern Andes, constituting the Cordilleras in Mexico, and the Rocky Mountains in the United States and British America. Three-fourths of the number originate in the mountain system of Western Manitoba and Montana, where the Col-

umbia, the Frazier, the Yukon, the Mackenzies, the Sasgatchawan and the Missouri rivers have their sources. Many of these low barometers are formed in the Rocky Mountains of Wyoming and Colorado; some in the Cordilleras of Mexico, which—when a high barometer covers the Gulf of Mexico—swing northwardly, and even northwestwardly, into Arizona, or northeastwardly into Texas. When no high barometer is over the Gulf of Mexico, they pass upon it and thence down Northeastward along the coast, either upon the Gulf Stream or parallel to it.

Low barometers also originate upon the Tropical Sea, east of the Windward Islands. They sweep in upon the North American Continent from the Southwest, and almost invariably during the month of August, September and October, are cyclones, that is, hurricanes. These cyclonic low barometers, being repelled, as will be shown, by the constant high barometer between them and their objective point, the Icelandic low barometer, describe a parabola. The apex of this parabola as to locality, depends upon the position at the time of the high barometer just referred to. If the high barometer is on an extreme eastward oscillation, then the apex of the cyclone's track is East upon the Atlantic, and not near the coast. If it occupies about its medium position, then the cyclonal apex is upon the Gulf, even as far west as the coast of Texas. For this reason, hurricanes sometimes sweep in upon the Gulf of Mexico from the Carribean Sea, sometimes only upon the peninsula of Florida from the West Indies, and at other times they do not touch the Southern coast at all, but strike the coast of Nova Scotia, in which case they traverse the Ocean north of the West Indies. As an illustration of the course these latter hurricanes pursue, we give in our storm-map the approximate track of the Nova Scotia cyclone of August 24th and 25th, 1873, which is fully described at the proper place. When storm centres,

by repulsion from Northeastward and Eastward high barometers, are driven upon the gulf, and are there met by a tropical low barometer, then most destructive storms occur along the Atlantic coast.

All low barometers traverse the Continent eastwardly—those from the Northwest often so far north that their tracks are beyond observation. The most favorite route for those from the Northwest—and for some also from the Southwest—is the Lake Region, thence down the Valley of the St. Lawrence upon Nova Scotia and New Foundland. Their next most favorite route is the Gulf Stream, along which nearly all the Southern low barometers and many from the West and even Northwest, sweep northeastwardly. The Valleys of the Missouri and Ohio, are traversed by both with about equal frequency.

Since the lowest point of depression within the area of low barometer is the storm centre, hence it is important to know their paths across the Continent. We have just said that they affect the Lake and St. Lawrence route more than any other, and next to this they prefer the Gulf Stream route. Though showing a preference for these routes, yet storm centres scarcely ever pass either route without sending off spurs that distribute more or less rain over the whole continent east of the Rocky Mountains.

It does not, however, matter where a storm centre originates that traverses or strikes the North American Continent, whether in Behring's Sea, on the Rocky Mountains, in Mexico, the Carribean Sea, or the Tropical Ocean east of the Leeward and Windward Islands, they all make their exit from the Continent through a comparatively narrow gate, between Southern Labrador and the middle of the Gulf Stream. This narrow strip is the established highway for all North American storms, which they all travel when they leave the Continent.

Precisely similar facts exist in Northeastern Asia, where the storms also have an established highway upon the North Pacific Ocean for their exit from that Continent, namely, the Kuru Sivo, the gulf stream of that Ocean.

But the low barometer is never alone. It always has a companion, its twin brother, the high barometer, its *tender* and *feeder*. The high barometer pours down upon the Earth the renewed and purified air; the low barometer sucks the air in, engorges it and returns it to the upper regions of the Atmosphere for purification and renovation. The high barometer hence is indispensible to the low barometer as a tender and feeder. They are in fact as inseparable a couple as were the Siamese twins, Chang and Eng. They are born together, live together, and die together.

The high barometer that accompanies the North American low barometer, always moves on the polar side of the latter*, generally at first somewhat ahead of it, then abreast with it, and finally falling somewhat in the rear. When a high barometer is entirely in front of a low barometer, that is, East of it, then the rate of motion eastward of the latter is retarded and heavy rain or snow falls, and generally violent storms accompany it across the Continent.

The cause for the heaviness of the rain and snow-fall precipitated by a retarded storm centre is this, the storm centre being retarded, moves slowly or not at all. Suppose the rate of movement is only one-fourth of the normal rate, which is about 30 miles an hour. Suppose further that no cause of intensification exists, then it will precipitate rain or snow four times longer than it would under ordinary circumstances, and consequently the rain-fall will be four times greater than

* This, however, is neither a peculiar nor an accidental case, for all over the Globe the high barometer that accompanies a low barometer moves on the polar flank of the latter, as will be shown hereafter.

ordinarily. Strong and steady moist winds are steadily blowing into and feed this retarded and hence slowly moving storm centre. These winds coming from over the Gulf on the South and Southwest, and from the Atlantic from Southeast to Northeast, are heavily laden with moisture, and hence pour into the storm centre an immense quantity of vapor, which not only extend the area of the cloud hanging over the low barometer, but give its volume greater density. Retardation not only gives longer duration to the storm at every locality over which it passes, but makes the fall more copious, from the abundant supply of vapor furnished by the inblowing winds.

The causes of greater energy and violence in a retarded low barometer or storm centre are these: (1) In proportion as the cloud has volume and density, so will be the electric charge it carries; and consequently its inductive action upon the Earth's surface underneath it. The cloud being charged with Positive Electricity, it induces and carries forward beneath it on the surface of the Earth, a proportionally intense charge of Negative Electricity. In proportion to the intensity of both these charges—for they are equipollent—is the energy of the action between the Earth's surface and the overhanging cloud. Under the low barometer we have demonstrated that there is an upheaval of air; and the strong and steady winds are indraughts that bear the supply of air to meet the demand of the upheaval. Hence, in proportion as is the energy of the action between the Earth beneath and the cloud above, so is the energy of the winds that sweep into the centre of the low barometer. (2) Low barometers, or storm centres, are impelled by a force that causes them to move from West to East, hence they are hurled against the high brometer, interposed in their front as against an unyielding wall. The centre of the low barometer is by this

impact driven nearer to the center of the high barometer, and the barometric gradient* becomes very steep. In proportion to the nearness of the disgorging to the engorging vortex, and in proportion to the steepness of the barometric gradient between them, will be the velocity and energy of the wind that blows from one to the other.

Whenever the high barometer is entirely in the rear, that is, West of the storm centre, then accelleration takes place, and its progress is signalized by dashing rains of short duration, with strong western gales, and a rapid rate of translation across the Continent.

The localities where the high barometers originate that accompany the low barometers in both America and Europe, have not yet been definitely determined. In America, the average point whence the high barometer issues, is in the Arctic Ocean north of Behring's Straits, though it generally is first observed east of the mouth of the Coppermine River. It moves out from the Polar Sea in curves from right to left, which gives it a Southeastward direction across the Continent to the Sargasso Sea high barometer.

The initial high barometers that accompany European and Asiatic low barometers or storm centres, come from the Polar Sea east of Nova Zembla. They likewise describe curves from right to left and have a southeastward course, to the permanent high barometer that covers the North Pacific

* Gradient is a railway term. In Meteorology it is applied to an imaginary inclined plane ascending from the centre of the low to the centre of the high barometer, based upon the readings of the barometer. It is a very graphic and expressive term when taken or applied to atmospheric pressure. But when first appropriated, the idea was that a high barometer was caused by an aerial ridge or mountain, and a low barometer as a trough or valley between ridges or mountains. Our facts and deductions show that idea to be erroneous; and that if there be any unevenness on the surface of the Atmosphere, the ridge is over the low and the trough over the high barometer. The term gradient must therefore be considered as applying to atmospheric pressure as indicated by the readings of the barometer, and not to the surface of the Atmosphere.

Ocean. Both the American and European high barometers, during a disturbed period extend gradually in area westward. The storm centre or low barometer meanwhile progresses eastwardly and extends its area and attending rains to lower Southern latitudes. Finally these high barometers sweep in behind the storm centre, and bring up its rear. They are accompanied by a clearing sky, and fair weather prevails while they last.

We perceive that these high and low barometers differ in several particulars from both the constant and periodical high and low barometers. That is—

(1.) They are not fixed as to localities, but are constantly on the move; and,

(2.) They endure but for a few days, until they have time to meet constant barometers of their own kind that attract and absorb them. That is, the Icelandic constant low barometer attracts and absorbs every low barometer that appears upon the North American Continent; and the North Atlantic or Sargasso Sea constant high barometer does the same to every transitory high barometer that appears on the same Continent. These high and low barometers, by their constant mobility, and transcient character, differ so essentially from both the constant and periodical high and low barometers, as to constitute a different species; hence we class them as temporary or transitory high and low barometers.

It is hence perceived that there are three species of both high and low barometers, namely: (1) The constant high and constant low barometers that persist upon the same localities throughout the year and hence forever; (2) the periodically high and low barometers that persist only for six months upon the same localities, and interchange places when the Sun crosses the Equator, or within ten days thereafter; and (3) the temporary high and low barometers that are

not fixed but moving. These originate on the western coast of all continents, and traverse it from West to East, occupying about three or four days in making the transit.

Since high and low barometers are the agents of Nature that cause all atmospheric phenomena, hence a classification of them is indispensible in order to unravel and explain the mysteries of the phenomena they produce.

It is a self-evident proposition that effects partake of the nature and properties of their causes. Hence constant effects must be produced by constant causes, periodical effects by periodical ones; and temporary effects can only be produced be the action of temporary causes.

It is however evident that high and low barometers are not *primative*, but only *secondary* causes; in other words, they are effects of an ulterior cause, and this ulterior cause must manifest its nature, character and laws through them. What then is this ulterior cause? This point demands attention and elucidation before the discussion can be carried on profitably any further.

CHAPTER IV.

THE ULTERIOR CAUSE OF ATMOSPHERIC PRESSURE.

I have demonstrated that a high barometer results from the force a local whirlpool, or downpouring vortex in the Atmosphere exerts upon the surface of the Earth beneath it; and that the low barometer is caused by a local upspurting vortex in the Atmosphere, relieving pressure upon the Earth's surface over the area where it prevails.

On the surface of the Atmosphere, the air rushes into the

vortex, is engulfed by it, and is poured down upon the surface of the Earth; into the other, the air on the surface of the Earth rushes in consequence of suction, is engulfed and thrown up like smoke over a fire, or like ashes, cinders, flame, smoke and vapor over a volcanic eruption. In both the high and the low barometer we have the phenomenon of air in motion, differing merely in direction of motion.

The constituent elements of the Atmosphere are oxygen and nitrogen, both invisible gasses, yet they are nevertheless Matter. Hence these ascending and descending currents of air, are Matter in motion. Since all experience and all observation teach us that Matter never moves except under the impulse of Force; hence some one of the Physical Forces must give the impulse that initiates and sustains this motion in the air; at one point causing it to descend upon the surface of the Earth, and at an other point causing it to return whence it came. The Physical Force that gives this impulse to move and sustains the motion when initiated, must be the ulterior cause of the high and low barometer. Hence which one of the Physical Forces is it that causes these moving columns of air? The field to be explored in order to determine this question, we perceive, is restricted to very narrow limits.

There are but four *primitive* Physical Forces, namely: Light, Heat, Electricity and Constitutism*. Probably to these magnetism may be added as a fifth; but all facts now known, justify the inference that Magnetism is not a *primitive* but a secondary Force: that is, an effect, of which Electricity is the cause.

If an electric current with just sufficient energy to electrolyze water, be required at the same time to make a magnet,

* For a demonstration of the existence of Constitutism see my Article "On the Relation between Force and Matter" in No. 5 of "*Half hours recreation in Physical Science*". Boston. ESTES *and* LAURIAT. June, 1873. This point will be amply discussed in the present volume and Sequel.

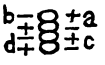
then it will electrolyze no water until the magnet is made. This fact is proof that Electricity and Magnetism stand in the relation of cause and effect towards each other.

Magnetism can only be considered as a primitive Force upon the assumption that ultimate particles of Matter —atoms —are naturally endowed with opposite polarities, which may be represented by + *plus*, and — *minus*, thus:

Fig. 5.

where *a* represents the atom, and + plus the *boreal* and — the *austral* pole of magnetism. Since the ends of steel or iron rods affected with the same polarity, mutually repel each other, and the ends affected with opposite polarities mutually attract each other, hence in the aggregation of atoms to form masses, it is to be inferred that the opposite poles, by mutual attraction, will arrange themselves side and side according to the law of mutual attraction between dissimilar poles, and mutual repulsion between similar ones. Consequently aggregation of Matter takes place by every alternate atom placing itself along side of or over the contiguous atom with poles reversed, thus, as in

D



A

Fig. 6,

where it will be perceived the atoms *a*, *b*, *c* and *d*, are superimposed, with poles alternately reversed. Such an aggregation will be a stable magnetic equilibrium; for each atom, being a natural magnet, when two atoms with poles reversed are superimposed, they by mutual attraction adhere to each other. The mutual affinities of these atoms now being grat-

ified, they are indifferent to all other aggregated Matter, though not indifferent to other atoms individually. The effect of their aggregation is therefore equivalent to a loss of polarity as regards other Matter. For the magnetism of the mass has become insensible as to exterior Matter.

Since iron, of all known substances, is most susceptible of the magnetic influence, therefore let us suppose the above atoms to be iron. Since Electricity in motion developes Magnetism at right angles to its current; therefore suppose a circular current of Electricity to flow around these atoms, ascending perpendicularly to the page at the point A (see

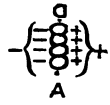


Fig. 7.

figs. 6 and 7), and descending at D, then the current will arrange these polarities so that all the plus ends will point in one direction, and all the minus ends in the opposite direction. The result will be a magnet with the joint energies of all the plus polarities manifested at one end, and the united energies of the minus polarities manifested at the other, as shown in fig. 7.

There may be some who prefer considering Magnetism as a primitive Force. It is for the benefit of such that I present the aforegoing solution of the problem from their standpoint. I prefer myself, however, to consider Magnetism a secondary Force, for the following reasons:

(1.) We have no evidence that atoms are natural magnets. In fact, many substances are so feebly susceptible of Magnetism, that it is yet doubtful whether they properly are susceptible to its influence at all.

(2.) That although no Matter is known that is not at all times and places affected by one or the other of the Physical

Forces, yet there is no evidence that the same form of Force persists unchangeably in the same Matter. If all atoms are natural magnets, then Magnetism forms the solitary exception to an otherwise universal rule.

(3.) All the other Physical Forces are mutually interconvertible; that is, when any given form of Force disappears, another form, its equal in energy, makes its appearance, into which it has become changed. Magnetism, as the electro-magnet shows, does disappear, and no other form of Force replaces it.

(4.) The disappearance of Magnetism in the electro-magnet, without being replaced by another Force, and without effecting any perceptable change of property in the Matter constituting the magnet except its own disappearance, warrants the inference that Magnetism is the result of a peculiar arrangement of atoms in the Matter that manifests it; and that its disappearance is owing to a return of the atoms to their former arrangement. Either this is the case, or it has the power of lapsing into nothing, which is impossible, for neither Matter nor Force can be either created or destroyed, therefore neither can lapse into nothing.

(5.) No other Force preserves its integrity constantly intack. Light incessantly changes into Heat; Heat, into Electricity, and Electricity constantly reverts into both Heat and Light. In fact, by an inherent faculty, each begets the others *per se*. In this respect Magnetism differs from all of them. It is impotent, and *per se* cannot beget either of the primitive Physical Forces; that is, the magnet has to be put in motion by some extraneous force, or if the magnet remain at rest, some conducting substance must be put in motion so as to pass by the magnet. In either case, it will excite an electric current in the adjacent conductor.

But here, again, a wide difference manifests itself between Magnetism and the Physical Forces. When any one of the

Physical Forces arises from the merging of another into it, the merging or causative force disappears by conversion, that is, by lapsing into the caused force. But before it changes, it has effected such a physical change in the condition of the Matter that it changes, if the force be Heat, its form, and the force changes form with it. But when Electricity—and by means of Electricity, Light and Heat—arises from the influence of Magnetism, the latter retains its original potency unimpaired, and continues indefinitely to excite the primitive Forces.

Here it would seem as though something arises out of nothing. But it is not so. Although the magnet retains intact its integrity and potency, and by its influence Electricity arises, and through Electricity, Light and Heat, yet nothing has been created. Electricity and whatever else has arisen, did not do so from a conversion of Magnetism into that Force, for Magnetism was only the medium of some other Force. But it is the Force that puts the magnet or the conductor in motion that becomes converted into Electricity.

(6.) Magnetism is not an inseparable concomitant of Electricity. No Magnetism is manifested with static Electricity, that is, Electricity at *rest*, but only with dynamic Electricity, that is, with Electricity in *motion*, when it invariably appears at right angles to the current; and,

(7.) The primitive state of Matter is the atomic or gaseous. Atoms are the units which aggregate to form masses. Light —which is diffused throughout the Universe, hence falls upon Matter everywhere, however widely and sparsely it is disseminated through Space and in whatever form it may exist. Since Light cannot impinge upon Matter however minute the particle, or massive the bulk, without more or less heating it; and since no Matter in any form can have its temperature changed without electric currents being started in

it flowing from the heated or heating points to those of lower temperature, hence no particle of Matter can exist without electric currents circulating in it.

In spheres like the Sun or planets, or in globules like atoms, these currents must be circular, flowing at right angles to an axis. The end of the axis around which the motion of the current is *direct* becomes affected with *boreal* magnetism, while that around which the current is retrograde becomes affected with *austral* magnetism* ; hence, every atom becomes an electro-magnet. Attraction and cohesion between the electro-magnetic atoms result as inevitably as between naturally magnetic ones. Dr. William Gilbert, physician to Queen Elizabeth, therefore announced a great and farreaching truth when in his *Physiologia nova de Magnete*, published in London, A. D. 1600, he declared that the great Globe itself is aggregated and coheres by virtue of Electricity ; for electric action causes the cohesion of Matter†. Gilbert's knowledge was too deep for his contemporaries to fathom, and therefore they could neither comprehend nor appreciate him. Eight generations have since come and gone, but their mental march has been so slow-paced that they have not penetrated to the advanced point to which he pushed his explorations. His wonderful insight and mental grasp enabled him to see and comprehend things clearly and distinctly that are yet too recondite for the apprehension of those who follow blindly the lead of second or third rate compilers of fragmentary and incongruous text books ; and his marvelous intuition far outran any deductions scholastics have been able to make, notwithstanding the vast accumulation of facts accrued in and contributed to the store of Human Knowledge by the three centuries that have since elapsed. The Future, however, will

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* *Vide* illustration, Fig. 4. p. 32.

† Globus telluris per se electrice congregatur et cohæret; motus electricus est motus coacervationis materiæ.

comprehend and appreciate him, and do him justice. I lay this stone upon his tomb as a first contribution for erecting a cairn to the memory of his genius, and to his scientific pre-eminence.

Since there is no difference in behavior between a natural magnet and an electro-magnet; hence the same explanation suffices to illustrate the conversion of a congeries of electro-magnets into an ordinary magnet, that has already been given for such conversion of a congeries of natural magnets in fig. 7, p. 52. It will, however, be necessary to conceive that to sustain the electro-magnetism of each atom a circular current of Electricity must flow constantly around each atom. These currents, when aggregated and cohering atoms are presented endwise, will have the direction as seen in A and B, fig. 8,

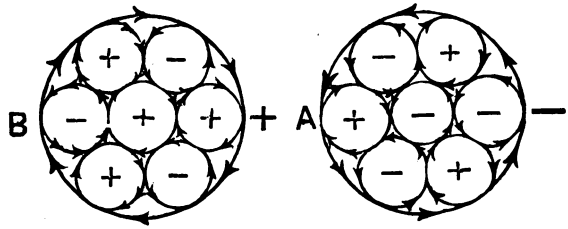

Fig. 8.

where A represents one end and B the other end of a mass of items aggregated naturally. The arrows show the direction of the electric current flowing around each atom, and the signs + and — the magnetic effect of each current as already explained. That is, the direct current produces + *plus* or *boreal* magnetism, and the *retrograde* — *minus* or *austral* magnetism. When the current is seen to be *direct*, the observer stands in front of the current, and when the current is seen to be retrograde, then he stands in its rear.

Now, suppose the aggregated mass of atoms to be placed in a helix wound so that it will place A in the rear and B in

the front of the current. Then every +, that is, *boreal*, pole in the mass will swing around and face to the front, and consequently every —, that is, *austral*, pole will face to the rear. The current around the whole mass replaces the atomic currents, or rather accords with them, and the end B, presenting all + poles, is the *boreal* or + pole of a magnet as seen in figure 8, and the end A the *austral* or — pole.

Though we do not accord to Magnetism the high rank of a primitive Force, yet the testimony of facts is so pointed and so plainly and forcibly expressed, that we must accord to it the high function of Director of all motion caused by the primitive Forces. It is the Executive that executes their will and enforces their laws.

A *boreal* pole will hurl a free electric current around it, either to the right or left, according to the direction the current may flow; that is, it will hurl a descending current from right to left around it, and an ascending current from left to right. The influence of an *austral* pole upon the current is such that it will hurl it in the opposite direction that a *boreal* pole will.

The opposite polarities of magnets not alone deflect in definite but opposite directions free electric currents, but they cause the rays of polarized Light to deviate from their normal direction, and rotate the plane of polarization to the right or left according to the kind of magnetism that affects the magnetic pole.

Prof. Pluecker, of the University of Bonn, experimenting with a Geissler's tube having a central bulb ellipsoidal in form, discovered that the luminous electric current flowing through the tube, became, as a magnet approached the bulb, concentrated into an attenuated luminous arch; passing the ellipsoidal bulb in the equatorial plane of the magnet, and "presented a repelled arch of stratified Light".

When a metallic plate, covered with a thin coat of wax or

tallow, is laid upon the poles of a horseshoe magnet, and heated by a spirit lamp between the poles, the melting of the wax shows that the Heat spreads more rapidly equatorially than axially to the magnet. This proves that Heat also is affected by the magnetic influence, and deflected from its normal course by it.

Magnetism being a secondary Force, is of an inferior rank than the Primitive Physical Forces. It hence is their menial or servant. At the proper place we will show that all Physical Forces, primary and secondary, evoke by Induction, or otherwise their opposite polarities, and that the evoked polarity is the thrall and menial of the evoking polarity. The evoking polarity is static, that is, at rest, while the evoked polarity, the thrall, is dynamic, that is, active, which manifests itself in the production of motion.

Facts show conclusively that Magnetism must be excluded from the list of primary Physical Forces; hence, the four Forces already named must complete the catalogue of energy in the Universe.

Nature possesses infinite and omnipotent Energy. But this Infinite Energy manifests itself only in the finite forms of Light, Heat, Electricity and Constitutism. All the economy of Nature is conducted by these four Forces. By them she lights up, heats up, and moves the Universe, and produces all the changes that takes place in Matter, and causes all the transformations that it undergoes. The search for the motive power of the Universe is hence narrowed down to these four forms of Force. Therefore, which one of these Forces is the cause of all physical movements?

Every form of Force must have a definite function to perform in the economy of Nature. The performance of these functions covers its sphere; and in executing its high office it does not and cannot interfere with the functions of any other Force. Each is sovereign within its own sphere, and

each sphere includes the Universe. Therefore, they are co-sovereigns. Their spheres are co-ordinate, yet distinct and separate. The processes essential to the welfare of the whole domain of Nature are subdivided between them. Vegetable life in the dark develops a leafless and flowerless root-like stem, that perishes sooner or later. A child born and retained in deep mines, will develop neither physically nor mentally, in beauty, strength and symmetry, but becomes shapeless and feeble in body, and idiotic in mind. A tadpole, excluded from the Light, never develops into a frog. It is hence seen that the function of Light is to initiate and carry forward the processes that shape and control the form and development of both animal and vegetable life, so as to effect the end contemplated in their creation. A certain degree of temperature is necessary so that Matter may change into the various forms necessary to supply the demands of both vegetable and animal life. This covers the sphere allotted to Heat. The function of Constitutism—as its name implies—is to constitute the various forms of Matter. When Heat becomes excessive, it stores it up for future use, by changing the form of Matter. When Heat becomes deficient, Constitutism relapses into Heat, and with it Matter also relapses into its former state. Its special function, therefore, is to conserve Force when the form of Heat becomes excessive, and to restore it when it becomes deficient. It hence modifies climate by keeping the temperature measurably within limits, and prevents sudden and violent extremes in both Heat and Cold, which otherwise would take place.

Matter, to maintain its vitalizing energy, must move through Space; it must rotate so as to expose all sides to the source of Light and Heat, to receive an equable distribution of the vitalizing influence of the Sun. Electricity is the motor of the Universe, that translates solar systems through Space, causes planets to revolve around suns, and

produces their axial rotation. Hence, we see that the Physical Forces, though having co-ordinate yet distinct spheres, are never antagonistic, but always amicable in their operations, acting harmoniously together in effecting the same great end and purpose.

From the nature and known functions of each of the Physical Forces, it is inferred that Electricity is the motor of the Universe, causing not only the movements of the countless millions of suns and planets in it, but hurling them with inconceivable velocity along unknown paths through Space. If it be the cause of the greater, the primary movements, it must also be the cause of the less, the secondary movements of Matter on and in those suns and planets, and in their Atmospheres.

That Electricity is the cause of the Atmospheric movements already described, is, from its nature and character, a legitimate hypothesis. If the hypothesis be true, then the electric conditions of the Earth s surface must be at certain localities permanently, and at others temporarily, such that the Earth draws down upon it the superincumbent air; and at other points the conditions must be such that the Earth heaves it up by repulsion; and this condition must be constant or temporary, according to conditions of the Atmosphere above it. Both the vertical movements, that is, the vertical downpours and uppours, occur in vortices. Hence, the horizontal movements of air, the winds on the surface of the Earth, and supposed movements on the surface of the Atmosphere, are easily accounted for. They are merely outflows from the disgorging vortex, and inflows of the engorging one. If, therefore, the vortices can be accounted for upon electric principles, then we at the same time account for horizontal currents issuing from the discharging end of one vortex, and flowing into the receiving end of another.

From the circumstances, and from all the known facts, we

infer, as already stated, that Electricity is the cause of all aerial, in fact, of all physical movements. Such is the hypothesis, and since it is verifiable, it is a legitimate hypothesis. But, as an hypothesis, it is nevertheless only a guess, and nothing more. It has no validity; for an hypothesis is not to be accepted as Science, even when sufficient facts give it countenance, and by sustaining it, have raised it to the dignity of a theory. Likewise, a theory, as such, is not to be accepted as Science until it has been verified by all known pertinent facts. It then, however, is no longer a theory, but a demonstrated Truth. It is then known to be true, and hence accepted as Science, for Science is that which is known and proven to be true.

Prof. Bischoff, of Germany, lays down the true canon for pursuing physical researches. He says when we explore unknown territory in the domain of Physics, we must take for our guides the facts furnished us in our laboratories. An hypothesis is an assumption that a given deduction or proposition is the true meaning of a declaration made by facts. It is proposed as such, to be tested by facts, and must either stand or fall by the test. The hypothesis that we have just enunciated, that Electricity is the cause of all aerial movements must be proven or disproven by analogous facts furnished in the laboratory. Before proceeding a step further, we must hence retire to the laboratory to consult similar facts that will be elicited by experiment.

In experimenting, any conducting substance will answer the purpose; but a metalic cone set upright will be the best.

If we examine the air above and around the cone before we commence the experiment, it will be found perfectly calm. If we bring a charged conductor, connected with an electric machine in operation, over the cone, and now examine the condition of the air above and around the cone, we will find it at

all points in motion. Horizontal currents are found pouring on all sides in upon the cone, and a vertical current so strong that it will blow out a candle, ascending from the cone and pouring upon the charged conductor.

If we now invert the cone and place it above the conductor, similar currents will instantly start, the horizontal ones again pouring upon the cone, but the vertical one now descending upon the conductor. These currents continue to flow as long as the charge is sustained upon the conductor, or in other words, until the current flowing upon the conductor has obliterated the charge upon it.

These currents are not only analogous to those observed attending high and low barometers, but though on a small scale, they are identical with them in origin, nature and character. We in fact have simulated Nature. We have produced in minature, with the limited capacity of a tiny apparatus, what Nature produces on a gigantic scale with unlimited resources. Since in our experiment, the impulse that sets the air in motion is unquestionably Electricity, there can be no doubt that all aerial movements, whether of ascending or descending currents, or the horizontal currents—the winds that sweep over the surface of the Earth—are likewise produced by Electricity.

While the dogma prevailed that the Physical Forces were imponderable, hypothetical fluids, it was held—because implied—that they were material. Fortunately, this dogma is now generally discarded, and no longer held in any respectable quarter; but unfortunately the deductions made from the dogma are yet accepted and inculcated as Science. But in time these will likewise be dispersed by the steady light emanating from the discovery of the immateriality, equivalence, identity and mutual interconvertibility of the Physical Forces; and rapid progress in Physical Science may be expected from the more accurate and enlarged ideas that are

gradually being acquired of the nature, character and functions of these Forces.

Amongst these new and enlarged ideas is the one respecting electric distribution or diffusion. While Electricity was regarded as a fluid, it was supposed that, like any other fluid, it could flow anywhere and did flow everywhere independent of other Matter. But since it has been ascertained that no Force in any form whatever manifests itself in the abstract, that is, independent of Matter as a medium; therefore the general conviction has been forced upon all inquiring minds that Force and Matter are inseparable concomitants. We know nothing of Force except what is revealed to us through Matter, and conversely nothing of Matter except what is revealed to us through Force. Hence, one cannot exist without the other, and where one is, there the other is also.

In regard to electric distribution or diffusion, it is now generally admitted that Electricity can only be diffused or distributed in two ways, namely: (1) Where Matter is continuous, it is diffused by conduction; and (2) where Matter is discontinuous, Electricity is diffused by convection; that is, by moving Matter conveying it across the space intervening between the disconnected points.

In the diffusion of Electricity by conduction through continuous Matter, it is Electricity that moves, and the Matter is at rest. In the diffusion of Electricity by convection, it is the Matter that moves, leaping the intervening space, and Electricity is at rest upon it. The clouds are insulated from the Earth, and so are the upper strata of the Atmosphere. Between them there is no continuous Matter in the wide space that separates them. Hence, if there be Electricity upon the Earth that is needed upon the clouds or in Space above, it must have a conveyance upon which to go where it is needed. It finds in the gasses of the Atmosphere, and especially in the floating vapor, a ready means of convection

by which it ascends to where it is needed. So it is with the upper region of the Atmosphere. If there be any Electricity there which is needed upon the surface of the Earth, the gases of the Atmosphere again furnish a ready means of convection, by which the Electricity descends upon the surface of the Earth.

But electric action can take place only between two points that are in opposite electric states. The Earth is always negative and the Atmosphere is always positive as regards the Earth, though negative as regards Space. The necessary conditions therefore always exist for elcctrie action between the Earth and the Atmosphere.

Two electric poles, the Positive and the Negative confront each other. The Positive is on the gases that constitute the Atmosphere, or on the vapor that forms the clouds; the Negative is on the nearest point of the Earth's surface, underneath the Positive wherever it may be. In fact, wherever there is one electric pole, the other always confronts it on the nearest point of adjacent Matter, because one pole always instantly evokes its opposite on the nearest Matter, for one electric pole can no more exist by itself than one magnetic pole can exist without the other. Electricity is a polar Force; and the nature and very essence of a polar Force is, that it develops in *pairs*; furthermore no pair of opposite electric poles can exist, however far asunder, without communication being established between them, that is, without an interchange of electricities taking place between them. Since Electricity cannot pass from one point to another except where the points are connected by continuous Matter—when it passes by conduction—therefore where the points have no material connection, the communication effecting an inter change of electricities between two insulated points, is by Matter moving between the two points. We repeat it, Matter moves between the two points.

This suggests the pertinent questions, does it move from one point only according to some inexorable law? or does it move indiscriminately from both points? If from one point only, is it from the point holding the induced, or from that holding the inducing charge? Before proceeding farther, it will be proper to give the reader a clear idea of what is called electric Induction.

We have already stated that all polar forces develop in pairs. Hence it follows that one kind of Electricity cannot be manifested by itself. When, with an electric machine, we evolve positive Electricity upon the disk or cylinder, an exact equivalent of Negative Electricity is evolved on the rubber at the same time. If a conductor charged, say, with positive Electricity, is insulated, then not only the atoms, of the surrounding air assume the negative state, but any conducting substance in the vicinity is coerced to do the same. The Electricity on the air or on the conducting substance, is said to be excited by Induction. It is the conductor, therefore, that holds the *inducing* charge, and the substance in its vicinity, the *induced.*

It is *static* Electricity on the conductor, that is, Electricity at *rest* that induces, that is, evokes the opposite polarity on the neighboring substance. But an electric current—that is, *dynamic* Electricity, or Electricity in motion—likewise by Induction evokes a current of the opposite polarity in any substance lying parallel to it. Suppose the current flows through a wire and there are an indefinite number of wires running parallel to the wire carrying the current; then if the current be Positive it will induce a Negative current in the wire nearest to it. But this current will flow in the opposite direction. This induced current will induce in turn a positive current in the next nearest wire, and so on indefinitely. The currents however become feebler in the order in which they stand related to the original current; and if there be a suffi-

cient number of wires, they finally become insensible. The following exhibits the law and nature of these currents:

Inducing current, say +,
Then induced current, 1st order —;
Induced current, 2nd order, +;
Induced current, 3rd order, —;
Induced current, 4th order, +, &c.

It must be borne in mind that the currents flow alternately in opposite directions, and that if the original current be Negative, the first induced current will be Positive.

The reader now having a clear idea of the law, nature, and character of Induction, is prepared to pursue the investigation, and to trace the law of Induction through all its ramfications, not only causing meteorological phenomena, but physical phenomena in the remote realms of Space.

The point now under consideration—the cause of an ascending current under a low barometer, and of a descending current under a high barometer, and consequently of the horizontal currents that connect the high and low barometer, involves only the action by Induction of static Electricity. At the proper time, when another class of phenomena will be passed under review Induction by dynamic Electricity will be considered.

Though it is static* Electricity upon the surface of the Earth that evokes the opposite charge on the gases of the Atmosphere, and hence indirectly initiates the aerial movement that forms the descending current under a high barometer, yet it is the evoked charge that causes the motion by self-repulsion, aided of course by the attraction of the inducing charge. The evoked charge is therefore dynamic, and motion is from it, that is, from the *induced* to the *inducing* charge. This might have been anticipated, for the induced is not equal in rank to the inducing charge. The inducing is

* I use the word static in its relative sense. No Force is absolutely static.

the sovereign, the induced is the subject, the thrall. The one is the master, the other the servant; therefore it is the menial that performs the work, while the idle sovereign, at ease upon the throne, commands and directs what is to be done.

We now can answer intelligibly the questions that led to the examination of this point, namely: (1) that in an electric discharge, Matter moves from one point to another under an immutable and inexorable law, from that which is the servant to that which is the master; (2) that it does not move indiscriminately and indifferently from both points, but from a definite point only; and (3) that it moves from the Matter holding the *induced* upon the Matter holding the *inducing* charge.

There is an obvious reason for this. Any mass of Matter surcharged with Electricity, is in an unnatural state, and since in an unnatural, in a destructive state. Destructive, because its aggregation as a mass cannot persist in that condition, but from self-repulsion it will be resolved into its primitive atoms unless there be some mode of obtaining relief. An effectual prevention against such a catastrophe is incorporated in the constitution of the Universe, by endowing every particle of Matter with authority to command, when in distress, the assistance of the nearest neighboring Matter. So imperative is this authority, that its commands cannot be disobeyed, for such are the relations and dependencies of each to all and of all to each, that if not obeyed it would not only sow discord and confusion throughout the realm of Nature, but the Universe itself would be resolved into chaos.

The Matter called upon instantly obeys. The call itself confers upon it the qualification to bring relief, by endowing it with the faculty of doing precisely what is necessary. If the distressed Matter is in the Positive condition, then it thrusts upon the compelled Matter the negative condition.

The Negative on the latter responds by acting upon the surrounding air and vapor so as to attract them, and by contact freights them with its own Electricity, and then by self-repulsion it hurls them upon the confronting Matter holding the positive charge. In default of air and vapor, when the emergency is so urgent as to require instantaneous action, then the Negative pole hurls upon the Positive Pole—as the surface of the Earth does into the cloud in a tornado—any free Matter until its charge is obliterated, that is, until enough negative Electricity has been transferred to it to restore its natural state.

The inference is inevitable from this statement of facts, that whenever there is a movement of air from above down upon the Earth, or an upward moving current from the Earth, such electric conditions must prevail at the points whence or whither they move, that in one case it by attraction pulls down the air from above, and in the other case by repulsion repels it upward towards the empyrean.

If we inspect Charts Nos. 1 and 2, we perceive there are four points on the Earth's surface where at all seasons there are constant disgorging vortices or downpours of air. We perceive that these four points are near the Tropics, two in the Atlantic and two in the Pacific Ocean. These disgorging or downpouring vortices are central over the uppours or upwelling waters from the bottom of the Sea, as shown in map 1, and around them as a focus, sweep not only the oceanic waters but the winds in the same direction.

The waters that rise to the surface there, rise from repulsion on the bottom of the ocean in consequence of higher electric and perhaps magnetic tension. They hence are the medium by which negative Electricity is conveyed from the bottom of the Ocean to its surface. The electric charge on the bottom of the ocean, hence is perceived to be dynamic, but on the surface it is static. Acting upon the air above by

attraction, it pulls it down. But its action is duplex. It induces an opposite, a positive charge, on the Atmosphere above, which is a necessary preliminary condition to attraction. But the motion is not produced by attraction alone, for the induced charge above, acting in unison with attraction from below, repels the air downwards.

On the same Charts it will be perceived there are four points on the Earth's surface, that throughout the year engorge and heave up the air that flows in upon them from all points of the compass. These four points are located one on the Atlantic and one on the Pacific Ocean, under the Equator, and one over each pole. The electric condition, and we will add the magnetic condition, at each pole is such that there is dynamic action heaving up the air over the poles thus forming vortices into which the air rushes from all points to be engorged and projected upwards. On the Equator the waters in a highly electric condition are dynamic, heaving up the air above them, but no vortices are formed, for the Trade Winds sweeping in opposite curves. meet and in arresting each other produce the Equatorial calm.

Besides these constant upheavels on the Equator and over the poles, and the constant downpours in the oceans along the Tropics the Charts show periodical engorging and disgorging vortices at definite localities that endure only for six months in the year, at the end of which period they exchange places.

The periodical engorging vortices, that is, low barometers are located near the centre of continents in both the Northern and Southern Hemisphere during the summer of the respective hemispheres. In the Northern Hemisphere during Summer a low baromter is located at the apex of the North American Continent in the Rocky Mountains where the Oregon, the Frazier, the Yukon, the Mackenzie, the Sasgatchawan and the Missouri have their sources. In Asia during the same time a low barometer is similarly located on the

Altai Mountains where the Obi, the Yenesei, the Lena and the Amour have their sources. During the Summer of the Southern Hemisphere, there is a low barometer located in South Africa, in the mountain system where the Congo, the Orange, the Zambezi and the Nile have their sources.

In South America, during the Southern Summer a low barometer prevails over the mountain chain where the Orinoco, the Apure, the Rio Negro and the Amazon have their sources. In Winter a disgorging vortex, that is, a high barometer, takes the place of the summer low barometer in Central Asia. High barometers during the Northern Winter practically cover all of North America, Asia, Europe and Northern Africa. During the Southern Winter, all of South Africa, Australia, and nearly all of South America, are likewise covered by high barometers. These facts show that low barometers prevail over continents during Summer, and high barometers during Winter. These are invariable facts, that regularly return in their season, and hence cannot be fortuitous.

They have a significance whose import no one has yet been able to grasp, and which consequently, has never been interpreted or rendered intelligible.

These facts originate in established laws and causes. They were ordained to subserve momentous and most beneficial purposes in the economy of our planet, and in ministering to the welfare of its inhabitants.

We will now proceed to discuss the causes of these phenomena; and at the proper time it will be shown what ends were to be accomplished by them.

It will be seen that low barometers, or engorging and upheaving vortices, prevail over continents, while the Sun is on the same side of the Equator as the continents. It is hence during the time that the Sun's influence upon the continent is at its maximum that the low barometer prevails. It will

also be observed that high barometers prevail over continents when the Sun is on the further side of the Equator. Hence a high barometer prevails on a continent when the Sun's influence is at its minimum upon the continent.

The Sun's influence is proportional to the amount of Light he sheds upon an area. Let A B, fig. 13, represent the width of an area from South to North under the Tropic of Cancer, then the space between the lines perpendicular to A B, represents the width of the pencil of Light that falls upon A B, when the Sun is on that Tropic; and the line of

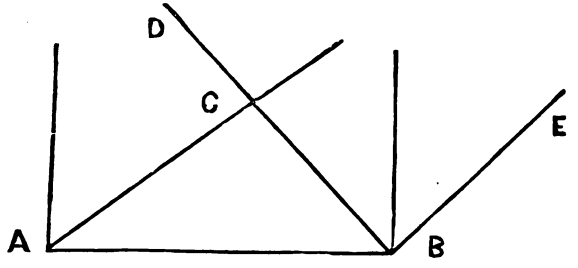

Fig. 13.

C B will represent the width of a pencil of Light that falls upon the same area when the Sun is on the Tropic of Capricorn; and since D B is equal to A B, therefore D C represents the excess of Light that falls on the area when the Sun shines perpendicularly upon it as compared with that when he shines obliquely from the farther Tropic; C D is 50 per cent. of B C. Consequently, the Sun's influence is fully 50 per cent. greater when at the vertical Tropic than when at the farther. What is true of a tropical section is true of any section north or south of it.

Observations on Telluric Magnetism show the following facts, namely:

(1.) It is undeniable that the maximum of magnetic disturbances, of unsteadiness and sudden oscillations and ex-

treme deviations in direction and violence of intensity, occur near the equinoxes, or say about the 11th days of March and September, when the respective solar magnetic poles are more directly pointed towards the Earth than at any other points on her orbit, and when the plane of the Earth's Equator passes through the Sun. Consequently these disturbances take place at the time when the Earth feels the maximum influence of the Sun's magnetic force, and when the Sun is under the maximum influence of Telluric Electricity.

(2.) Observations likewise show that the next greatest magnetic intensity, greatest steadiness in direction, and least fluctuations in both, prevail, in the Northern Hemisphere, in the months of June and July; and in the Southern Hemisphere, in the months of December and January; or about the 11th days of June and December, when the Earth passes through the solar nodes. In other words, the maxima occur when the plane of the Sun's Equator passes through the Earth, and the Earth's magnetic poles are more directed towards the Sun than at any other point on her orbit. They occur, therefore, at the time when the Earth feels the full influence of the Sun's electric force, and the Sun the maximum effect of the Earth's magnetic force.

Since all physical phenomena are covariants, as is manifest in the synchronous periodicity of sunspots, auroras, cyclones, magnetic and electric intensities, etc., and moreover since Magnetism depends upon Electricity, therefore, although no observations have been made to determine the variation and intensity of Electricity in and upon the Earth, yet we know *a priori* from the dependent and inseparable relation between them, that the oscillations in direction and intensity of Magnetism must accord with corresponding variations in the tension of Electricity.

The inference, however, that electric intensity of the At-

mosphere is covariant with other telluric affections is at variance with the deductions of physicists who have made atmospheric Electricity a specialty. But their observations, correctly interpreted, comfirm the inference we have made. Their observations as treated, have been barren of scientific results, except making us acquainted with a highly important order of physical facts. They err by assuming two false hypotheses: (1) that the Electricity of the Atmosphere is evolved, partly at least, by friction between the atoms of the gases composing it, in the movements of the winds; and (2) by holding, inconsistently, that the Atmosphere, especially when moist, is an electric conductor.

We dissent from both these views; and in regard to the latter proposition—which only is necessary to discuss here—we hold the common opinion that the Atmosphere is a non-conductor, and that Electricity is not distributed or diffused through it by *conduction* but by *convection*. Observers have been principally occupied by observing positive Electricity in the Atmosphere. They give the average of their observations; and since these are made in a positive stratum of the air, the average shows a positive state. When the average is small, they term it low electric tension, when large, high tension. But these we regard as erroneous deductions for the following reasons:

(1.) The Earth is Negative—the Atmosphere Positive. Where the Negative and the Positive meet, they obliterate each other, that is, they produce a neutral state where no electric excitement is sensible.

(2.) Over the Earth's surface between the Negative on it, and the Positive on the Atmosphere, there hence is a neutral stratum, varying in depth from three to five feet, according to the conditions of the Atmosphere and the nature of the Earth's surface. In a level open country, this stratum under favorable conditions is very shallow. The interior

of houses, the streets of cities, and deep valleys are generally negative, scarcely ever neutral, and never positive, except under a more than average high barometer. Over the tops of houses and of hills and the summits of mountains the Atmosphere is always positive, except when a low barometer prevails.

(2.) The depths of the neutral stratum not only varies with atmospheric pressure, but a negatively electrified stratum of air underlies it near and at the centre of a low barometer. When observations are made in this negative stratum, they show negative Electricity; when in the neutral stratum they indicate no electric excitement; but when made in the overlying positive stratum, they show positive Electricity.

(4.) It is because—except upon rare occasions—the instruments of observation are immersed in the positive stratum that the result is, the showing of a large excess of positive Electricity in the Atmosphere.

(5.) Under a low barometer, the Earth has more than ordinary electric tension. It hence transfers upon the air in contact with it negative Electricity. It now repels such air, causing it to ascend to the Positive in the Atmosphere. This rising column of air constitutes the negative stratum that during the prevalence of a low barometer underlies the neutral stratum. The neutral stratum then overlies this negative one, at greater elevation and has greater depth than before. The instrument of observation being fixed, is at a uniform height above the Earth; hence, by the rising and falling of these strata is by turns immersed in all of them; hence it indicates merely the quality and quantity of the Electricity in the atmospheric stratum in which for the time it is immersed, and not the kind nor the energy of the electric charge upon the Atmosphere as a whole.

It is self-evident that the energy with which the Earth repels the superincumbent air upward, must be proportional

to the intensity of the electric charge upon her. Hence, very often under the lowest point of barometrical depression, that is, within and around the storm centre, negative Electricity suddenly appears in such great intensity as to exceed the measuring capacity of the instruments. At a period of great electric excitement, the instruments being often immersed, both in the Negative and Neutral strata, their indications, when averaged, show only a small excess of positive Electricity for the period. But this is no indication whatever of the charge either upon the Earth or in the Atmosphere. These reasons are sufficient to justify us in dissenting from the ordinary deductions made from observations on atmospheric Electricity, and warrant the opposite conclusion that a Positive average greatly in excess of the normal is an evidence of low instead of high electric tension both on the Earth and on the Atmosphere.

Physicists have deduced from their observations, that since the major minimum of the Positive is between four and five o'clock p. m., and the minor minimum about four a. m., that these are periods of least electric tension, and that since the observations show the major maximum at about eight a. m., and the minor maximum at between nine and ten p. m., therefore these are the diurnal periods of greatest electric tension. Observations on Atmospheric pressure show that the diurnal periods of major maximum are at 9 a. m.; and the major minimum at four p. m.; that is, that the barometer daily reaches its lowest point at this time; then there is a rise to about nine p. m., when it remains stationary for awhile; then it begins to fall until about four a. m., when it becomes stationary, and then rises to about nine a. m., when the maximum for the day is attained.

Observation and experience have established the fact that nine-tenths of the tornadoes, and nearly all violent hailstorms occur in the afternoon about the time of the lowest barome-

ter, and that the next period in their frequency and intensity is between three and four in the morning—both at the barometrical minima for the day. But by far the most energy and violence are manifested by the afternoon phenomena. Our eyes and ears bear such unequivocal testimony to the terrific grandeur and imposing character of these afternoon phenomena, that no one can avoid the inference that the greatest electric tension must prevail at the time when, not only the greatest number of thunder-storms, tornadoes and hail-storms occur, but when they manifest their most terrific and destructive violence.

The following phenomena are found to be synchronous: (1) Least positive Electricity in the lower strata of the Atmosphere where the observations are made; (2) Lowest diurnal barometer; (3) The most terrific tornadoes, and the most violent thunder and hail-storms; and (4) the highest electric tension both on the Earth and in the Atmosphere.

We are indebted for most of our information concerning the variations of Electricity, in kind and quantity, on the Atmosphere, to the labors of Schubler, of Stuttgard, Arago, of Paris, Quitelet, of Brussels, Dr. Wislizenus, of St. Louis, and especially to the Meteorological Observatory at Kew, England. The summary of all their observations is, a low average of positive Electricity at and near the Equinoxes; a high average during Winter in the Northern Hemisphere, and a medium average in Summer, or in July and August. These observations also show a high annual average for the years of minimum sun-spots, auroras, cyclones, and magnetic disturbances.

All these facts corroborate the interpretation we give to the observations made, and the explanation we give for the results attained. The low average of positive Electricity is owing to the fact that the instruments of observation are always on the same level, while both the neutral and nega-

tive strata rise or rather thicken under the influence of high negative tension on the Earth, and fall or shallow under low tension. Our interpretation is the only one possible under the circumstances, namely, that when the Earth is laboring under high electric tension, she electrifies the stratum of air in contact with her, repels it, and consequently with it, forces up the neutral stratum in which the Positive and Negative meet and obliterate each other. Often the effect of the high tension is to so thicken the negative stratum that its depth is greater than the height of the instrument above the ground, when of course it then shows negative Electricity of intensity beyond the measuring capacity of the instrument.

The above interpretation and explanation account for the uniform ratios the numbers bear towards each other when, by observation, Positive electricity was detected in the Atmosphere, when Negative, and when no Electricity at all. Wherever the observations may have been made, of the entire number, about four per cent. will indicate negative Electricity on the Atmosphere; about six per cent. show a neutral state, and the remaining ninety per cent. show a positive state

Still stronger corroboration of the view here given is afforded by the facts: (1)—already stated—that the daily oscillations of atmospheric pressure, that is, the hours of high barometer, nine a. m. and nine p. m., are synchronous with the maxima of positive tension on the Atmosphere, and the hours of daily low barometer—four a. m. and four p. m.—are synchronous with the hours of low positive tension. (2) Observations on atmospheric pressure show, average high atmospheric pressure, that is, high barometer, prevailing during Winter in the Northern Hemisphere, especially in the months of December and January, which again is synchronous with the maximum of positive electric tension on the Atmosphere; that a medium high

barometer prevails in the Northern Hemisphere during July and August; which again is synchronous with medium positive tension; and that the annual average lowest barometers are in the months of March and September, and therefore are synchronous with the minimum of positive electric tension on the Atmosphere; and (3) In the eleven and half year sunspot period of physicists—but which I call the Jovial Cycle, and hence consisting of 11.86 years—there are two maxima, that is, a major and a minor maximum of cyclic average high barometer, and these again are synchronous with the cyclic average high electric positive tension on the Atmosphere, and there likewise are two minima of cyclic average low barometers, and these also are synchronous with the cyclic average low positive tension. It is therefore evident that what physicists call an average low positive electric tension on the Atmosphere—when resolved into its component elements—is equivalent to an average of high negative electric tension on the Earth, and hence that high negative electric tension upon the Earth stands related to low atmospheric pressure, that is, to a low barometer, in the relation of cause to effect.

The proximate cause of high and low barometers is hence evidently electric tension on the Earth, because atmospheric pressure varies inversely to the electric tension of the Earth. When tension is great, the Earth transfers negative Electricity, with which she is affected, upon the air in contact with her, and throws the air off towards the Zenith by repulsion in the direction whither it at the same time is attracted by the Positive on the overhanging cloud that always forms and persists above and around the upheaving vortex of a low barometer. When tension on the Earth is feeble, the Positive on the Atmosphere, by self-repulsion, pours down the oppositely electrified air through a vast whirlpool upon the surface of the Earth. The negative charge on the Earth,

however feeble, is not in the meanwhile passive but active. By attraction in the same direction that the Positive above impels, it pulls the air downwards and aids in producing the descending column. Let it be stated here once for all, that no physical motion is *simple*, but always *composite*, of which attraction and repulsion are factors. When the impulses given by each are in the same direction, then accelleration of motion ensues; when they are in opposite directions, then, retardation, and when at right angles, etc., then deviation in direction of motion takes place. But since attraction and Repuslion are modes of electric action, hence Electricity is the cause of physical motion. Since there are oscillations in the intensity of these correlated and reciprocal modes, which act from separated Matter and from different points, hence there must be oscillations in the quantity of Electricity both on the Earth and upon the Atmosphere. What, therefore, is the cause of these ebbs and flows of Electricity upon our planet and on its Atmosphere?

CHAPTER V.

CAUSE OF EBBS AND FLOWS OF ELECTRICITY.

From facts already stated and from causes and laws deduced and established, the solution of the problem, what is the cause of the ebbs and flows of Electricity upon our planet and on its Atmosphere, is comparatively easy. By inspection of the charts showing average atmospheric pressure, we discovered that low barometers prevail over continents in both the Northern and Southern Hemispheres, when the

Sun is on the same side of the Terrestrial Equator as the continents are; in other words, during the Summer of that hemisphere, when the Sun's influence is at its maximum on its continents. Since a low barometer and high electric tension on the Earth are synchronous, therefore the Sun must be the cause of the flow in the electric tide that then prevails in that hemisphere. By inspection of the same charts we also discovered that high barometers prevail over continents in both hemispheres in Winter, or during the time the continents and the Sun are on opposite sides of the Terrestrial Equator, when of course the Sun's influence is at its minimum in the hemisphere where the continents are located. Since we have shown that a high barometer is an indication of low electric tension on the Earth, and since a high barometer and low electric tension are synchronous, therefore again the Sun must be the cause directly or indirectly of the ebb in the electric tide that then prevails in the hemisphere where the continents are located.

Having ascertained that the Sun directly or indirectly is the cause of the ebbs and flows in the electric tide that alternately visit the Earth and its Atmosphere, the next inquiry is, in what manner are the daily, annual and cyclic tides produced?

The Sun is the source of Life, not only of our planet but of the Solar system; Light, Heat, and Electricity, and consequently all their vivifying influences emanate from him; but how? Light emanates from the direct influence of the Sun, but in what mode is not known, and at present it would be premature to inquire.

Without committing ourselves to any theory either expressed or implied in it, we will adopt the common-place expression and say "Light radiates from the Sun". Do Heat and Electricity likewise radiate from him? No one, that we are aware of, has held that Electricity did, but many have

supposed that electric currents flowed from the Sun to all points in Space. The hypothesis however has almost universally been accepted that Heat radiates from the Sun. But facts incontestably contradict the hypothesis. For instance: if we make a convex lens of ice of a low temperature, it will act like what is called a burning glass, and at its focus it will set everything combustible on fire when the Sun's rays are passed through it. However long the ice lens may be used in an atmosphere greatly below the freezing point, the ice will give no indication of melting or being in any manner affected. How is this possible upon the hypothesis that the Sun radiates Heat? These heat rays must in the experiment pass through the ice without affecting it, yet when they reach the focus beyond, they set everything on fire. The idea is preposterous.

In Winter, under a cloudless sky and dazzling Sun, but on a day with a temperature far below the freezing point, if soot be thrown upon the snow, by evening it will have melted the snow underneath, and the soot will be found deeply sunk into it. Likewise if on such a day two cambric handkerchiefs, one white and the other black, are spread side by side upon the snow, in the evening the black one will be found to have melted the snow, and to have sunk down deeply into it, while the white one is still lying on top, and actually will show that it has shielded the snow from the rays of the Sun. What causes this difference? Did more heat fall on the black cambric than on the white? Evidently not. What, then, is the explanation of the phenomenon that one has melted the snow and the other has been a protection against melting?

Experiment will furnish the following facts, that sufficiently explain the phenomenon. Blacken a few inches at the end of a bar of iron, then put the blackened end in the focus of a convex lens placed so as to concentrate the Sun's rays

upon it. The point where they fall will become heated. But instantly as the temperature at and near the focus rises, an electric current is found to flow from the heating point. If the circuit is now completed by connecting both ends of the bar by a silver wire, however long the current may flow, the temperature of the wire will be but little if any affected, because silver is the best known conductor of Electricity. The longer the wire the more unequivocal will be the success of the experiment. Suppose the wire encloses the room. Finding that the current will not heat the silver, we cut the wire at one of the remote points from the bar and insert a section of platinum wire. Instantly it is found that the platinum is heating. It not only becomes hot, but red hot; and finally it is raised to a brilliant white heat which melts it, which cannot be done in any furnace that ever has been constructed, because platinum is the most refractory of all metals. Why is not Heat only, but Light also, developed in the platinum section? Simply because of the low conductive capacity of platinum. If the electric conductive capacity of silver be expressed by 100, then 10 will express the conductive capacity of platinum. According to some authorities, it is much lower. Light and Heat are therefore developed in the platinum section, because it has not the conductive capacity sufficient to transmit all the Electricity of the current.

We have been taught by this experiment, not only interesting and important facts, but a far-reaching truth and fundamental law in Physics have been developed and demonstrated. We began the experiment with Light, which we concentrated upon the blackened end of a bar of iron. Our apparatus was all darkness outside of the point of impact. In contiguity with the point was Heat, but beyond that, in the remainder of the bar and wire there was cold until the platinum was reached. In this cold space, however, there

flowed a strong electric current to the platinum section, and a weaker current from that section onward. But on the platinum both Heat and Light were developed, at the expense, however, of the Electric current. A whole cycle of transformations has taken place. Light was transformed into Heat, Heat into Electricity, and finally Electricity into Heat and Light again. All these transformations have taken place under the law of compulsion, or inexorable necessity. Light fell upon a *black* substance, which color is incapable of reflecting Light, but being compelled to dispose of it, and having the faculty of transforming Light, by necessity it changed it into another form of Force, namely, Heat. Heat is propagated or distributed but slowly by convection and feebly by conduction, but passing easily into other forms of Force. To avoid excessive accumulation, it became transformed into Electricity. In a good conductor Electricity is distributed almost instantaneously to the remotest points on the Globe. In non-conductors it will not pass at all; and in poor conductors, if in sufficient quantity, it will tax to the utmost their conductive capacity, and all Electricity in excess of that capacity, passes by disruptive discharges, or becomes transformed into some other mode of Force. In this instance the excess of Electricity over the conductive capacity of the platinum became converted into Heat, and the Heat for want of conductivity into Light again.

This experiment illustrates the mutual interconvertibility of the Physical Forces, and shows the persistence of Force, different in form but equivalent in energy, through a whole cycle of changes. Like Matter, Force changes its form, but not its essence. The fundamental principle upon which the Universe is founded, is the changeability and indestructibility of Matter and of Force.

We can now explain intelligibly the mysterious behavior of the white and black cambric handkerchiefs. Objects that

are white are so because they reflect the rays of Light that fall upon them. Those that are black, are so, because they cannot reflect any Light that falls upon them. The white cambric handkerchief reflected all the rays of Sunlight that fell upon it; hence there could be none of the force converted into Heat. Consequently, it remained upon the top of the snow. The black color of the other rendered it incapable of reflecting any Light; hence it disposed of it by converting it all into Heat. Consequently, the snow melted underneath it and it sank down into it.

The cause of the ebbs and flows in the electric tide that at fixed periods manifests themselves on the Earth and in the Atmosphere, is clearly shown, by the experiment, to be the transmutation into Heat and Electricity of the Light shed by the Sun upon the Earth. When the Sun is on the Equator, and when his influence is equally divided between the Northern and Southern Hemispheres; when he is transferring the engorging vortices that have prevailed for six months over the continents in the hemisphere, from which he is retiring to the hemisphere which he is entering; and likewise translating the six months disgorging vortices from the hemisphere he is entering, to the one he is leaving, then the electric tides have—like those of the Ocean at the same time—their greatest range in their ebbs and flows. Over the whole surface of the Earth, then takes place what the sailors call "the swing of the wind, end for end". They not only change in the direction from which they blow, but they blow with intensified energy. Cyclones in all forms are so frequent and marked, that by common consent they have been named "Equinoctial Storms". In the tropical and subtropical regions of the hemisphere from which the Sun is retiring, this is the hurricane season, and in the hemisphere which he is entering, it is the period when the most violent and destructive tornadoes occur. The whole Earth is affected. Electric

waves roll over it from the North Pole to the South Pole, known as electric storms or earth currents, that sometimes affect telegraph wires to such a degree that communication is interrupted. These electric storms in the Earth cause terrific earthquakes and volcanic eruptions, which are more frequent and violent at these seasons than at any other time of the year. The intensity of terrestrial magnetism is necessarily also affected by them, as is shown by a series of observations extending through many years, and the oscillations and declinations of the magnetic needle then have their maxima.

By inspection of the charts, it will be perceived that it is only the continental aerial vortices that are affected by the passage of the Sun across the Equator. They exchange places; that is, the low barometer or engorging vortex, accompanies the Sun from the hemisphere from which he is withdrawing, and replaces the high barometer or disgorging vortex in the hemisphere the Sun is entering; and *vice versa*. But the high barometers or disgorging vortices along the tropics on both oceans are unaffected, except that they become restricted to the oceans, and hence confined within narrower limits. They are, however, intensified in energy.

We have accounted for the low barometer—the engorging vortex—upon electric principles, that is, by a high electric charge upon the Earth electrifying the air in contact with it, and hence throwing it off towards the Zenith, which produces an ascending column or uppour of air from the surface of the Earth. To account for the extraordinary electric charge upon continents in Summer that produce this uppour, we have shown that the Sun's influence in the hemisphere is then at its maximum. We have shown that the reason why the Sun's maximum influence is then felt, is because the quantity of Light shed upon any given area in a hemisphere at the time when the Sun is at the Summer Solstice of that

hemisphere, is 50 per cent. greater than when at its Winter Solstice. We have shown that Light, being one of the Physical Forces, is hence transmutable into any other form of Physical Force. We therefore draw the inevitable inference, that the excess of Light that falls upon a hemisphere when the Sun is at or near its Summer Solstice, over and above what falls upon it when the Sun is at or near the Winter Solstice of that hemisphere is, by the operation of natural laws, converted into Heat. By the inexorable law of necessity the Heat into which Light has been transformed, passes into Electricity. Upon this principle, we satisfactorily account for the Heat of Summer and for the high electric tension during this season upon the land surface of the Earth.

But why does not the same reasoning apply to the water surface of the Earth? Why does not then also a sufficient high electric tension prevail over the Ocean to cause an ascending column of air? We have already pointed out the physical principle that answers these questions. We allude to facts stated: that any Matter that appears white does so because it is endowed with the capacity to reflect Light, and therefore disposes of it by reflection; and that any Matter which appears black does so because it is not so endowed; and not being able to dispose of Light by reflection, by the inexorable law of necessity is compelled to transmute it into Heat.

Matter when assailed by an excessive quantity of Heat can dispose of it in several ways: (1) To a limited extent by conduction and convection. (2) To a greater extent by conversion into Electricity, and (3) By Matter itself changing its form in which case so exhaustive is the demand for Heat that cold ensues. The Heat in such case becomes transformed into Constitutism.

When under the influence of Heat, Matter changes its form,

a double transmutation takes place. (1) Matter changes its form, either from a solid to a liquid; from a liquid to a vapor; or from a vapor to a gas, and (2) Heat is transformed into Constitutism, that is, into that form of Force necessary to constitute the given form of Matter.

It is self-evident that a less exertion of Force is necessary to effect a single transformation of simply one form of Force into another than to effect a double transformation of both Force and Matter. My esteemed friend, Dr. A. Jaminet, who was medical advisor to the St. Louis Bridge Company, and who had in charge the sanitary regulations for the workmen while engaged in the caissons in sinking the piers, incidentaily observed a new and hitherto unknown fact, which is not only very interesting but of the highest scientific import. He wished to ascertain by experiment the relative temperature at which pure water boils in bright copper and in glass, under an atmospheric pressure of 47 1-2 lbs. to the square inch. In other words his object was to determine whether the difference in the experiment first made by Gay Lussac, namely: that pure water under ordinary atmospheric pressure boils at 212° in a bright copper vessel, but requires 216° in a glass one, is constant or varies with pressure. The experiments since that time made by Silbermann, Favre and others had left this point undetermined, but had verified Gay Lussac's observations.

Dr. Jaminet used two large capsules, one of bright copper, the other of glass, filled with distilled water. He placed them upon insulated stands and heated them with spirit lamps. The water in the copper capsule boiled when the thermometer immersed in it indicated a temperature of 270° Fahrenheit, and that in the glass when the thermometer showed a temperature of 274° Fahrenheit. He repeated the experiment with filtered Mississippi water; it boiled at 268° in the copper, and 272° in the glass vessel. These experi-

ments show that 4° is the constant difference between the boiling point in a copper vessel, and that in a glass one.

The following is the new fact he observed: Placing his finger upon the copper capsule (he did not make the same experiment with the glass one), when it was in a strong state of ebulition at 270°, the ebulition instantly ceased, and the temperature in a few seconds sank to 267°. It did not commence again until the finger was removed, and the temperature had again risen to 270°. The proximate cause of this behavior evidently was the interruption of insulation by placing the finger upon the vessel; because when insulation was restored by removal of the finger, ebulition recommenced when the temperature had risen to the former point. But the immediate cause was that Heat instead of being transformed into Constitutism as it would be compelled to do in vaporization, found an easier vent by transforming into Electricity, but the latter required a medium for free conduction to the Earth, to discharge as rapidly as formed.

Vaporization in this particular case shows when we scrutinize it closely, that two transformations take place simultaneonsly: (1) a change in the form of Matter, that is, the water becomes a vapor; and (2) a change in the form of the Force immediately concerned, that is, Heat becomes transformed into Constitutism. This fact so clearly declares what takes place that it is not possible to misunderstand it, namely, (1) that less force is required to affect a single transformation than a double one; and (2) that Matter as regards change of form is far more refractory than Force.

That it takes four more degrees of Heat to boil water in glass—a non-conductor of Electricity—than it does in copper—a good conductor—is so important as well as so curious a fact, that besides its intrinsic merit, an explanation of it will not be taken amiss, nor considered out of place.

White or colorless Light, when made to pass through a

prism, is analyzed into its component primary colors. This shows its composite character. But if we examine the spectrum, the facts are disclosed that some colors bear a nearer relation to Heat, and some a nearer relation to Electricity than others, while some colors stand equally related to these forces. The spectrum likewise shows that not all the Light that impinges upon the prism is transmitted, but that a portion of it has been transformed into Heat and into Electricity. The maximum of Heat is found at a point immediately outside of the red rays, the least refrangible rays of the spectrum; and the minimum of Heat at a point outside the violet, the most refrangible rays. The reverse of this is the case with Electricity. Its maximum is found at a point immediately outside of the most refrangible—the violet—rays, and its minimum outside of the red rays, where Heat has its maximum. In other words the maxima of these two forces are found at opposite extremes of the spectrum, and the point of the minimum of one is that of the maximum of the other. Polarity is here manifested; Heat at one pole of the spectrum, and Electricity at the other.

Each primitive color in the spectrum manifests similar polarity. Look at the red, yellow and blue bands in the spectrum. On the side next the red there is orange caused by the refraction of yellow towards the pole of Heat overlapping the red refracted towards the Electric pole. On the side of the yellow band towards the blue there is green, caused by the yellow refracted from the thermal towards the electric pole overlapping the blue refracted from the electric towards the thermal pole.

It is the Matter constituting the prism that causes the wonders of the spectrum. It transforms a portion of the rays of Light into Heat and into Electricity, while in the meantime it segregates the rays that remain into species, and arranges them according to color. That, however, Force never under-

goes any transformation in form except through the agency of Matter, is not an isolated but it is a universal truth. But the converse proposition is likewise true that Matter never undergoes a change of state except through the agency of Force.

Returning to the facts of the spectrum, we find that so far as a transformation of Light into other modes of Force has been occasioned, it has proceeded from unity to duality. It was one or unity while Light; it is after transformation two or dual, namely, Heat and Electricity. This fact when generalized, is found to be universally true, namely, that no Force ever changes its form without resulting in two forces, one of which invariably is Electricity. The converse proposition again is likewise found to be true, namely, that Matter never changes its state or form without developing simultaneously two forms of Force, one of which again is Electricity*.

We have just stated that the spectrum shows that the amount of Light that the prism did not transmit was transformeed by it into two modes of Force, namely, Heat and Electricity. This is a general truth. When Electricity which emanates from Light and Heat, is reconverted, Light and Heat simultaneously appear. When Heat disappears, in evaporation, for instance, by conversion into Constitutism, simultaneously with such conversion Electricity appears, for it has been established by experiment that the vapor is charged with Electricity. The law is universal, as we have just stated. No Marter can change its form, that is, pass

* It will be an interesting problem for physicists to solve by experiment, whether the Electricity developed when Matter changes form on the ascending scale, is the same in kind as that developed on the descending scale. When Matter changes, step by step, from the solid until the ultimate—the gaseous state—is attained, the change is on the ascending scale. When the change proceeds from a gas, step by step, until the solid state is reached, the change is on the descending scale. Is the Electricity developed on both scales the same in kind, or is it on one scale Positive and on the other Negative?

from the solid to the liquid state, from the liquid to the vaporous, or from the vaporous to the gaseous states, neither can it relapse from a gaseous or any other state into a lower form, without developing Electricity. This is also true of chemical action. No new combination of Matter can form, nor old ones dissolve or disintegrate, without Electricity being developed. Why? Because no new combination can form, nor old one break up, without changing the quantum of Constitutism. When the compound occupies less space than its component parts originally did, then less Constitutism will be required to constitute the compound body than was required to constitute the simple elements separately. For instance, a cubic inch of water occupies about 1-3000 part of the space that is required to contain the quantity of oxygen and hydrogen gases necessary to make a cubic inch of water. Consequently, when oxygen and hydrogen gases combine to form water, 1-3000 part of the space occupied by the elements of which it is composed only being required to contain the product, less Constitutism in proportion is required to constitute the new combination, and the surplus quantity of Constitutism appears in the form of Electricity and of Heat, which latter in this case is enormous. One pound of hydrogen in combining with oxygen, sets free Heat enough to raise 62,031.6 pounds of water one degree of Fahrenheit; or, which is the same thing, Heat enough to raise one pound of water from the freezing point to 62,031.6 degrees on Fahrenheit's scales. For this reason, all chemical elements that shrink in bulk when they form compounds become hot.

The same principle reversed obtains when, by chemical combination, the volume of the compound becomes larger than the combined volumes of the constituent elements were. In the act of combining, the volume of the mass expands; it therefore occupies more space, and consequently requires

more Constitutism to constitute it than in its elementary form. The requisite Heat to form this additional Constitutism is abstracted from the mass and from Matter in contact with it. Consequently, the mass and whatever is in contact with it, becomes cold. The same is the case when a compound resolves into its component parts, when they expand and occupy more space, separately, than the space required by the compound, they on the same principle become cold.

In the change of form in Matter, as when a solid liquifies, or a liquid vaporizes, and especially so when the vapor, as superheated steam, for instance, dissociates into its ultimate component elements, oxygen and hydrogen gas; then the expansion is so immense, and the abstraction of Heat to form the necessary Constitutism so great that intense cold is produced. We shall give a remarkable illustration of this when we come to speak of hail formation, in the Sequel to the present volume.

The general principal as to the development of Electricity in the transformation of both Matter and Force, is expressed in the following summary: Whether the transformation of Matter be a mere chemical change, or only a change of form; whether in the change it expands or contracts in volume; whether the amount of Constitutism required be greater or less to constitute those changes; whether it becomes cold under expansion, or hot under contraction; or whether it becomes visible or invisible, one invariable phenomenon accompanies these protean changes of form, which is, the electric tension on the Matter involved is always increased. The universal law, therefore is, that Electricity is simultaneously developed with the new form into which any one of the Physical Forces is being converted; or, which is about the same thing, where a change of form in Matter takes place. This includes not alone the ordinary changes, as from a solid to a liquid, from a liquid to a vapor, and from vapor to gas,

and *vice versa;* but it equally applies to elementary atoms or molecules of Matter when they chemically combine and form compounds, or when an old compound resolves into its component parts.

Since these chemical changes and transformations of Matter, and consequently of Force, are incessantly going on in the Sun, on the Earth and in its Atmosphere, on the planets and even in stellar Space, therefore, Electricity is an omnipresent Force, ready at all times and places to perform its function, which is that of motive power to the Universe.

We are now prepared to assign the reason why it requires four more degrees of Heat to boil water in a glass vessel than in a copper one. It has been ascertained that steam forms on the bottom of the water in contact with the surface of the vessel containing it. Hence, it is there that the transformation of Heat into Constitutism takes place. But we have already seen that in the transformation of any Force, Electricity simultaneously makes its appearance with the forming Force. Hence, when Constitutism forms to constitute the water steam—which is the cause of the ebullition—Electricity must form then and there likewise.

But further, steam forms at the point where two dissimilar substances are in contact. Electricity never develops except under precisely identical conditions; that is, two substances must be either in contact or connected by a conducting substance.

Prof. Nichol, in his Cyclopedia of the Physical Sciences—article on Ebullition—says: "Probably little electric currents are excited, which assist the formation of steam." We think there is no room to doubt that such currents are excited. If there be no Electricity when steam is formed, then this is the only exception to what as far as known is a universal law; namely, that all physical changes are accompanied by the development of Electricity. When steam is

formed, there is not one transformation only but two take place: (1) Heat is transformed into Constitutism; and (2) Water is transformed into vapor. If under such extraordinary conditions, no Electricity is evolved, then it is in contravention of all known physical laws, and therefore miraculous. But we know that no physical law is either contravened or suspended in this case, because the steam as it escapes is found positively electrified. Whence comes the Electricity with which the escaping steam is found affected, if it be not evolved simultaneously with the formation of the steam? It is therefore presumptive that the material of the vessel holding the water has an agency in the evolution of the Electricity. Let us see.

Copper is a good conductor of Electricity; and glass is a non-conductor. It is not supposable that glass can afford the same facilities in exciting and transmitting Electricity that copper will. We infer, therefore, that it is owing to this impotency of glass as regards the development of Electricity, that water in glass vessels requires four degrees higher temperature, than in copper. The following facts warrant this inference: (1.) It is acknowledged that there is such a property as tension in vapor. For instance, no vapor will form in a liquid under ordinary atmospheric pressure—fifteen pounds to the square inch, unless a Force appears within the liquid sufficient to resist and overcome this pressure. This is the reason why water boils at a lower temperature upon mountains than upon the level of the Sea. It is found that the boiling point is lowered one degree for every 550 feet of elevation. (2.) Tension is a *nomen et omen**. It is a reality. It signifies that the thing to which it is applied is manifesting Force, but that itself is not Force, but only an effect of Force. Of what Force, therefore, is the

* *Nomen et omen.* A name significant of the thing to which it is applied, and not what Lord Bacon calls *nomina nihilorum*, names of nothings with which Scholasticism abounds.

tension of vapor the effect? Surely not of Heat; because when vapor or steam reaches its full expansion, it is cold. The Heat that caused vaporization disappears in the act, being changed into Constitutism. But the vapors still have tension, which we perceive when they aggregate into clouds. They mass undeniably by attraction, acting within the limits permitted by repulsion, and form an equilibrium, before coalescence of vescicles takes place. The vescicles are kept assunder by repulsion, which makes them resist compression. The resistance they offer to compression is tension or what is known as elasticity. The cause of this resistance is two-fold: (1.) Matter in any form occupies Space. The same quantity occupies different dimensions in Space according to the form the Matter is in. In the solid form it occupies the least possible dimensions, as a gas it does the greatest. If it be compressed to smaller dimensions, it gives up a proportional quantity of Constitutism, which reappears as Heat; and (2) When two or more aggregates of Matter, or two or more atoms, are simultaneously affected with the same kind of Electricity, they repel each other; if by dissimilar kind, they mutually attract each other. Clouds, that is, the vescicles of vapor that constitute them, are always Positive. Consequently it is the self-repulsion of Positive electric tension that keeps the vescicles so far assunder as to prevent coalescence. Hence the tension on the cloud is electric tension. And (3.) When scraps of metal are thrown into a glass vessel, evaporation commences as quickly and proceeds as freely as if the water were in a metallic vessel; and the steam is seen to form around the scraps of metal. This fact is conclusive that the four degrees of higher temperature required to boil water in glass than in a copper vessel, is owing to the non-conducting property of the glass, it being able only under compulsion to furnish the Electricity necessary to evaporation.

Before this digression, we were discussing the cause of the ebbs and flows of Electricity in the Earth and in the Atmosphere. Observation has established the fact that the average annual maximun of electric tension, as well as the greatest annual oscillations in tension in a hemisphere—after eliminating the equinoctial disturbances—are during its Summer, and that they are to a great extent local to the hemisphere. The inquiry traverses a great and fundamental principle in Physics, namely, the transmutation of Energy. Hence it cannot be pursued understandingly by the student, nor can he be rewarded for his pains without a clear and brief statement of the elements of this great physical law, giving an intelligible explanation of it.

CHAPTER VI.

WHAT BECOMES OF THE LIGHT OF THE SUN.

We have already shown that as far as the land surface of the Earth is concerned, the ebbs and flows of Electricity are unquestionably owing to the presence of the Sun in that hemisphere. He undoubtedly exerts other influences—for instance, such as by electric induction, etc.—than merely by shedding 50 per cent. more Light upon it than when in the opposite polar hemisphere. The extra quantity of Light is, however, the main factor to be considered that is involved in the problem. Light is not cumulative. Though it is being constantly poured upon the Earth, like the waters of the rivers into the Ocean, yet the Ocean preserves its level. Consequently—to use a common phrase—it is extinguished

as rapidly as it is poured upon the Earth. But to be extinguished does not imply and does not mean that it is destroyed; for Light is one of the forms of Force, and Force is as indestructible as Matter. The question, What becomes of it? has already been answered. It undergoes a transformation of form into other modes of Force. A portion of it is instantly, when it comes in contact with the Earth, transformed into Electricity, which causes electric currents in the Earth producing earthquakes. Another portion is transformed into Heat which raises the temperature of the soil and makes the Earth a genial habitation for both vegetable and animal life. The greater portion, however, is converted into Constitutism, which transforms the water both on the land and in the Sea into vapor, that water the fields and fructify the Earth.

We have seen that Forces always develop in pairs; and that one of the pair invariably is Electricity. Hence the reason why Electricity is the all-pervading Force, being universally diffused by Conduction and Convection. Vapor conveys it from the surface of the Earth to the region of the clouds, where, under its influence, rain, hail, and snow are formed. Its abnormal tension on clouds—as will be demonstrated in the Sequel—causes those mysterious, appalling and dreadful phenomena, the tornado and hurricane, which strike the bravest and stoutest hearts with terror, awe and dismay.

The electric tension especially on continents in the hemisphere for the time being under the Sun is no longer a mystery. Consequently the reason for the change from a high barometer, or disgorging vortex throwing down the air upon the continent during the absence of the Sun in Winter, to a low barometer, or engorging vortex throwing up the air during the presence of the Sun in Summer, is likewise a secret no longer.

But if the Sun changes the continental vortex from a dis-

gorging one when he enters the hemisphere by crossing the Equator, why does he not also change the oceanic vortices? We have seen that the disgorging vortices that for six months have prevailed over the continents, and poured down dry air upon them, leave at his approach, and are replaced by engorging vortices that suck in the moist air from the surrounding oceans drawing it into the centre of the continents. Why do the disgorging vortices that pour down dry air upon the oceans remain unaffected by the approach of the Sun, except a contraction of the area they cover, which are now almost exclusively limited to the Ocean? Is there not an equal increase in the proportion of Light shed upon the oceans in Summer, and compared with that of Winter, as upon the continents? If so, what becomes of it? It does not persist as Light and penetrate to the bottom of the Ocean, for at a few hundred feet below the surface of the Ocean it is dark. It must therefore pass into some of the other modes of Force. Some of it unquestionably passes into Heat; but not all of it, for the temperature of the Ocean is comparatively little affected by the solar rays. The vapor that forms the clouds which distil the rains that water the Earth, filling the rivers untill they overflow, and clothing the fields with verdure, comes from evaporation on the surface of the Ocean.

At the city of St. Louis on an average fully 1,000 miles from the Ocean whence the vapor comes, the rainfall on each acre is about 7,000 tons annually, or about 4,000,000 tons to a square mile. The amount of rainfall in the State of Missouri hence is over 300,000,000,000 tons annually. Now this enormous quantity of water is not only vaporized over the Ocean, but it is transported a thousand miles into the centre of the Continent, and then raised to an elevation of from two and a half to three miles above the Earth.

When the amount of rainfall in Missouri is supplemented by the quantity that falls in the adjoining States in the Mis-

sissippi Valley alone, the quantity is so stupendously great that the Human Mind is utterly incapable of conceiving an adequate idea of it. This inconceivably great quantity has to be augmented by the rainfall over the whole Globe, to obtain the total amount of work done by solar Energy in vaporizing water, and in raising and transporting it to all parts of the Earth. Add to this the weight and volume of air moved by drawing it down upon, and propelling it along the surface of the Earth, and then hoisting it up again, an amount of work requiring an expenditure of far greater Energy than the forestated aqueous movement, and even then we have not the total amount of solar Energy expended upon the Earth and its Atmosphere.

But taking transportation and elevation of water alone, as to distance, weight and quantity, and we have so stupendous an amount of work done by the Sun, that the whole Human Family, all the oxen, mules, horses and steam engines in the world could not perform one millionth part of it. With this fact staring us in the face, why should we ask what becomes of the energy of the Sun that is shed upon the Earth in the form of Light?

The inquiry is, What becomes of the Light shed by the Sun upon the Ocean? A portion of it—perhaps all of it—becomes transformed into Heat. But if so, then it does not persist long enough as Heat to become sensible as such. According to the universal law of dual evolution, Electricity is simultaneously evolved with Heat. But why does not the Heat accumulate, and the water surface of the Ocean become as hot as the land? The answer is, that whichever may be the case, whether the transmutation of Light be immediately into Constitutism, or mediately through Heat, the final result is, that the Light passes into the constitutive Force, and its accompaniment Electricity, which is necessary to form the incessant stream of vapor issuing from

the Ocean like from a great cauldron and spreading it self over the whole Globe. This stream of vapor forms clouds in the sky whose rains water the thirsty land, giving fertility to the soil and clothing the continents in verdure.

We have just seen that the quantity thus lifted and transported from over the Ocean upon the Land is so stupendous, that the Human Mind is struck dumb with wonder and amazement at its magnitude. Yet this work is accomplished in so silent and unobtrusive a manner, that neither the agency nor the operation has been detected, nor even suspected by Man in the thousands of years that he has been a dweller upon the Earth.

Operations upon a scale so gigantic, so universal, so uniform and ever efficient cannot take place casually; but they must be inevitable consequences and of natural agencies established and incorporated in the constitution of the Universe. Efficient causes must not only be established there, but natural affinities between Force and Matter that work in harmony with these causes, facilitating their operations and ensuring their efficiency. Of these natural affinities and other agencies that facilitate the operations of physical causes, Prof. Nichol says: "The action between two bodies showing electric tension takes place with increased facilty, if one or both of them be easily vaporized. There is consequently more powerful action between the Atmosphere and surfaces of water, than between it and dry surfaces. Vaporization is increased by this action".

In the case of the bodies he mentions, the Matter of one, the Atmosphere, is gas, the extreme state of divisibility of Matter; the Matter of the other, water, a liquid, stands three removes below the state of extreme divisiblity. The action and reaction of both, is therefore expended upon the water and the effect is to increase its vaporization. But action can only take place between so much of the bodies as are in actual

contact. Evidently contact only continues until the affinities are satisfied, when repulsion ensues and they are driven asunder and in this case the air is thrown off. Attraction compels a constant stream of greedy air to flow down upon the water to replace that which has its affinities gratified and has been repelled. These are the causes of that constant flow of saturated air from the Ocean over the Land, and of the constant stream of air that descends upon the surface of the Ocean. The affinities arise as well from the opposite conditions of the bodies as to moisture, one being wet and the other dry, as to their opposite electric states, one being positive, the other being negative. The cause why there is a descending current upon the Ocean is self-evident. Attraction between two bodies excites a mutual tendency to move towards each other. If both bodies be free, they both move. If both be fixed then neither moves, but they find a medium of convection by which they mutually interchange affinities. If one is fixed, and the other is free, then the free body moves to the fixed. In this case the water may be considered as fixed, hence the mobile Atmosphere moves down upon it.

The reason is therefore apparent why the presence of a vertical Sun in a hemisphere does not change the downpouring vortex over the Ocean, as well as over a continent, into an uppouring vortex. The currents of dry air returning from their long circuit over the continents, are eager for a drink. Being Positive by self-repulsion from above and attraction from the Negative upon the Earth beneath, in their eagerness to drink, they rush towards the surface of the Ocean, forming a whirlpool—a veritable aerial maelstrom of immense size—into which they rush and are poured down to the surface. Having slaked their thirst by drinking the vapor that incessantly rises from the Ocean, they set out again upon a long journey into the centre of the continents

to water the thirsty fields by distributing bounteously the refreshing rain over the Land.

CHAPTER VII.

ELECTRIC SPIRALS.

A further proof that Electricity is the cause of the high and low barometer—the disgorging and engorging vortices—and consequently of all atmospheric movements, is the form of the spiral that these movements describe. There are two species of spirals, the right-handed and the left-handed*. The corkscrew is a right-handed spiral, its prong being coiled to the right. If the prong were coiled to the left then it would be a left-handed spiral. The threads of all screws are right-handed spirals. When the wheels of carriages etc., are fastened by nuts the thread on the axle on the left side of the carriage is a left-handed spiral. In the following figure 12, *a* is a right-handed spiral and *b* a left.

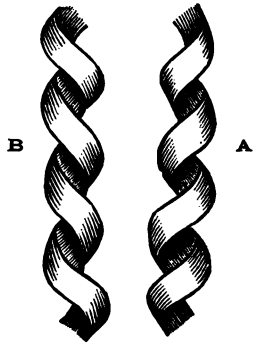

Fig. 12,

* The right-handed spiral is sometimes called *dextrogyral* and the left handed *laevogyral.*

Or suppose that both *a* and *b* were spiral stair-cases, then a person descending *a* will describe the spiral of a corkscrew, in moving successively say, from East to South, West, North, East, etc., until he reaches the bottom, which is precisely the spiral described by the air in descending the vortex of a high barometer in the Northern Hemisphere, as will be seen by the outflowing winds from the areas covered by high barometers.

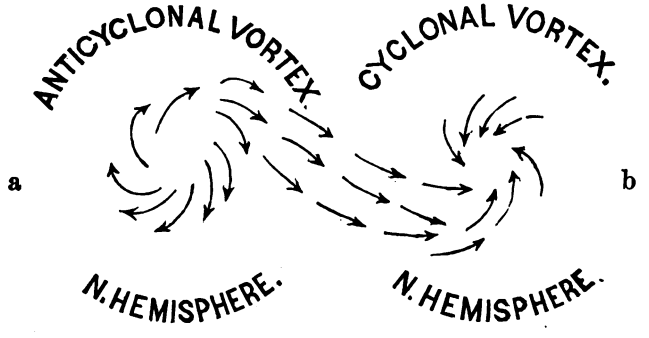

Fig. 9.

See Chart and also figure 9, *a*. But if a person ascends such a spiral stair-case, then he describes likewise the corkscrew spiral; but he now moves successively from say East to North, West, South, East, etc., until he reaches the top of the stairs. Now this is precisely the movement of the wind in the cyclonal vortex or low barometer in the Northern Hemisphere, as will be seen by inspection of the same Charts and figure 9, *b*. This is the reason why the whirl of the whirl-wind, tornado, hurricane and water-spout in the Northern Hemisphere is invariably contrary to the hands of a watch. Electric discharges from the clouds to the Earth, or from the Earth to the clouds describe the same spiral, as will be seen by examining trees or other objects struck by Lightning. The right-handed or corkscrew spiral is therefore the electric spiral of the Northern Hemisphere, described by all electric movements in that hemisphere.

It is an interesting and pertinent fact, that climbing plants generally in the Northern Hemisphere pursue the electric spiral of that hemisphere; the hop (*Humulus Lupulus*), and the climbing buckwheat (*Polygonum dumetorum*), as far as I know are the only exceptions.

If a person descend or ascend a left-handed spiral stairs, his movements are the reverse of those in the corkscrew spiral. When he lands on descending, his movements are contrary to the hands of a watch, and when he ascends, he moves in the same direction with the hands of a watch. By

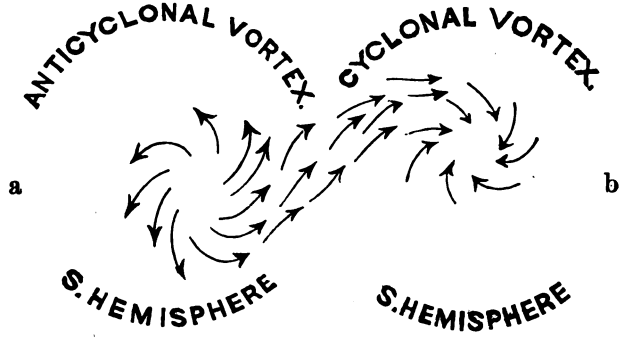

Fig. 10.

examination of the Charts and of figure 10, *a* and *b*, we find these directions correspond with the ascending air in the cyclonal vortex of the Southern Hemisphere, and with the descending air in the high barometer or anti-cyclonal vortex of the Southern Hemisphere, and with the ascending air in the cyclonal vortex of the same hemisphere. If we examine the whirl of the whirlwind, of the tornado, hurricane and water-spout in the Southern Hemisphere, the direction we find is invariably with the hands of a watch. Objects struck by Lightning in that Hemisphere, show it invariably pursues there the left-handed spiral. It is therefore the electric spiral of that hemisphere.

In both hemispheres a flash of lightning appears zigzag, because a spiral viewed in profile always appears zigzag.

These facts are interesting not because they are curious nor even wonderful, but because they are significant. They lead us into the recesses of the Unknown, and unveil mysteries of the most momentous import. They disclose causes and laws that underlie all terrestrial and atmospheric phenomena. Yea, underlie the very foundation of the Universe.

CHAPTER VIII.

WHY ARE PHYSICAL MOVEMENTS UNDER IDENTICAL CONDITIONS IN OPPOSITE DIRECTIONS ON OPPOSITE SIDES OF THE EQUATOR?

In contemplating these wonderful phenomena, questions like the following arise and demand a solution. Why should the waters of the Ocean on one side of the Equator, at exactly similar localities, such as polar, tropical and sub-tropical, and therefore under identical influences, yet invariably move in curves and circles having reverse directions to those similarly located on the other side of the Equator? Why should the winds above the surface of the Ocean in both hemispheres coincide with the direction of the currents of water underneath? Why should the air, whether descending upon the Earth, sweeping her surface, or when ascending from her, invariably in that polar hemisphere describe curves of the same direction, while in the opposite polar hemisphere it describes curves of the opposite direction? Why should Lightning, in its almost inconceivably rapid

flight, sedulously observe the electric spiral of its native Hemisphere!

Facts so uniform in their development, each one having its place, and every one in its place, so harmonious and systematical as a whole, yet directly the reverse on the opposite side of the Equator, but still concordant, have a significance that cannot be over-estimated. They signify that there is a physical agent in each hemisphere that controls all physical movements, and that wields omnipotent power therein, yet all movements work harmoniously together to effect the same great end, "Each being part of a stupendous whole".

What are these physical agents? what are their functions? and what laws govern their actions? Facts alone can disclose the agencies, and answer these questions.

Electric currents continuously circulate through the "crust of the Earth", from East to West. Around the North Pole these currents consequently circulate from left to right, or with the hands of a watch. According to electric laws already illustrated (see figure 4, *b*), these currents must produce Boreal Magnetism at the point around which they circulate. Hence, the origin of the Boreal Magnetic pole that directs and controls all physical movements in the Northern Hemisphere.

These electric currents circulate around the South Pole of the Earth, also from East to West, therefore from right to left, and according to the electric law illustrated heretofore (see fig. 4, *a*), they produce Austral Magnetism at the point around which they circulate. Hence, the origin of the Austral Magnetic pole that directs and controls all physical movements in the Southern Magnetic Hemisphere.

We have shown heretofore that in Nature there subsists between the Physical Forces the relations of sovereign and subject, of master and thrall. We have given an illustration of these relations in the inductive action of Electricity.

We have shown that the inducing charge is the sovereign, the induced the subject. The latter is enthralled by the forformer. It holds it in indissoluble bonds. No power can release the thrall until the behests of the master are obeyed, which are to bring relief to the master by obliterating its tension.

Hence it is seen that the induced electric charge is of lower rank than the inducing one. It is dynamic, the worker, the actor, while the inducing charge is static, the inactive Sovereign at ease upon his throne. The same relations subsist between evoking and evoked Magnetism. The former is static, the latter is dynamic, the one is the sovereign, the other is the subject.

We have already seen that Magnetism is not a *primitive*, but a *secondary* Force. It may with propriety be called a mode of Electricity, for Electricity manifests itself by various modes. One of these modes is Attraction and Repulsion, which are the only characteristics of Magnetism. In fact there can be no doubt that Magnetism depends upon Electricity, and is an effect of it. I have already shown that its function is that of minister or director of the other Physical Forces, especially of Electricity.

Matter is moved by Electricity, but Magnetism directs where the Matter must go. So faithfully, punctually, and perfectly does it perform its function as superintendent, that whenever and wherever an atom or a world is wanted, instantly the atom or world is in place.

We hence infer, that though all atmospheric movements are caused by Electricity, yet Magnetism directs the motion. Atmospheric movements are not rectilinear but in curves or

* I have already called attention to the fact that the waters of the Ocean, and other physical movements describe the figure 8. Here we have another illustration of the law. Examining figures 9 and 10, and tracing the wind from the *debouchement* of the anti-cyclonal vortex to the *embouchure* of the cyclonal vortex, we find that both describe a diagaram resembling the letter S. One—that in the Northern Hemisphere—however is reversed, Superimposing these diagrams they

rather spiral whirls*. Since a current of electrified Matter moving, is virtually an Electric current, therefore according to the law of mutual action and reaction between electric currents and magnets, the magnet must whirl in definite directions any free electric current around it. Since the Boreal Magnetic pole of the Earth is the lord paramount in the Northern Magnetic Hemisphere, therefore in that Hemisphere the curves described by the air in the downpours and uppours in the whirl of the winds, and in all electric discharges, ought to coincide with the motion that a boreal magnetic pole will impress upon a free electric current moving in the same direction as these atmospheric currents do; and consequently in the Southern Hemisphere the curves and whirls ought to be the reverse of those in the Northern Hemisphere; the direction being such as an Austral Magnetic pole will impress upon free electric currents subjected to its influence. Now the direction in which a magnetic pole will influence a free electric current to move, depends upon the kind of Magnetism by which the pole is affected, and the direction the current flows. A boreal magnetic pole whirls a free electric current around it in the opposite direction that an Austral pole does. Besides this, either pole will hurl a descending current in the opposite direction it will an ascending one.

A boreal magnetic pole will hurl a free descending current around it from right to left, that is, contrary to the movements of the hands of a watch; and an ascending one from left to right, or in the same direction the hands of a watch move. On the contrary, an austral pole will hurl a descending current from left to right or with the hands of a watch, and an ascending one from right to left, or against the hands of a watch.

give the figure 8. The cuts delineate the tracks on the surface of the Earth; on the surface of the Atmosphere in each hemisphere the wind describes the diagram reversed it did on the surface of the Earth. Hence the the whole circuit of the wind is represented by the figure 8.

Comparing these effects with the actual facts existing in both polar hemispheres, we find that the theoretic facts for the Northern Hemisphere, are the actual facts in the Southern Hemisphere, and *vice versa*. Therefore the actual facts in either hemisphere, are the reverse of what they ought to be according to theory. In other words, to produce the phenomena in the exact form they exist, would require the domination of the austral magnetic pole in the Northern Hemisphere, and that of the boreal magnetic pole in the Southern. Here is a palpable conflict between theory and fact. How can the differences between the two be explained and reconciled; and how can the deductions from the theory and the actual facts be harmonized?

The electric currents that circulate through the Earth from East to West, are conduction currents, because the Earth is continuous Matter. No current can flow in any direction without inducing currents in adjacent Matter in the opposite direction. Consequently, the electro-negative currents that circulate from East to West through the Earth must induce parallel electro-positive currents in the Atmosphere flowing in the opposite direction. Since the Atmosphere is not continuous, but disjointed Matter, these are not *conduction* but *convection* currents, that is, the Electricity is conveyed by the gaseous atoms of the Atmosphere moving from West to East. This is the cause of the general eastward movement of the Atmosphere, interrupted, however, by the stationary vortices shown on the Charts. The conduction current in the Earth, and the convection current in the Atmosphere, being two parallel currents of Electricity flowing in opposite directions, must, according to the electric law discovered by Ampere, repel each other. This mutual repulsion between the currents in the Earth and those on the Atmosphere, accounts for the flocks of floating ice crystals constituting very high cirri clouds often encountered and observed by aero-

nauts. It also accounts for the flocks of dust and pollen of pines that float along at high altitudes in the Atmosphere as smoothly as if they were on the surface of a river. It does more. It accounts for the mutual repulsion between the Sun and planets, and between planet and planet.

Suppose *a*, figure 11, to represent the Sun, and *b* the Earth. Let N represent the North Pole in each, Z the Zenith, E the East, and W West. They both rotate upon their axes from

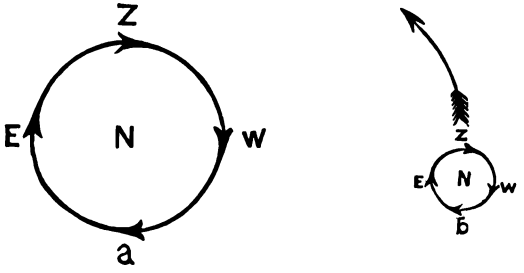

Fig. 11.

W *via* Z to E. But electric currents circulate around them contrary to the direction of their axial rotation, as shown by the arrows, that is, from E *via* Z to W. In fact these currents are the causes that produce *Boreal* Magnetism at the North Pole, where they are direct—see figure 4, *b*—and Austral Magnetism at the South Pole, where they are retrograde—see *a*, same figure.

The currents in the sun must act inductively upon the Earth —in fact upon all planets—and must evoke electric currents in them flowing in the opposite direction, as will be seen by comparing adjacent currents of *a* and *b*, figure 11. It can be demonstrated, that this electric action of the Sun produces the axial rotation of the planets. But this would be foreign to our purpose, since we are dealing with Meteorological facts and phenomena, and not with Astronomical ones, except so far only as is necessary to develop and demonstrate causes

and laws that underlie both Meteorological and Astronomical Science. However, as the physical law has already been developed and demonstrated for meteorological purposes that a boreal magnetic pole hurls a free electric current around it in a direction contrary to the movement of the hands of a watch, and the austral magnetic pole in the direction the hands of a watch move; therefore we may as well state that both the boreal and the austral poles of the Sun hurl the Earth around him as a center in the curve and direction shown by the large arrow near *b*, figure 13, causing the revolution of the Earth on her orbit.

The fundamental facts that unravel the manifold and complicated phenomena of Meteorology, are the electric currents circulating through the Earth, and those they induce upon the Atmosphere.

Between these there is an inherent repulsion, because they are parallel electric currents flowing in opposite directions. This repulsion accounts, as already stated, for many heretofore unexplained phenomena of the Atmosphere where substances with greater specific gravity than the air, are found floating in it. But an additional fundamental law is, that no substance susceptible of electric influence, can move anywhere without being affected by magnetism, in such a manner as to evoke an electric charge upon it if it be in a neutral state, and if not, then to intensify the charge already upon it. In the Northern Hemisphere the Boreal Pole acts in this manner upon the air, vapor or anything passing through the air, and either charges them with Electricity or intensifies the charges already upon them. In turn, these act inductively upon the Earth's surface beneath them, and intensify the charge already upon it. If the Earth's surface underneath be land, then the charge induced upon it is the thrall of the charge on the air and clouds. They carry this charge forward along the surface beneath them, in their east-

ward flight. If that surface be uneven, then, since the Earth is charged with negative Electricity, from self-repulsion it is driven to the highest points—whither it is also attracted by the overhanging charge—and there communication with the clouds above for an interchange of electricities is established. This is the cause and the origin of the engorging vortex or low barometer, and is the reason why low barometers affect mountains so much.

But attraction sweeps the vapor from the surface of the Ocean to feed the engorging vortex over continents. All the Energy of the Sun shed in the form of Light upon the Ocean, is expended upon the water, vaporizing it, that is, changing it in form, and consequently by a universal and inherent law, the Light itself is also changed into other forms of Force. But one invariable accompaniment of a change of state in Matter, or of Form in Force, is the evolution of Electricity. Hence, the surface of the Ocean becomes surcharged with Electricity, which, acting inductively upon the dessicated air coming from over the continents, evokes positive Electricity upon the dry air, and by attraction pulls it down upon the bosom of the Ocean. This occasions the disgorging vortex or high barometer, with its descending current of air.

In the general atmospheric movement horizontally along the surface of the Earth from West to East, and consequently around both magnetic poles as centres, the influence of Magnetism is plain and so palpable that it cannot be mistaken. But in downpouring and uppouring vortices we have vertical instead of horizontal currents. These vertical currents also have a rotary motion around a centre, and must revolve around a magnet, one pole of which is pointed towards, or upon the Earth, and the opposite pole towards Space, perpendicular to the surface of the Earth. All things that move under the influence of Magnetism, have their elec-

tric condition intensified. This causes them to move in a spiral, and therefore around an axis.

The school boy knows that a ball does not descend perpendicularly to the Earth, that is, in a straight line, but in a spiral. What imparts this spiral motion to a descending or an ascending column of air, to a ball, or to any other object falling from a great elevation, even to Lightning? It is unquestionably the universally directing Force, Magnetism. But how can there be in the air a vertical magnet with one pole pointing towards the Zenith, the other towards Nadir? The answer is, the experiments of Meisner and Faraday show that oxygen gas is highly susceptible of the magnetic influence, in fact, the most magnetic of all gases. It is evident that this constituent of the Atmosphere is sufficient alone to furnish the material for this invisible magnet.

In the vortices of the Atmosphere, it is seen that the whirl caused by this invisible magnet is, in both polar hemispheres, contrary to the motion that the dominant magnetic pole in the hemisphere will impart to an electric current. Why should this be so?

We have seen that the function of the dominating magnet in a hemisphere is to whirl the air in horizontal currents eastwardly around itself as a centre, and to excite Electricity upon any moving Matter in that hemisphere. Consequently, it excites Electricity upon the moving air and vapor floating in it. Impotent as a magnet is to excite Electricity without itself being in motion, or without a conducting substance moving past it; yet when the conditions, self-motion, or a moving substance are supplied, then not only moving bodies but bodies at rest inevitably will become charged with Electricity.

It is legitimate to infer that the Electricity evoked by a boreal pole will have an inherent tendency, when proper

conditions exist, to form the opposite or austral pole, and *vice versa*. It will likewise have other qualities dissimilar to the Electricity evolved by an austral pole. It certainly has more affinity for the opposite magnetic pole than for that which evolved it. This hypothesis explains the generally conceded fact that air coming from the South Pole, for instance, and poured down upon the surface of the Ocean through the disgorging vortex along the Tropic of Capricorn, and which, by the Southeast Trade Wind, is poured into the Equatorial calm where it rises, crosses the Equator, and is poured down again through disgorging vortices along the Tropic of Cancer. Thence it passes to the North Pole, as a surface current. Such, likewise, is the case with the air returning from the North Pole. We have already indicated that this is likewise the case with the waters of the Ocean. Why should this be the case, if it be not a fact that air and water that have been to one magnetic pole, and been subjected to its influence, have now a repulsion for that magnetic pole, and an affinity for the opposite pole? The fact that they do cross the Equator and proceed to the opposite pole, is proof that this is the case. If they have actual repulsion for the pole they are leaving, and affinity for the pole towards which they are moving, then this repulsion and affinity, or rather attraction, are electric, and they are virtually electric currents. If they are necessitated to form magnetic poles, they will naturally form the pole pointing in the direction they are moving, which is of that kind of magnetism opposite to that with which they have just been in contact.

Moreover, Positive Electricity, by Induction, always evokes its opposite, the Negative; and the Negative, the Positive. Why should not Magnetism—which is a mode of Electricity—act similarly, and the Boreal pole by Induction evoke the Austral, and the Austral the Boreal? We know it to be a

fact that in metals always any given magnetic pole does evoke its opposite. Why, then, should it not do it when acting upon the invisible gases of the Atmosphere?

When a magnetic pole induces another in metals, it does so through the medium of a momentary electric current circulating around both the inducing and the induced pole. We have already seen that a current of air being the motion of electrified gas, is virtually an electric current. If, therefore, such a current is necessitated to change its direction from a horizontal current to a vertical one—as when an electric charge is to be conveyed from the clouds to the Earth or *vice versa*—then the creation of a magnet to control and direct the movements of the current is necessitated, for the magnetic pole to perform this function must be in the coil of the spiral in which the current moves. It is therefore perceived that the controling magnetic pole of a hemisphere will inevitably evoke its opposite pole, to be its thrall and servant to execute the physical laws within its domain.

The conflict between theory and facts, noted before, vanishes when we look at all the elements involved in the problem. The apparent conflict arose from assuming too much, namely, that the dominant magnetic pole in a hemisphere did everything directly. The deduction hence was that the facts would be of such a character that they could be traced to the direct action of the local magnetic pole dominating the hemisphere in which the phenomena occurred. But by examining the facts and comparing them with the requirements of the theory, it was made evident that this was true only to a very limited extent; in fact only of the most general and least conspicuous phenomena; while the most imposing and most conspicuous phenomena not only contradicted the theory, but showed the reverse required by the theory to be true, namely, that the phenomena were so distinctly marked

that they could only be attributed to a magnet of the kind that dominated in the opposite hemisphere.

Here was a dilemma. Either the whole theory of magnetic influence had to be abandoned, or it had to be so modified as to harmonize with the facts and mold them into a systematical whole.

Upon a thorough examination, the theory of magnetic influence was found to be true; but the same principles had to be applied to it as in electric dynamics, namely, when necessity is upon a magnetic pole, it also evokes its opposite polarity by Induction, and makes of the polarity so evoked, a servant, and so administers the law vicariously. The theory thus enlarged, harmonizes all the facts. Antagonism disappears. It would never have manifested itself if the principle had been recognized that in Magnetism, whenever the master is right-handed, the servant must be left-handed, and *vice versa*.

CHAPTER IX.

MUTUAL REPULSION BETWEEN HIGH AND LOW BAROMETERS.

The electric nature of atmospheric phenomena is so plain and palpable "as to be known and read of all men". There are, however, a class of facts of such vital importance that without a knowledge of their nature it is impossible to understand and explain any, even the most ordinary meteorological phenomena. These facts demonstrate conclusively the electric nature of the high and the low barometer, the

controling phenomena of Meteorology, besides proving that these phenomena are of electric origin.

We have taken great pains to convey to the minds of readers clear and precise ideas of the nature and even the form of these phenomena. To do so, we have employed the simplest and most explicit language at our command; because if we failed in conveying clear ideas, we felt our whole labor would be lost. One point we think we have succeeded satisfactorily to establish in the minds of all, namely, that the air which flows through the vortices of the high and low barometers, is electrified air. Since the air that constitutes the moving ascending and descending columns of the phenomena is electrified air, hence they are virtually electric currents. To be sure they are *convection* currents, but recent experiments in Europe show that convection currents manifest in every respect identical properties as *conduction* currents, and are governed by the same laws. Since one ascends from the Earth and the other descends to her, they are parallel electric currents flowing in opposite directions. Hence they fall under the control of Ampere's first law, namely: "*parallel electric currents flowing in opposite directions repel each other.*" The high and the low barometer, therefore, must repel each other. Such was the deduction I made nearly twenty years ago. But no data existed then by which either to verify or to disprove this hypothesis. Sufficient facts however, were collected that verified beyond all doubt its truth. Twelve years ago I for the first time announced it in a paper prepared for the press. But it fell dead, because the public either did not understand it, or failed to see its importance. Scholastics, arrogant and disdainful towards all who question the authority of the schools, could not condescend even to look at it. How could it be expected that they would greet anything, except with disdain, which is in con-

flict with the notions inculcated in the schools, and which is not couched in their formulary and conventional terms?

> " Though, proud and disdainful, their sight they may seal,
> Yet Man cannot cover what God would reveal."

In my hands it has not only been invaluable to explain old facts, but fruitful in suggesting new ones, whose existence I had not suspected before.

Nearly five years ago from the present writing, namely, in September, 1873, I made a demonstration (see the accompanying Map, No. 2), of the mutual repulsion between the high and low barometers, and sent it to the Signal Office. The map is a combination of the storm map and map of high barometers, taken from the *Monthly Weather Review* for August of that year*. The double lines represent the track of the

* The following were the circumstances which led to my preparing and sending the map in question: Being in the Rocky Mountains of Colorado, I observed on the 2d day of August, 1873, a high barometer that came from the Southwest and passed to the North east, which direction is at right angles to the normal course of high barometers. The daily observations at all the stations not being accessible to me there, I wrote to the Signal Office for information, stating I could not account for the abnormal course of that high barometer unless by repulsion from a low barometer in the Southeast. I requested as a favor that they look and see whether a low barometer was on that day over the eastern part of the Gulf or coast of the South Atlantic States. General Myer being absent in Europe, attending the International Congress of Meteorologists, a subordinate replied that an examination of the records showed that a low barometer did pass northeast along the Atlantic, being southeast of Florida and Georgia, on the days —the 2d and 3d—named. The writer added, but it was ridiculous to suppose that a low barometer on the coast of Florida could exert such influence as to drive a high barometer out of its normal course so far distant as the mountains of Colorado. The writer concluded by lecturing me upon the beauties and canons of the Undulatory Theory. That letter is preserved.

I felt somewhat miffed at the tone and spirit of the missile, and hence retorted with a demonstration of the correctness of my theory, drawn from their own observations, as mapped in their Monthly Review. General Myer, upon his return from Europe, acknowledged the receipt of the map and accompanying letter, stating that he had carefully and with great interest examined the map and theory, and had compared both with the facts. As far as the facts of that month were concerned, the theory in every respect was completely verified. He concluded that if facts generally confirmed this theory, I had made the most impor-

high barometers, and the single lines that of the low barometers. The figures to the left of the tracks indicate the day of the month, and the figures 1, 2 and 3, to the right of the tracks the observations; 1, or first observation, 7 : 35 a. m.; 2, 4 : 35 p. m.; and 3, 11 : 35 p. m. The figures likewise indicate the localities of the centres of each at the time of observation. To indicate accurately the actual atmospheric pressure at the time, lines more or less concentric would have to be drawn around these localities as centres. It was found impracticable to do so on the map; hence the reader must in imagination supply these wanting isobars, or lines of equal pressure.

The reader must also remember that there is a permanent high barometer on the Atlantic Ocean, southeast of the Bermudas, which repels all low barometers on the North American Continent, and attracts all high barometers traversing the continent.

It has already been demonstrated that a high barometer is a descending current of Electricity; hence two high barometors are *two parallel electric currents flowing in the same direction*, therefore, according to Ampere's second law, *they attract each other*. This is the reason why the normal path of a high barometer on the North American Continent is Southeast. The reader must also bear in mind another fact, namely, that there is a constant low barometer over Iceland which repels all high barometers on the North American Continent, and makes them hug as closely as possible the low barometers or storm centres they feed West or Southwest of them. It attracts all low barometers or storm centres according to the law noted above that appear upon that Conti-

tant metorological discovery of the age. The Signal office now use this principle of Attraction and Repulsion, in accounting for the deviations in direction of both high and low barometers, but they evidently do not comprehend its value nor see the extent of its application to meteorological phenomena.

nent. This is the reason why the normal course of every storm centre in North America is Northeast.

When we once succeed in fully grasping the principles of the inherent repulsion between parallel currents of Electricity flowing in opposite directions, and the inherent mutual attraction between parallel currents flowing in the same direction; and apply this great principle to the high and low barometers, and see how indispensible it is to assure the faithful and efficient performance of their functions; then we see and realize for the first time the fact that the world as well as Man is "fearfully and wonderfully made". As far as adaptation of means to ends is concerned, everything is perfect, simple, yet sublime and wonderful. Take, for instance, the functions of high and low barometers, as makers and distributors of rain. They are an inseparable electric couple; always contiguous yet ever distinct; as essential to each others' existence as to the performance of their function in the economy of Nature; yet they could not persist separately, nor perform their joint functions, if repulsion did not exist between the dissimilar parts in a pair, nor attraction between similar parts in pairs. For instance, we have already pointed out that the Sargasso Sea high barometer attracts every high barometer on the North American Continent, and repels at the same time the transcient low barometers or storm centres there. Suppose the passing storm centre is between the Sargasso Sea permanent high barometer and the continental transcient one. Then it compels the storm centre to hug the continental high barometer, while both feed it on opposite sides. This in fact is one cause of those immense rainfalls that are so frequent along the Gulf and South Atlantic sea coast. We have already pointed out the Icelandic permanent low barometer; besides which there is the constant low barometer around the North Pole. Both of these attract the

low barometers and repel the high ones on the North American Continent. Every low barometer on the North American Continent would therefore move North along the Meridian into the Arctic Ocean, if when it makes its appearance, a high barometer did not instantaneously spring up—induced by it—between it and the Polar low barometer. This high barometer repels the continental low barometer southward, but leaves it under the influence of the Icelandic low barometer, which causes it to traverse the Continent from West to East. But here we have again double attraction and double repulsion. The polar low barometer attracts, and North Pacific permanent high barometer repels, the continental transcient low barometer or storm centre. Attraction and repulsion, acting along the same line and in the same direction, would force the storm centre along the Meridian upon the Polar Sea, were it not that the transcient high barometer is interposed on this line that repels it. The effect of this attraction and repulsion acting on opposite sides and in the same direction, however, compels the storm centre to hug its companion and feeder as closely as possible; and its energy is proportionate to the force that impels the storm centre into close proximity with its attendant and feeder. In illustration of this we have the storms of the Atlantic coast. All the disastrous storms that ravage this coast from the Gulf of Mexico to the Gulf of St. Lawrence, are caused (1) By the attraction of the Icelandic low barometer in its front, and (2) by the repulsion of a high barometer on or along the Gulf of Mexico, propelling it in its rear. Under the influence of both, it moves down with the Gulf Stream northeastwardly But almost invariably it finds a high barometer interposed between it and the point of its destination, Iceland. This high barometer is on the great highway, or rather the gate of the great highway of storms of the North American Continent, between Southern Labrador and the

Gulf Stream, through which all storms of the continent pass. The high barometer over the Gulf of St. Lawrence is partially isolated from its brother, the Sargasso Sea permanent high barometer, by the low barometer sending out a feeler between them. It therefore obstinately maintains its position for days, battling with the storm centre advancing by the Gulf Stream. During this battle, the dreaded, disagreeable and destructive Northeaster rages over the New England, the Middle States, and southward. No Nor'easter ever occurs except when there is a high barometer headed off and driven down upon Nova Scotia and Lower Canada; and no disastrous storm along the Atlantic coast occurs except under these conditions, as the records of the Signal Office show. The latest storm of this kind I now recall is the one that caused the disaster to the United States steamer Huron, on the 23d and 24th of November last (1877). Storm Centre or Low Barometer No. VIII of the Signal Office, arrived as early as the 16th of the month, upon the Pacific Coast in Oregon. It was driven southeastward by its companion high barometer No. V, which simultaneously made its appearance on the 16th in the Northwest, until it touched the Gulf of Mexico on the 19th. Its high barometer now having outstripped it and passed on its front upon the Atlantic Ocean, the storm center moved slowly in a northeastward direction until the morning of the 21st, when it was in Southeastern Missouri. An area of high barometer now appeared in the Northwest and drove it southeastward with such rapidity that at the afternoon observation it was central on the Gulf coast, east of St. Marks, Florida. Another storm centre was approaching from the West Indies, southeast, which no doubt by attraction influenced somewhat this rapid movement. But the accelleration was due to the combined influence of repulsion in the rear and attraction in front, which always exist where accelleration takes place; whereas, when retardation

takes place, the conditions invariably are reversed, namely, repulsion in front and attraction in the rear.

It now moved eastwardly, and on the morning of the 22d —having, during the night been joined by the tropical storm centre—it was central on the Atlantic coast a short distance south of Savanna, Georgia. It now almost stood still, but swung around in a semicircle to the Northwest, and by morning of the 23d it was a short distance west of Charleston, South Carolina. As to the cause of this retardation and deflection, we find it to have been what the *Monthly Weather Review* says of high barometer No. V of November: "On the 19th and 20th, this high area moved into the St. Lawrence valley and New England; this region being nearly circumscribed by the remarkably high isobar of 30.60. On the 21st the highest barometer was transferred to Nova Scotia, with slowly diminishing pressure, attended, in New England and the Middle States by *high Northeastwardly winds* (Nor'-easter) until the 26th. On the 27th and 28th it disappeared." During the time that this area of high barometer covered Nova Scotia, storm centre No. VIII of November moved slowly Northwest until the 25th, when it united, on Lake Michigan, with storm centre No. XI, coming from the South. Passing upon Lake Superior, the united storm centre turned eastward on the morning of the 27th, but moving very slowly. It moved slow because it had to displace the obstruction in its front—the high barometer over Nova Scotia—that repelled it.

The following is what the Review says of the disaster:

"It was during the night of the 23d and 24th, when the storm centre was in West Virginia, that the United States steamer Huron was wrecked on the North Carolina coast, at Nag's Head, fifty miles north of Cape Hatteras. A southeasterly wind was blowing with a heavy swell at the time of the disaster."

This is a fair example of these Gulf Stream storms, though in this case deflected, as was the hurricane of September 19th, 1876, from the city of New York to Lake Huron, a distance of 500 miles, due Northwest, by the extreme size and energy of the high barometer over the New England States and over Nova Scotia.

Whenever a storm centre is in or at the head of the Gulf Stream, and a high barometer over Nova Scotia, a northeaster with destructive gales will prevail along the New England coast and that of the Middle Atlantic States.

The southeast gale that caused the disaster to the Huron was the wind that would be anticipated by those versed in meteorological Science. The wind on all sides blows into a storm centre, in the Northern Hemisphere in curves from right to left. Hence, at any point East or between East and Southeast of a storm centre, the wind blows from the Southeast. Since the storm centre in the Northern Hemisphere is always a few points to the left from the direction towards which the wind blows; we therefore always know the direction of its locality: and if the wind blows from the Southeast across the meridian of our locality, and is steady in direction, then the storm centre is either standing still or is approaching our locality. If the wind veers from East or Southeast by way of South, then the storm centre is passing North of our locality. If the wind veers from Southeast or East by way of North, then we know our locality lies north of the path the storm center is traveling.

The Southeast wind at the time of the Huron disaster, showed that the centre of the high barometer was East of the locality where the disaster occurred. The Sargasso Sea constant high barometer seems to have been on the Northeastward point of its eliptical oscillation. The issuing of a storm centre from the Tropical Sea, is proof of this. Hurricanes originate only on tropical seas, between the constant sub-

tropical high barometer and the Equatorial constant low barometer, say from 8° to 20° degrees distant from the Equator. Hence they can only originate when the constant high barometer near the tropics is at or near the polar limits of its oscillation, and therefore uncovers the Tropical sea.

The point of destination of the hurricane low barometer is a low barometer situated near or upon one or the other of the polar circles. For instance, the objective point of the West Indies cyclonal low barometer is the Icelandic low barometer. The point hence lies through the area covered by the Sargasso Sea high barometer, located centrally Northeast of the place where the hurricane makes his appearance. It is therefore the repulsion of this high barometer that whirls the cyclonic low barometer around it as a centre, by a curve North by way of West. This is the cause why the track of all tropical hurricanes in all parts of the World are parabolas. On Map 2 is delineated the track of the Nova Scotia Cyclone of August 24th to 26th, 1873. It will be seen it swung around the Sargasso Sea high barometer, its feeder, from left to right. This is the normal direction of hurricanes in the Northern Hemisphere. They invariably swing from left to right around the subtropical high barometer. In the Southern Hemisphere they as invariably swing from right to left around their feeder, the subtropical high barometer in that Hemisphere. This is a very significant fact.

The air that flows through vortices of the high and low barometers in the same hemisphere pursues the same form of spiral; in the opposite hemisphere, the opposite form of spiral. The spiral in the Northern Hemisphere is the right-handed or corkscrew spiral. In the Southern Hemisphere the spiral is left-handed. The high barometer is a descending current of Electricity, circulating through a right-handed spiral in the Northern Hemisphere; and the low barometer is an ascending current circulating through the same form of

a spiral in that hemisphere. Experiment demonstrates that a fixed electric current, descending through a right-handed spiral—or which is the same thing, a right-handed helix—will impel a free ascending current flowing through a similar helix, around it from left to right. A descending fixed current circulating through a left-handed spiral—that is, left-handed helix—such as is the spiral of the Southern Hemisphere, deflects a free electric current around it from right to left. We therefore find that the movement of hurricanes from the Torrid into the adjacent Temperate Zone conforms to the law governing spiral electric currents. In the Northern Hemisphere the hurricane, typhoon, etc., are hurled upon continents from the Southeast. In the Southern hemisphere they invariably come from the Northeast.

It is an established fact that the West Indies hurricane often originates near the coast of Senegambia in Africa; but under the normal impulse of the high barometer in the Northern Hemisphere, it is carried west around the area of high pressure from left to right, and is hurled upon the North American Continent, where it swings around Northeast to Iceland. Likewise the hurricanes of the Indian Ocean originate near the Northwest coast of Australia. Under the normal influence of the Southern high barometer, they are impelled from right to left and pushed westward across the Indian Ocean upon South Africa, where they swing around to the Southeast. The reason why no tropical hurricane comes from a Western ocean upon a continent, is because it is impossible, for they cannot set at defiance the law of their own existence.

The track of the Nova Scotia Cyclone delineated on the map, is not as accute as they generally are. It however conveys a clear idea of the movements of these meteors from the Tropical Seas into the Temperate Zones.

The repulsion between the high and the low barometer is

EXPLANATION.—Arrows show direction the Centres moved. Low ar
of track, No. of the observation. 1st observation, 7:35 a. m.; 2d, 4:35 p. ; a

not more curious and interesting than important. Indeed, a large portion of meteorological facts were impenetrable mysteries, without a knowledge of this great principle. In order, therefore, to demonstrate the existence of this repulsion, and to give the reader a vivid idea of it, we prepared the accompanying map, No. 2.

Before proceeding to an examination of the map, we wish for a moment to call attention to other physical phenomena which can now be explained intelligibly. By reference to Charts Nos. I and II, it will be observed that the Equatorial currents on the Ocean are formed by two currents coming in curves from the west coast of the nearest continents. The one south of the Equator is a continuation of a current that flows from the Southwest from the Antarctic Ocean Northeast to the nearest southern point of a continent, thence northward along the west coast of the continent towards the Equator. The one north of the Equator is a similar current coming from the Arctic Ocean flowing south towards the Equator along the west coasts of the continents. If we examine farther, we find each swings around the subtropical high barometer in its hemisphere, as a centre. Similar currents can be produced by experiment in the laboratory. Take a dish contained acidulated water, and place it upon the poles of a horseshoe magnet. Send by wires electric currents down upon the point immediately over each magnetic pole, and the result will be an equatorial current. The current around the austral magnetic pole, will sweep into the equatorial current from left to right; and that around the boreal pole from right to left.

Since high barometers are descending currents of Electricity, therefore the waters of the Ocean behave in the Northern Hemisphere as though an austral magnetic pole was buried beneath the Ocean in the centre of the high barometer near the Tropic of Cancer, and in the Southern

Hemisphere as though a boreal magnetic pole was buried under the Ocean centrally to the high barometers near the Tropic of Capricorn. The facts are conclusive proof that high barometers are descending currents of Electricity. The existence of these magnetic poles respectively is accounted for by causes and laws already noted and explained.

Charts Nos. I and II convey practically a correct idea of the form of the areas covered by both high and low barometers. Two points must be borne in mind: (1) the locality where atmospheric pressure is greatest; and (2) where it is least. Around these points as centres (see charts) isobars are drawn indicating that along a given isobar, atmospheric pressure is equal. The isobars near the centres enclose almost circular areas. But the areas become more and more irregular as distance from the centre increases. When a low barometer is between two areas of high barometer, the area it covers is oblong. When it is driven between two high barometers, the area becomes wedge-shaped; because the opposite high barometers drive in its flanks upon the centre, causing tornadoes and hurricanes. The distance between the two centres, varies from 350 to 1500 miles. When they are very near, the difference in pressure is not very great. But if the distance is medium, and the difference in pressure great, not only furious gales prevail in the space between the centres, but a hurricane rages around the centre of the low barometer.

Map No. 2 only shows the synchronous low barometers most affected by the high barometers. It would have crowded the map too much to have laid down the tracks of the thirteen storm centres that passed over the Continent during the month.

Storm centre No. 2 was a surviving storm centre from July, and caused the deflection of high barometer No. I, for a few days Northeast, that is, at right angles to its normal

course. It was not mapped by the Signal Service. It took the normal route of all Gulf storm centres when a high barometer prevails in the Northwest, that is, Northeast with the Gulf Stream.

On the morning of August 1st, storm centre No. 1 passed northeastward from Omaha. On the morning of the 3rd it was on the Gulf of St. Lawrence below Quebec. The rapidity of its movement shows it was accellerated by the repulsion of high barometer No. I in its rear. On the night of August 3rd, low barometer No. 3 showed itself in the extreme Northwest. It seems to have felt the attractive influence of storm centre No. 2 then Southeast of the coast of Florida, and hence moved slowly southeastward in opposition to the repulsion of high barometer No. I in its front. But by the evening of the 4th it was driven back Northwest, and at midnight it was near the locality where it was first observed the day before. By the morning of the 5th, it had swung around a large semi-circle by way of West to South. But high barometer No. I had now doubled its track and was proceeding due South; the storm centre therefore continued its circular course and swept around the high barometer now Southeast of it by way of North; after which it moved very rapidly and by evening was north of Lake of the Woods, and passed beyond observation north of Lake Superior. On the morning of the 6th, storm centre No. 4 was observed in Nebraska. The high barometer was now over Chesapeake Bay. Consequently the storm centre swept around it in a curve North by Northwest.

On the afternoon of the 7th, storm centre No. 5 appeared in Central Kansas. High barometer No. I was now central of the coast of North Carolina. It is evident from the rapidity with which storm centre No. 4 moved that it was accellerated by an area of high barometer in its rear. This high barometer was no doubt forming a junction with No. I, and

therefore covered the Lower Lake Region. Under the repulsion of these conjointly, storm centre No. 5 took a due north direction, and passed beyond observation next day in Manitoba.

Passing on to storm centre No. 8 we observe it appeared in the extreme Northwest at midnight of the 17th. High barometer No. II was then central east of Massachusetts; but feeling the repulsion of the tropical cyclone now advancing slowly from the Southeast, it was deflected upon the Gulf of St. Lawrence, and finally driven, on the afternoon of 18th, towards Hudson's Bay. It reappeared on the morning of 20th Northwest of Montreal. Now examine the track of storm centre No. 8. Its first impulse was to move around high barometer II in a curve by way of north. Since every storm centre is accompanied by a high barometer on its polar flank as a feeder, this feeder under the influence of its co-high barometer which attracted it must have outstripped No. 8, accellerated its motion and made it change its course in a southeast direction.

Upon the principle that any electric current flowing in one direction, induces a parallel current flowing in the opposite direction, every tropical hurricane invariably induces upon the continent it is approaching a high barometer. I have not the observations of the Signal Service of that date to refer to, but there can be no doubt that about midnight of the 18th a high barometer made its appearance in the Mississippi Valley. Under the influence of this high barometer and the retreating high barometer from the Gulf of St. Lawrence upon Hudson's Bay—storm centre No. 8 was thrown with accellerated velocity into the extreme Northwest, beyond observation, on the afternoon of the 19th. It no doubt swung around on its centre and reappeared as storm No. 9 of the Signal Service on the morning of the 20th, precisely the same date that high barometer No. II reappeared near

Montreal, after having swung around in a similar circle. It will be observed that this storm centre on the 21st made an immense curve to the south at the same time the high barometer No. II swung around its axis by way of North in the Atlantic south of Nova Scotia. It was the repulsion of the Tropical hurricane bearing down upon Nova Scotia, that caused this swinging around upon its centre of the high barometer.

High barometer No. IV now appeared in the Northwest, moving rapidly under the attraction of high barometer No. II on its front; and being in the rear of storm centre No. 9, accellerated its motion; in fact, driving it like a wedge between high barometers Nos. IV and II. The repulsion of storm centre No. 9 upon the rear of high barometer No. II, assisted it in getting out of the way of the Cyclone, now East of South Carolina. But now examine high barometer No. IV. From the united repulsion of storm center No. 9 on its front, and the cyclone bearing down the Gulf Stream, it is almost arrested, as will be seen by examining the observations upon it at that date. On the 24th, the Cyclone forces it in a curve towards the Northeast, and on the morning of the 25th repels it beyond observation towards Hudson's Bay, whence it reappears on the 26th north of Lake Superior. During the 24th and 25th, there raged the most terrific and destructive Cyclone in Nova Scotia ever experienced on the Northeast Coast. On the coasts of New Foundland, Cape Breton and Nova Scotia, and in the Gulf of St. Lawrence, no less than 1032 vessels, mostly engaged in the fisheries, were lost, and over six hundred persons were drowned. On the ocean, before it reached that coast, southward of New England, over 90 vessels more are known to have been lost. The value of the property destroyed on land and sea and along the coast, was estimated to have been from $3,500,000 to $5,000,000.

If we examine the track of the Cyclone—storm centre No. 10—we find its motion to have been extremely slow in consequences of the Sargasso Sea high barometer on its right flank, forcing it upon the high barometers on the continent, and on the coast in its front. The cause of its retardation was the repulsion of these high barometers on its front. But being fed on all sides by moist winds that swept the ocean, it gathered energy enough in its progress to clear them out of its path. The prolonged battle was terrific, and accompanied by fearful loss of life and property, as is always the case when a cyclonal vortex has to clear its path of obstructions.

In regard to this matter of repulsion, we finally call attention to the behavior of storm centre No. 11 from the 26th to the 27th of the month, as compared with that of high barometer No. IV. It will be observed that both—during these days—pursued devious courses, yet comparison shows that their paths were parallel to each other. The swing on its centre of the high barometer on the 28th and 29th, was caused by storm centre No. 11 passing down on the Gulf Stream in its front, and between it and the Sargasso Sea high barometer.

We must here close the evidence to prove, and the argument to demonstrate that there is repulsion between the high and low barometers. We close, not because the facts in either have been exhausted, but because we have presented sufficient evidence and have said enough to convince every impartial thinker and earnest seeker after Truth that such repulsion is proven to exist beyond gainsaying. The question is now submitted for decision. "If I tell you not the truth, believe me not."

But much more has been proven than merely repulsion between dissimilar barometers, and attraction between similar ones. It has been proven that the repulsive action between

a high and a low barometer emanates from the same principle that causes repulsion between two paralled currents of Electricity flowing in opposite directions. It likewise has been proven that the attraction between two similar barometers takes place upon the same principle as the attraction between two parallel currents of Electricity flowing the same direction. It hence is seen that high and low barometers are governed or controlled by the same laws that electric currents are; in other words, they are governed by electric laws, and therefore must be electric phenomena.

Since the high and the low barometer are electric, and cause all other phenomena of the Atmosphere, therefore all atmospheric phenomena are electric also.

CHAPTER X.

HIGH AND LOW BAROMETERS THE CAUSE OF ALL ATMOSPHERIC PHENOMENA.

Elaborate as has been the discussion of the nature and character of high and low barometers, the subject has by no means been exhausted. In fact only enough has been said to make the subject intelligible, not only so far as they are directly concerned, but for the purpose of understanding how other phenomena stand related to them, because they underlie all other atmospheric phenomena, being the immediate causes of them. It is impossible for us to understand effects unless we understand beforehand the causes of the effects. Furthermore, we must know the laws that govern the causes, and the modes by which the causes act. High and low bar-

ometers are, however, only the proximate, not the ultimate, cause of other atmospheric phenomena. They are themselves effects of a more remote cause. They are mere organisms by which and through which the ulterior cause performs its functions.

It is Electricity that is the ulterior cause of the high and low barometers, and mediately through them the cause of all other meteorological phenomena. But what Electricity is, can never be ascertained directly. We only know that it is one of the forms of Physical Energy or Force, and that Force itself in all its forms is an invariable, immaterial entity. Hence, Electricity or any other Force can only be known through its manifestation in Matter. We know it by the behavior of Matter under its influence. "The invisible things of the World are clearly seen by the things that are made." In the phenomena manifested by Matter, we study the causes that influence its behavior; we ascertain the different modes by which a cause acts; and determine the laws which the cause sacredly observes in all its modes of action.

Through phenomena we attain a knowledge of the Unseen and the Invisible. It is through them that we apprehend the principles of the structure of the Universe, and become acquainted with the causes that constitute it a moving, living organism. It is by means of closely observing atmospheric phenomena, and by carefully collating, comparing and studying facts that we attain to a correct and clear idea of the form, nature and character of the high and low barometer. It is by careful examination and scrutiny of their form, nature and laws, that we ascertain their vital and essential functions in the Economy of Nature. All this is necessary and indispensible work that has to be done to qualify us to undertake the examination and explanation of any atmospheric phenomenon whatever, even of the most simple kind.

High and low barometers form a nucleus around which the facts that constitute the Science of Meteorology cluster and crystalize. This is the reason why we have given them such prominence in this discussion, and have devoted so much time to their elucidation. The advanced, elevated, and therefore advantageous standpoint, the reader has been enabled to attain by this discussion, from which to take an enlarged and comprehensive view of meteorological facts and phenomena, is full compensation for the time and labor expended in its attainment.

This will become more and more apparent as the investigation and discussion progresses. The student, however, cannot fully appreciate it, until he sees a long array of facts that had appeared heterogeneous and discordant, fall into line at their proper places, and constitute a complete, harmonious and symmetrical system, as beautiful as it is wonderful and sublime.

It has already been repeatedly stated that the high barometer and the low barometer stand towards other atmospheric phenomena in the relation of cause to effect; they being the cause, the effect the phenomenon.

An effect always partakes of all the essential qualities of its cause. High and low barometers, we have said, cause all other atmospheric phenomena. This is a proposition that requires to be proven before it is entitled to demand acceptance. Winds are atmospheric phenomena; hence, if the proposition be true, winds must be caused by the high and low barometers.

CHAPTER XI.

THE CAUSE OF THE WINDS.

We have stated that an effect partakes of all the essential properties of its cause. At the proper place we showed that high barometers and likewise low barometers differed from each other as to the time of their duration. According to this difference, we have classified them into constant, periodical and temporary high and low barometers. Now, if they cause winds, then the winds so caused must partake of this distinct quality of their causes, and likwise must be constant where the cause is constant; and periodical where periodical causes prevail, and temporary where the cause is temporary. We find on both sides of the Equator that constant high barometers cover the oceans along the Tropics. We also ascertain, from examining Charts Nos. I and II, that constant low barometers cover the Equatorial belt on both oceans. We likewise see that constant low barometers cover each terrestrial pole. If high and low barometers cause winds, here are physical conditions that must cause constant winds.

We have described the high barometer as a disgorging vortex, that pours the air down upon the surface of the Earth; and the low barometer we have described as an engorging vortex, that sucks the surface air in and pours it up towards the Zenith. Since we have proven this view of the high and low barometers to be true, therefore the air must flow from the disgorging vortex to the engorging one. The disgorging vortex whirls in such a manner that in the Northern Hemisphere the outflowing air describes curves from left to right; and the whirl of the engorging vortex in the same hemisphere, is such that air flowing into it describes curves from right to left. Consequently, the wind between the dis-

gorging vortex along the Tropic of Cancer and the equatorial engorging vortex, must blow from the Northeast. Since these high and low barometers are constant, the winds that they cause must be constant also. What are the facts?

Ever since the oceans have been navigated, it has been known that between the calm along the Tropic of Cancer on both the Atlantic and the Pacific, and the Equatorial calm, a constant northeast wind is blowing. It has hence received the name of the Northeast Trade Wind. It is also seen that the Northeast Trade Wind is the passage of the outflowing air from the mouth of the disgorging vortex to that of the engorging one; and that it is constant because the phenomena causing it are constant.

By reference to the Charts it is seen that a high barometer with its characteristic central calm covers both oceans near the Tropic of Capricorn, flanking the Equatorial calm on the South, as that of the Tropic of Cancer does on the North. Attention has been called to the fact while pointing out the cause for it, that the electric spiral of the Southern Hemisphere is left-handed; that is, coiled in the same direction as would be the prong of a left-handed corkscrew. Hence, the air poured down by a Southern high barometer flows out in curves from right to left; and consequently the air flowing into and up that spiral, describes curves from left to right, that is, in the same direction the hands of a watch move.

The disgorging vortices in the Southern Hemisphere are located on both Oceans near the Tropic of Capricorn. The outflowing air describes curves from right to left, or contrary to the movements of the hands of a watch. Hence the outflowing winds on the North and Northeast side of these areas of constant high barometer flow towards the Equator from Southeast into the area of constant low barometer along the Equator. The inference therefore is that between the

calm of the Tropic of Capricorn and the Equatorial calm there is a constant S. E. wind. What are the facts?

It has been known ever since ships crossed the Equator the first time, that a constant Southeast wind blows between the Equatorial calm and the calm of the Tropic of Capricorn. This wind has been named by the merchantmen the Southeast Trade Wind, under which name it is mentioned in physical geographies, and known by that name the World over. If we look for the cause of this wind we find it to be the outflow of a constant high barometer, and the inflow of the constant low barometer along the Equator*.

Since the outflowing air in the Northern Hemisphere, describes curves from left to right, therefore on both the Atlantic and Pacific Oceans, north of the area of calm in the centre of the constant high barometers covering those oceans along the Tropic of Cancer a constant Southwest Wind must prevail. This is found actually to be the case, for such a wind does prevail and it has been called the Southwest Passage Wind, but is generally mentioned in books as the Return Trade Wind.

Similar reasoning applies to the oceans South of the Tropic of Capricorn on the polar side of the areas of calm; and there also a constant wind is found to blow from the Northwest. This is the Northwest passage, or Return Trade Wind of the books. These winds in both hemispheres describe, what in Navigation is called a loxodromic curve, and, unless they flow into and feed a passing temporary low barometer on their polar flank, they pour themselves into the low barometer that constantly surrounds the Pole in their hemisphere.

* The low barometer along the Equator is not properly a vortex. The winds moving in the northern and in the southern curve meet each other from opposite directions; hence by arresting each other, produce the Equatorial calm. That it is not a vortex, is proven by the fact that no rotary storm—Cyclone—has ever been known to cross the Equator, or to exist upon it.

In the Northern Hemisphere the loxodromic curve is from right to left, in the Southern Hemisphere from left to right.

It is hence evident that the proposition that winds are caused by high and low barometers, is true as far as the Trade Winds, the only constant winds on the face of the Earth, are concerned. The following facts, that are undeniable, show it to be true:

(1.) The Northeast Trade Wind blows from the Equatorial side of the calm under the Tropical constant high barometer in the Northern Hemisphere, into the constant Equatorial low barometer.

(2.) On the other side of the Equator, the Southeast Trade Wind blows from the Equatorial side of the calm under the Tropical constant high barometer in the Southern Hemisphere, into the Equatorial low barometer.

(3.) From the polar side of the Tropical calm in the Northern Hemisphere, a southwest—the so-called return trade wind—issues, that blows into the constant low barometer surrounding the North Pole, and

(4.) On the polar side of the Tropical calm in the Southern Hemisphere, issues a northwest wind, misscalled return trade wind, which blows in curves into the area of constant low barometer around the South Pole. Since these winds blow invariably from areas of high barometer, the conclusion is unavoidable that the high and low barometers stand towards these winds in the relation of cause to effect. The winds in fact are merely outflows from the disgorging vortex, and inflows of the engorging one. The fact that the Trade Winds cease or disappear near the continents, where the high and low barometers also disappear, is cumulative evidence of the truth of the proposition that high and low barometers are the cause, and the winds are the effect. Not a solitary fact can be cited that contravenes this proposition.

We inferred that if winds were caused by high and low

barometers, that constant winds must prevail over the entire section of the Earth's surface under the influence of constant high and constant low barometers. Having found this inference to be true by examining the facts, we hence draw another inference, namely: that periodical winds must prevail in all regions where there are periodical high and periodical low barometers, flowing from the area covered by the high into the area covered by the low barometer.

By reference to Chart I it will be perceived that during the months of the Northern Summer, and consequently Southern Winter, that is, from the 1st of April to the 1st of October, an average low barometer prevails in Central Asia, and that an average high barometer during the same period covers Southern Africa. We hence infer that during this period a steady southwest wind blows over the Indian Ocean and Southern Asia. What are the facts? Our Physical Geographies tell us, and all authorities concur, that from the 1st of April to the 1st of October, for six months, the Southwest Monsoon blows from South Africa over the Indian Ocean upon Southern Asia. It is hence evident that the mysterious Southwest Monsoon is the outflow of the high barometer in South Africa, whence it comes, and the inflow of a low one in Central Asia, whither it goes.

By examination of Chart II, it will be seen that on the 1st of October a change takes place. The high barometer in South Africa lifts, and a low barometer takes its place. The low barometer in Central Asia also lifts, and a high barometer takes its place. The conditions are now reversed, and remain so during the next six months. We hence infer that since the conditions are reversed, the phenomena are reversed also; and that during this period a northeast wind blows from Central Asia over the Indian Ocean and upon South Africa.

We again ask, do the facts verify this inference? All au-

thorities are direct and pointed in their testimony, that for six months from the 1st of October to the 1st of April, the Northeast Monsoon blows from Central Asia, over the Indian Ocean into South Africa. The facts are precisely what we anticipated. The high and the low barometers, having exchanged positions, we inferred that the Monsoons had reversed their direction also. The general proposition that winds are caused by high and low barometers, is again verified; and likewise the special inference that periodical high and low barometers cause periodical winds. The testimony of the Monsoons is direct and unequivocal upon this point.

The same proposition would receive additional confirmation by examining the physical conditions prevailing at the localities at the time when the Harmattan, the Etesian Wind, the Pampero and other periodical winds prevail. But it is unnecessary to do so. Those who are either incredulous as to the theory, or curious to know what the facts are, will find upon examination that these winds, like the Monsoons, without any exception, invariably blow from periodical high barometers into periodical low barometers.

There remain for discussion only temporary or variable winds. Since they are temporary and variable, Are they caused by temporary high and temporary low barometers changing localities constantly in their transition across the Land and Sea?

We have already stated that there are high and low barometers which are not shown and could not be shown on Charts I and II, because these charts only show average facts, whereas, to show temporary high and temporary low barometers required charts that would show *actual* facts, with their constantly changing aspects.

The reader can form a clear idea of the varying aspects of temporary high and low barometers, as regards change of locality, and consequently of the necessary shifting of the wind to

conform to the change in locality, by inspecting the track of high barometer No. IV, on map No. 2, from 26th of August, second observation, to the second observation on 27th; and the localities of storm centre No. 9, at the same dates and observations. The wind on the north side of the locality of the storm was on the 26th somewhat east of north. At the time of the first observation on the 27th it was northeast, because the wind in the Northern Hemisphere always blows about 20° to the right from the storm centre. At the second observation, the respective localities of the centres were such that the wind between them was nearly due east.

Again, if we look at the position of the centre of the high barometer at the third observation on the 29th, and the supposed position—because it had passed beyond observation—of the storm centre at the same time, we see that the wind in the rear of the storm centre must then have been from the southwest. If we examine the devious track of the high barometer from midnight of the 27th to midnight of the 29th, and the supposed position of the storm centre after midnight of the 27th, we perceive that the wind must have veered —on the left side of the storm centre—during this time from northeast by way of north to the southwest. The reader, after examining the changes of relative position of the centres of high and low barometer from the 26th to the 29th of the month of August, 1873, as shown on the map, can have no difficulty in conceiving how the wind between two points must have shifted to conform to the changed positions of these two centres. On the 26th, the centre of the high barometer was North, then Northeast, back to North, then West, and finally Southwest, on 29th, of the storm centre.

Before proceeding to the discussion of the variable or temporary winds, a few preliminary remarks are necessary, respecting the origin of the temporary high and low barometers that make their appearance on the west coast of all continents

and traverse them from West to East. In America, it takes on an average four days for them to make the transit.

The Aleutian constant low barometer occupies within limits, the relative position towards the American Continent, that the Icelandic low barometer does towards the European. As might be anticipated, the action of both towards their respective continents are similar. Both of them have regular variations in their intensity, which correspond to the ebbs and flows of electric intensity in the Earth and Atmosphere. Under an ebb their energy diminishes and the areas covered by them contract. Under a flow their energy increases, and the areas they cover enlarges correspondingly.

So far only, however, are their actions precisely similar. Beyond this, when they are closely scrutinized, a marked difference is detected. Under an increase of energy and superficial expansion, the area covered by each elongates in the direction of the continent. At all seasons of the year, the elongation eastward of the Icelandic low barometer breaks up into nucleii which are fully organized storm centres. They arrive upon the continent of Europe as such, and pass over it towards the East. Their energy is however, vastly increased as soon as they are fairly upon the Continent. On the contrary, the Aleutian low barometer only during Winter sends forth fully organized storm centres which strike the Continent as rainstorms from Alaska to California. During Summer it generally only sends forth nucleii of atmospheric depression, which only form into storm centres after their arrival.

In Summer nearly all the storm centres that water the Mississippi Valley and the Atlantic Slope, originate in the Northern Andes, or Rocky Mountains as the eastern chain of the Northern Andes are called. They form from the incipient centres of depression thrown off by the Aleutian constant low barometer. The central point from which these storm

centres emanate is in the mountain system of Northwestern Montana and the western part of the British province of Manitoba. Since Naturally low atmospheric pressure prevails over all mountain chains, hence many storm centres are formed in the Rocky Mountains of Colorado, New Mexico, and even in the Cordilleras, Old Mexico. These all sweep across the North American Continent and in their departure on their way to the Icelandic low barometer, pass over the great highway of storms between the centre of the Gulf Stream and the Southern point of Labrador. Those coming from the Gulf are very apt to be retarded by a transitory high barometer in their front on this highway.

We have stated heretofore that the high and low barometer are as much an inseparable electric couple as are the two poles of a magnet. Hence whenever a low barometer makes its appearance, simultaneously its complement, the high barometer, also appears; and *vice versa*. One induces the other, in accordance with the electric law, "in whatever direction an electric current flows, it induces a parallel current flowing in the opposite direction". But since two low barometers are two parallel currents of Electricity flowing in the same direction; hence according to Ampere's second law, already stated, they attract each other. There being a constant low barometer over each pole of the Earth, every temporary low barometer as soon as formed, therefore would plunge into the polar low barometer, unless a high barometer be on its polar flank between it and the polar low barometer.

Hence it will invariably be found, that when a low barometer induces its complimentary high barometer, the latter appears on the polar flank of the low barometer; and whenever a high barometer induces its complementary low barometer, the latter appears on the Equatorial flank of the high barometer. Were it otherwise the low barometer, with its

canopy of clouds that distil the rain, would rush along the meridian into the polar low barometer.

Hence every storm centre has its feeder—its complimentary high barometer—on its polar flank to repel it, which prevents it from passing into the polar low barometer, until it has performed its mission in watering the Land by traversing the Continent, until it has reached its goal, the Ocean, when it is free. If it have traversed the American Continent, it plunges into the Icelandic low barometer. But if Asia, it plunges into the Aleutian low barometer.

Besides the complementary high barometer, the transitory low barometer has its main feeder on its front over the Ocean that it is approaching. In America, this is the constant high barometer covering the Atlantic north of the Tropic of Cancer; and in Asia, the constant subtropical high berometer that covers the North Pacific. These exert likewise a repulsive influence upon the storm centre, delay it on its march across the Continent, and give it time to perform its work more effectually than it otherwise would. Besides these, there are the feeders on the Oceans to the West, which assist in propelling it by a shove in the rear against the influence in its front.

Rainy spells are not caused by a single low barometer, that is, by the movement of the main storm centre across the Continent, but all such low barometers are broken up into a series of storm centres that follow each other regularly in succession for several days across the Continent. Each of these is accompanied by a high barometer on its polar flank. Such attendant high barometer unites with those that preceded it, and have halted to enable the storm centres to swing around them Northeastward to Iceland. Therefore the area, to the Northward of the tracks of the storm centres, covered by a high barometer, daily enlarges by successive accretions from attractive absorption of the series of high

barometors accompanying each minor storm centre. As it enlarges, it forces the rains from day to day farther South, until the whole Continent is watered, and the series of storm centres exhausted. This area of high barometer under the influence of the attraction of the Sargasso Sea high barometer, moves in the normal direction Southeastward until it unites with the latter, and is absorbed by it. In its Southeast course, it often heads off the low barometer and forces it to retreat and swing around by way of the Northwest, instead Southeast.

Surveying the entire field, we ascertain how varied and complicated are the movements of the temporary high and low barometers, and how their respective localities are constantly changing. Hence, if they are the cause of temporary winds, we infer these winds must be very inconstant and changeable in the direction they flow. The centre of the low barometer is the converging point of all the currents of air that flow into it. The isobars drawn around the centre show that its usual form is elliptical. The centre being the lowest point, the air flows on all sides across these isobars into the centre. It is, therefore, merely a question of fact whether the air does flow into this central area or not. The U. S. Signal Service publish tri-daily maps of their observations over nearly the whole continent. On these maps will be seen the barometrical readings at each station at the time the observations are made; the force and the direction of the wind, and isobars drawn around the localities where the highest and lowest readings of the barometer were at the time. These maps must hence decide the question of fact at issue, namely, whether the wind on all sides does blow into an area of low barometer. They show that such invariably is the case. We must therefore accept it as an undeniable fact.

But whence do the winds come? If we take their back trail and follow it up to their source, we find they issue from

an area of calm in the centre of a high barometer. If we now examine these Signal Service maps, we find that the winds on all sides blow out across the isobars that enclose the highest barometrical readings. Now, since the winds invariably are found to come from the centre of a high and go to the centre of a low barometer, the deduction is unavoidable that they are the cause of the winds.

A continent, however, is never large enough to show the centres of all high barometers that pour their tribute of air into the engorging vortex of a low barometer. If we trace the winds back in the direction whence they come, we find as distance from the centre of a low barometer increases, so do the readings of the borometer become higher. If we reach the margin of the map, before we find the source of the wind, then we know the high barometer that supplies the current of air, is located in territory not shown on the map. Likewise, the high barometer on a continent supplies air to engorging vortices located in territory not shown on the map. In that case, we find the outflowing air diverging from the centre towards all points of the compass. But we are just as much assured that these currents of air flow into engulfing vortices, as we are when we see the headwaters of a river that they flow to the Ocean.

With this statement of facts, and the inferences deduced from them, I leave the question whether the Winds are caused by high and low barometers, to be decided by the unperverted judgment and common sense of the public generally. If the facts are as I have stated them to be, then it requires very little mental acumen, and no time for reflection, nor for a second thought, to arrive at a satisfactory conclusion. If I have not stated the facts truly, then, since the records are open and accessible to all, let me be exposed by showing the falsity of my statements. It is a mere question of plain, palpable facts; and the sources from which I claim

to have drawn them are in almost every neighborhood in the land. If I have falsified the records, let it be shown wherein I have done so. But, as long as it is not shown that I have done so, I shall insist that my statement is a faithful transcript of the record, and that the deductions I have drawn from the facts, must be accepted as a demonstrated Truth, namely, that all winds are the outflows of areas of high barometer, and inflows into areas of low barometer. Let a solitary wind be shown that ever has occured or that ever will occur, where it was not and is not an outflow of air from a disgorging vortex, and inflowing air into an engorging one, and then I will admit, but not till then, that there is a solitary exception to the statement that high and low barometers stand towards wind in the relation of cause towards effects, they being the causes and the winds the normal effects of these causes.

CHAPTER XII.

THE CAUSE OF CLOUDS AND RAIN.

I have announced the postulate that high and low barometers are the cause of all atmospheric phenomena. I claim to have demonstrated conclusively that this postulate is true to the fullest extent as far as regards the winds. But winds are only a part of atmospheric phenomena. There are other phenomena that are far more imposing and no less constantly obtruding themselves upon our attention than the winds. These are clouds, rain, hail, snow, whirlwinds, tornadoes, hurricanes and waterspouts.

Daily wherever we may be, these omnipresent phenomena in one shape or other obtrude themselves upon our attention. Like the ancient Sphinx, they are constantly propounding riddles to us, and challenge their solution. They demand of us to explain the causes for their occurrence, and to give the laws that control their behavior. They ask us to give a reason for the great variety of their forms and aspects, and for the vast variation in their energy. They request us to tell the length of their period, so that the time may be foreknown, and consequently foretold when they will reappear. They exact of us to foretell what will be their distinctive character at the next and at each recurring period: whether they will be mild or severe; gentle or violent, so that it may be known when it is necessary to excercise prudence, and what degree of caution is to be observed.

Since we cannot answer these questions, they like the ancient Sphinx devour us; for "the people" now as in the days of the prophet "perish for want of knowledge". That "crude mass of incongruities" miscalled Meteorology affords no Light whatever, but darkness rather. Scholastics, its reputed highpriests, are silent and "dumb dogs that cannot bark". They are likewise blind; and "when the blind lead the blind, both fall into the ditch".

There is but one book that is authority upon Meteorology, and that is the *Book of Nature*. The whole Science in all its amplitude, length, breadth and depth is recorded in this Book; engraven in facts, illustrated and written all over in characters of living Light. But this Book is never read now, except through the distorting glasses of worthless treatises, composed of visionary theories and wild speculations, theories not only without a physical basis, but in contravention and defiance of known facts.

The Atmosphere has a depth of at least sixty miles. The high barometer we have demonstrated to be a downpour of

air from the surface of the Atmosphere upon the surface of the Earth. Air coming from so great an elevation must be destitute of vapor; having, in its ascension, parted with it in the region of the clouds. Hence the high barometer is always under a clear or clearing sky. The great elevation whence it comes is the reason why the air poured down in Summer is always cool and refreshing, and why in Winter it is deadly cold, especially when the high barometer comes from the Polar Circle, for then its supply of air is furnished by the upheaving vortex over the Pole.

The air on the surface of the Atmosphere being for some time in contact with outer Space—which is intensely Positive—becomes by contact likewise intensely Positive, and hence is repelled by Space down to the Negative on the surface of the Earth, whither it is also attracted. Conversely, the air for some time in contact with the surface of the Earth becomes intensely Negative, and hence is repelled up to the Positive in Space whither it is likewise attracted. But if it were possible to consider these movements separate and apart from electric attraction and repulsion, all our observation, experience in analogous matters, and common sense teach us that air a long time in contact with Space must become avidious to kiss the Earth; and likewise the air for a long time in contact with the surface of the Earth equally as avidious to kiss the Sky. There can be no doubt whatever of this reciprocal action between the Earth and Space, in fact between all bodies whether Suns or planets, however widely distributed in Space.

> "Each are but parts of a stupendous Whole,
> Whose body Nature is, and God the Soul."

The Universe is a living, moving, and not a dead, inert Organism.

There are many analogies between the circulation of the air and the circulation of the blood. At some points in its

course, the blood is perpetually renewing, while at other points it is perpetually becoming vitiated in the performance of its function of repairing wastes, removing effete Matter and keeping the animal organism in a sound and healthy condition. When its capability to serve the animal economy has become exhausted, it returns to the heart for reinvigoration, and to the lungs for revitalization. Its eternal round, therefore, is not an indifferent and aimless action, but a necessary and indispensible work. So it is with the air. When it has become contaminated by too long contact with the Earth, and vitiated by vegetable and animal respiration, and hence deprived of its vitalizing qualities, it rushes into the vortex of the low barometer, and is carried up by it to the surface of the Atmosphere, where it is renewed by being reinvigorated and revitalized by contact with outer Space. It then rushes into the vortex of a high barometer, and by it is poured down upon the surface of the Ocean, where it takes upon its wings the refreshing vapor wherewith to moisten and cool the parched lips of teeming continents. When it has become exhausted in the discharge of its beneficent mission to the Earth, it is relieved and retranslated to the Sky for refreshment and recuperation. It thus travels an eternal, endless circuit. The high and the low barometers are the physical organisms by and through which this perpetual motion is initiated and effected.

We know that all vital functions are performed, in fact all the phenomena of life, are caused by the circulation of the blood. Since we have no doubt about it, we never ask the question, whether this or that phenomenon manifested in the living organism, be caused by some other agency than by the circulation of the blood.

When we see that the circulation of the air is analogous to that of the blood, why should we have any doubt or ask the question whether the high and low barometer—the organ-

isms that keep the whole Atmosphere in perpetual motion—are the causes of all phenomena that make their appearance on the Atmosphere?

But though analogies and deductions drawn from them, may furnish strong and in every respect corroborating evidence, they are nevertheless not conclusive proof that the high and the low barometer—the primary phenomena which control the Atmosphere as a whole, must control all its parts. Likewise, it does not follow that though the proof is positive and so overwhelmingly direct as to be irresistible, that if they are the cause of winds they must also be the cause of clouds, rain, hail, snow, and all the various forms of Cyclones. If the high and the low barometer are the cause of all these, then facts must exist that prove this to be the case so clearly that it cannot be gainsayed. What are the facts?

We will have to pursue the same method and argument in tracing the clouds, rain and cyclone to the high and low barometer, that we did when we were examining and discussing the causes of the Wind. We hence will re-enunciate the same proposition in form, only changed as to the subject matter, as we did at the commencement of the investigation of the cause of the winds, namely: If clouds and rain* are caused by high and low barometers, then constant high and constant low barometers must, where they prevail, cause constant cloudiness and constant rains; periodical high and low barometers must cause periodical cloudiness and rains during their prevalence, etc.

We ascertain, by examining Charts I and II, that along the Equator on both the Atlantic and Pacific Oceans, there is a constant low barometer; and that these equatorial areas of

* In the present volume, we shall only discuss cloud formation, and the precipitation of rain from the clouds. The cause of rain, of hail, of Cyclones, and of Dew, will be fully discussed in the Sequel.

low barometer, are flanked on both the right and left by areas of constant high barometers, the one on the north side is located along the Tropic of Cancer, and the one on the south side along the Tropic of Capricorn.

Since for reasons heretofore assigned, it is desiccated air that is poured down through the vortex of the high barometer, there is always a clear or clearing Sky under the high barometer; therefore on the Ocean along both Tropics and in the region of the Trade Winds, a generally serene and cloudless Sky must prevail. Again, since the low barometer is the recipient of all the vapor gathered by the wind on its way over the Sea and the Land; therefore cloud formation must be constantly going on over the Equator, and consequently the Equatorial belt must be the belt of constant precipitation. What are the facts?

The reader must bear in mind that neither the centre of the Tropical high nor that of the Equatorial low barometer is rigidly and absolutely fixed. Both are affected by the movements of the Sun. During the Northern Summer, the centre of the Equatorial low barometer—as indicated by the calm—follows the Sun to 10° or 12° of North Latitude, then covering the greater part of the Carribean Sea, the north coast of South America, and the Isthmus of Panama. It is during this time that the rainy season prevails there. The Sun, in his Northward march during the same time, pushes the North Atlantic high barometer—whose average centre is at about 30° North Latitude, nearer to the Pole; and in Winter drags it nearer to the Equator. Besides these movements, this high barometer oscillates from East to West, and *vice versa*, probably swings around an ellipse, so that when on its extreme Eastern oscillation, it covers North Africa beyond the Nile, and when on its extreme Western swing, the Continent of North America to the Cordilleras of Mexico. In fact the subtropical high barometer on the North

Atlantic and North Pacific, meet and shake hands across the continents. While one swings East, the other at the same time swings West. When the exact periodicity of these oscillations is once established by observation, we shall be able to foretell with tolerable accuracy the time when Typhoons are likely to make their appearance upon the Asiatic coast, and the West India hurricane upon the Gulf or Southeast coast of North America.

It is plain that the Region of the Trade Winds will be affected by these changes of locality in the high barometer, widening and narrowing so as to conform to the central position of the high barometer. When the observations upon the Trade Winds are averaged 30° 45′ is the polar limit of the Northeast Trade Wind in Summer, and 24° 45′ in Winter. But the average physical facts of any section of the Earth's surface, can give only the average or general meteorlogical phenomena of that section, and not its special, that is, it real phenomena. The reader must therefore bear in mind, that we are dealing only here with average physical facts of the Region of the Trade Winds and Equatorial calm, and therefore can only show their general not their special phenomena.

The high and low barometers likewise are merely averages for these localities. They are no doubt subject to many fluctuations in energy, and these fluctuations must bring with them corresponding modifications of phenomena. The word constant hence is not to be understood in the sense of uninterrupted, for it is not true that on any part of the Earth's surface there are invariable phenomena. For instance, in Physical geographies, the Equatorial belt of calm is marked as the Zone of constant precipitation, yet the facts correctly stated by Alexander Keith Johnston are: "But the rain does not fall, as is erroneously supposed, for continuous days without interruption; indeed a day of uninterrupted rain is more rare in tropical countries than in Europe. Notwith-

standing local causes, the phenomena succeed each other with great regularity. The Sun rises generally in a clear sky; clouds appear two hours before noon; and at noon the rain sets in, frequently pouring torrents for four or five hours; but at sunset the clouds quickly disappear; the rains cease, and not a drop falls during the night."*

Those who have sojourned in the Rocky Mountains will he struck with the accuracy that this extract describes the mountain phenomena. But this is not surprising when, as we will show in the Sequel, exactly similar physical conditions prevail at both localities.

Columbus on his voyage of discovery, found his ship driven westwardly by a gentle constant Northeast wind—the Northeast Trade Wind, till then unknown. His companions became alarmed at this circumstance, because they feared it would prevent their return to Europe. It was afterwards ascertained that there is so little labor and difficulty in sailing across the Ocean from East to West in the region of the Trade Winds, that the Spaniards named this section of the Atlantic *El Golfo de las Damas*—the Ladies' Gulf. All who have made a voyage along this region, speak in raptures and enthusiasm of the exhilirating northeast wind, and of the deep serenity and blueness of the cloudless skies. These conditions are precisely what we anticipated from the nature and character of a high barometer.

But as the ship approaches the Equatorial calm, squalls, accompanied by rain in showers, make their appearance, and increase in frequency as the distance from the Equator diminishes. Before the ship enters the calm, there looms up in the Southern Sky a dark bank of cloud, stretching along the horizon from West to East. These clouds, from their dark color, are called the "black marking pots", by the sailors. And daily under them torrential rains are falling for hours,

* *Vide* his Physical Atlas of Natural Phenomena.

accompanied by wind squalls and terrific electric explosions. When the rainfall occurs in a calm, so great is frequently the quantity, that the Ocean is covered to a depth of three inches with fresh water. Mr. Johnston says: "The quantity of rain that falls in the Equatorial belt in one month is greater than that during the whole year in Europe." In corroboration of this is the testimony of Commodore Wilkes, who, as commander of the Exploring Expedition, crossed this belt in the Summer of 1838. It was found to extend from 12° to 4° North Latitude. He was ten days in crossing it, and during the ten days the rainfall was 6.15 inches, or at the rate of 224.6 inches during the year.

The proposition to be verified was, that high and low barometers are the causes of clouds and rain. Our first inference was, that if the proposition be true, then constant high barometers that pour down upon the Earth desiccated air, must be under a constantly serene or cloudless Sky, and that constant low barometers, being the recipient of all the vapors gathered by the winds over land and Sea from the time the air is poured down until it is sucked in and engorged by its vortex, must be covered by a constant canopy of clouds, from which rain is constantly falling. The facts we have stated must be considered ample proof of the proposition so far as the constant high and low barometers are concerned.

The second inference we drew from the same premises was, that the proposition being taken for granted, periodical high and periodical low barometers must cause periodical seasons of drought under the former and a periodical cloudy and wet season under the latter.

To test the truth of this inference, there exist periodically the exact conditions required, alternately in Southern Asia and in South Africa.

It will be seen by an examination of Charts I and II, that

for six months, from the first of April till the first of October, a high barometer prevails over South Africa; and that during the same time, a low barometer prevails in Central Asia. We have already shown that these conditions cause the Southwest Monsoon, a moist wind blowing from over the Indian Ocean upon the Southern coast of Asia. Hence the inference that during these six months a generally clear sky and consequently a drought prevails in South Africa, and under the low barometer in Asia a cloudy and rainy season prevails during these six months.

It will also be observed that during the remaining six months of the year, a transposition of these high and low barometers has taken place. A high barometer now prevails over Central Asia and a low barometer in South Africa. We have already pointed out that these conditions cause the Northeast Monsoon, a moist wind that blows from the Indian Ocean upon the coast of South Africa. We hence infer that conditions being reversed, the phenomena will be reversed also. That a drought then prevails in Asia, and a rainy season in South Africa. Both inferences hence must be either proven, or disproven, as the case may be, by the actual facts as they are found to be in both Asia and South Africa at the designated periods.

First, as regards the facts when the Southwest Monsoon blows from the Indian Ocean upon Asia. The Western Ghauts lie almost at right angles across the track of the Southwest Monsoon. During the prevalence of this Monsoon, from April to October, the Western Ghauts are almost constantly enveloped in clouds and scarcely a day passes without a terrific storm raging upon the summits. It is during these six months that the enormous amount of rainfall of 305 inches and upward occurs upon these mountains, while at Bombay, at the base of the mountains, and upon the shore of the Arabian Sea, the quantity of rainfall during the same

time is only 80 inches*. The Eastern Ghauts, lying behind the Western, and longitudinally to the Southwest Monsoon, during these six months, receive only about 30 per cent. of their average annual rainfall. But the Yama Dong, in Assam, and other mountain chains in Farther India are, during this time visited with similar violent storms and torrential rains as those of the Western Ghauts. So are the Himalaya Chain North of the Bay of Bengal.

As to the character of the storms that visit the Himalayas, the following will serve as an example. The Hindos in midsummer make annual pilgrimages to religious shrines situated upon high peaks of these mountains. Upon the frontier of Tinnevelly, upon one of the Saduragiri is the Mahalingam, a shrine built to commemorate a manifestation of Siva. A circuitous path ten miles in length from the base of the mountain, leads along fearful chasms and deep mountain torrents to the shrine. The bed of a mountain torrent that skirts the shrine is used when dry as a camping ground. On Sunday, August 1, 1875†, thousands of pilgrims, men, women, and children were cooking, eating, singing and dancing and otherwise amusing themselves in this dry, sandy ravine. At 5 p. m., suddenly a black cloud accompanied with total darkness struck the mountain, and a tremendous rain fell. In ten minutes the hitherto dry ravine was filled by a wave of water rushing headlong into it, carrying with irresistible force everything in its way—men, women, children, cattle and fowls that had been brought to be sacrificed—indiscriminately to destruction.

Total darkness rendered the confusion more terrible. Only

* The cause of this discrepancy will be given in the Sequel.

† As evidence that meteorological disturbances are synchronous over the whole Globe, it will be remembered that on this very day, those torrential rains fell that caused such disastrous floods in the States of Missouri. Iowa, Illinois, Indiana, Kentucky, Ohio, and West Virginia.

a few of the ill-fated group saved themselves by catching hold of the boughs of trees*.

Phenomena such as these prevail under the periodical low barometer, during the six months that it covers the Continent of Asia.

On the 1st of October, a transposition of the high and low barometers takes place, which continues for six months, that is, until the 1st of April. The Charts show that the Southern point of Asia, however, remains in the edge of the low barometer. The Asiatic high barometer being under the control of the North Magnetic pole of the Earth, pours out its air in curves from left to right. Consequently, a Northeast wind, the Northeast Monsoon, then prevails. Sweeping over the Bay of Bengal, the Northeast Monsoon now strikes the Eastern Ghauts as a moist wind; and during its prevalence, seventy per cent. of the annual rainfall on those mountains takes place.

The Eastern Ghauts, however, are far more avaricious in harvesting the rain, than are the Western. They take all, not even leaving gleanings, for during these six months of the prevalence of the Northeast Monsoon, not a drop of rain falls upon the Western Ghauts, but an uninterruptedly serene and cloudless sky prevails. The phenomena of a rainy season on one side of a mountain chain, and a drought on the other, are meteorological facts that are general throughout the Globe; and disclose a cause, and a higher law than scholastic meteorologists have ever dreamed of. In the Sequel the cause of these phenomena will be pointed out, and the law demonstrated.

The periodical low barometer from the first of October to the first of April is located centrally in South Africa, near 10° South Latitude, in the mountain system where the Or-

* This phenomena is identical with that called in the Rocky Mountains "cloud-bursts", the causes of which will be explained in the Sequel.

ange, Congo, Zambezi and the Nile have their sources. Dr. Livingstone, who spent years and finally laid down his life, in exploring this part of the African Continent, speaks of the frequent enormous rainfalls in this region during the months of December, January and February. The concurrent testimony of all authorities is, that it is during these months South Africa and also Australia have their rainy seasons.

It has already been pointed out that the Equatorial belt of calm in America, during the Northern Summer covers the Isthmus of Darien—or Panama, as it is now generally called—the Northern coast of South America, and the Caribbean Sea. When the Sun declines towards the Tropic of Capricorn, this belt of low barometer with its calm area follows him, until at midsummer—of the Southern Hemisphere—its locality is at the headwaters of the Amazon, fully five degrees South of the Equator. The South Africa periodical low barometer is likewise connected with the constant low barometer along the Equator, following the Sun South in our Winter, and returning with him Northward in our Summer. It is during its march Northward in our Spring that the enormous rainfalls take place in Central Africa that flood the Nile and give fertility to the land of Egypt.

Charts I and II both show a low barometer over the Aleutian Islands and the Northwest Coast of America. Since one Chart shows the meteorological phenomena of one half of the year, and the other for the other half, therefore the two together show a low barometer in the same region for the entire year; hence a constant low barometer must prevail there. The inference therefore is, that cloudy weather must constantly prevail over those Islands and the Northwest Coast, and more or less constant precipitation must be taking place there. The observations of the Russians made at Sitka, while they possessed those Islands and Alaska, show that

the average number of days fair weather prevails, is only forty in a year.

When we examine the seasons of drought in India, South Africa, Australia, America, etc., we find everywhere that the droughts occur during the time those regions are covered by high barometers, whether they be constant, periodcal, or temporary. All that is necessary to be convinced, is to examine so as to ascertain what the facts are in each case. There cannot remain a lingering doubt in the mind of any one who will look at the facts calmly and dispassionately, that the relation of cause and effect subsists between the electric couple called for want of a better name, high and low barometer, and clouds and consequently rain. At least where constant high and constant low barometers exist, a constant serene sky is over the one, and constant cloudiness over the other, and constant precipitation under the cloudiness. Such is likewise the case with the periodical high and low barometers, alternating with each other: whenever they change, the seasons of drought and of rain alternate conformably to the change from high to low barometer, and *vice versa*.

Not only is this the case with the phenomena of drought and wetness themselves, but with their extremes. Excessive droughts always characterize continuous and more than ordinarily high barometers, and excessive and heavy rains the more than ordinarily low ones.

After what we have said, taking into consideration what is now generally known about high and low barometers and their phenomena, it is hardly necessary for us to proceed further and demonstrate the connection between temporary high barometers, and clear, cool and dry weather; nor to show the dependence of cloudy, warm, and rainy weather, upon a temporary low barometer. It would be far more interesting and instructive to demonstrate the causes of the various concomitant and peculiar phenomena that attend

each; that is, to show why clear, cool, and dry weather attend one, and cloudy, warm, and rainy weather attend the other. The limits we set to the discussion in this volume forbid this at present: hence it must be deferred to the future occasion, when we will discuss the special facts and phenomena of Meteorology.

But we cannot leave the point yet, without endeavoring to throw further light upon it, for the information and guidance of those who wish to inform themselves minutely on the subject discussed.

Man is from habit an empyric, and not from reflection a philosopher. The common-sense Man takes experience for his guide, and constantly revises his notions as experience enlarges. From these revised notions he draws inferences as to what will be the probable nature and character of the impending phenomena. The Scholastic takes for his guide average experience and observation reduced to a mathematical formula, which he never thinks of revising. From these formulas he precalculates the future. As he does not expect exactness, he is elated when there is the least semblance, but not even dissatisfied, much less disgusted, however widely the actual facts may, as they generally do, differ from the deduced theoretical facts. Both err in not founding their notions upon universal and immutable physical causes, of which phenomena are the normal and necessary sequences. Both use average facts; and an average fact is a fiction, such as Nature never has produced, and never will produce. Special and actual facts in all their integrity are what is wanted. Until we have them we can have no Science, the dictum of the theorist to the contrary, notwithstanding.

Though the cause of a change in the direction of the wind and of the temperature in the air, may not be generally known, yet the inhabitants of all countries predict a change in the weather corresponding with the actual facts that have

followed similar changes observed before. For example, the inhabitants of North America East of the Rocky Mountains predict when the wind sets in from the West or Northwest that it will become clear and cool, if in Summer, and if in Winter, very cold, from observing such changes before. Why? When the wind bursts from the West or Northwest, it is because a low barometer with its canopy of clouds, rain, or snow, has passed off to the Eastward and a high barometer is succeeding it, coming from the West or Northwest and pushing it off the Continent. This high barometer pours down from a great elevation dry air, hence no new clouds can form, and existing ones disappear The low temperature of the air thus poured down is owing to the great elevation whence it comes. The people hence know the fact that when a high barometer comes marching across the country from the Northwest, it brings with it clear and cold weather, although they may not know that there is such a phenomenon as a high barometer.

These same people when the wind changes to the South or Southeast, predict moderating, warm, and cloudy weather, with rain or snow according to the season. Why? Because experience and observation have taught them, that warmer, clouding and threatening weather, with rain or snow, follow closely upon the heels of a change of this character. But the cause of this change they do not know. They do not know that they have been under a high barometer whose centre while it was West of their locality overflowed them with a cold Northwest wind; that when they were under its centre, they experienced a calm, and that when the centre had passed East of them, the outflowing wind came from the East, and is pouring itself into the vortex of a low barometer approaching from the West which brings with it clouds and rain, its peculiar phenomena.

The common people therefore know the fact that a low barometer is accompanied with a rising temperature, clouding, threatening weather, and rain and snowfalls, although they may not know that there is such a phenomenon as a low barometer.

Let the caviler, and those, too, who have honest doubts about the correctness of the facts and principles herein set forth, examine the Tri-daily Weather Maps published by the Signal Service. On them they will find atmospheric pressure delineated by isobars drawn around the centres of both the high and the low barometers, the temperature of the air, the force and direction of the wind, at all the stations of observation, the aspects of the Sky, whether clear or cloudy, and the state of the weather, as fair or rainy. Let them compare the phenomena there indicated, with reference to the high and the low barometer; and if they find not the facts to bear overwhelming evidence of the correctness of my statement and of the truth of the theory I have advanced, then let them speak out and expose me. Otherwise let them forever hold their peace.

It is time that theories should harmonize with facts, and that scholastics should cease to say one thing, and Nature another. All who claim to be seekers after knowledge must forsake speculations, and free themselves from the trammels of the schools. They must see the gracefulness of plain, honest facts, be charmed by their simplicity, and beauty; and must, whatever obstacles interfere, woo, win and be wedded to them, in mind, soul and thought, and Truth will be the holy offspring of the happy union.

I have written this volume in the interest and love of Truth, with a view of promoting the welfare and happiness of mankind, by enlarging the boundaries of knowledge. If I have mistaken my powers, or overrated my capabilities and

qualifications as a teacher, I hope charity will accord to me honesty of purpose, and well-meant intention and commendable zeal to aid in the enlightenment of Mankind. I now leave the work to the candid scrutiny and impartial judgment of all earnest inquirers after Truth.