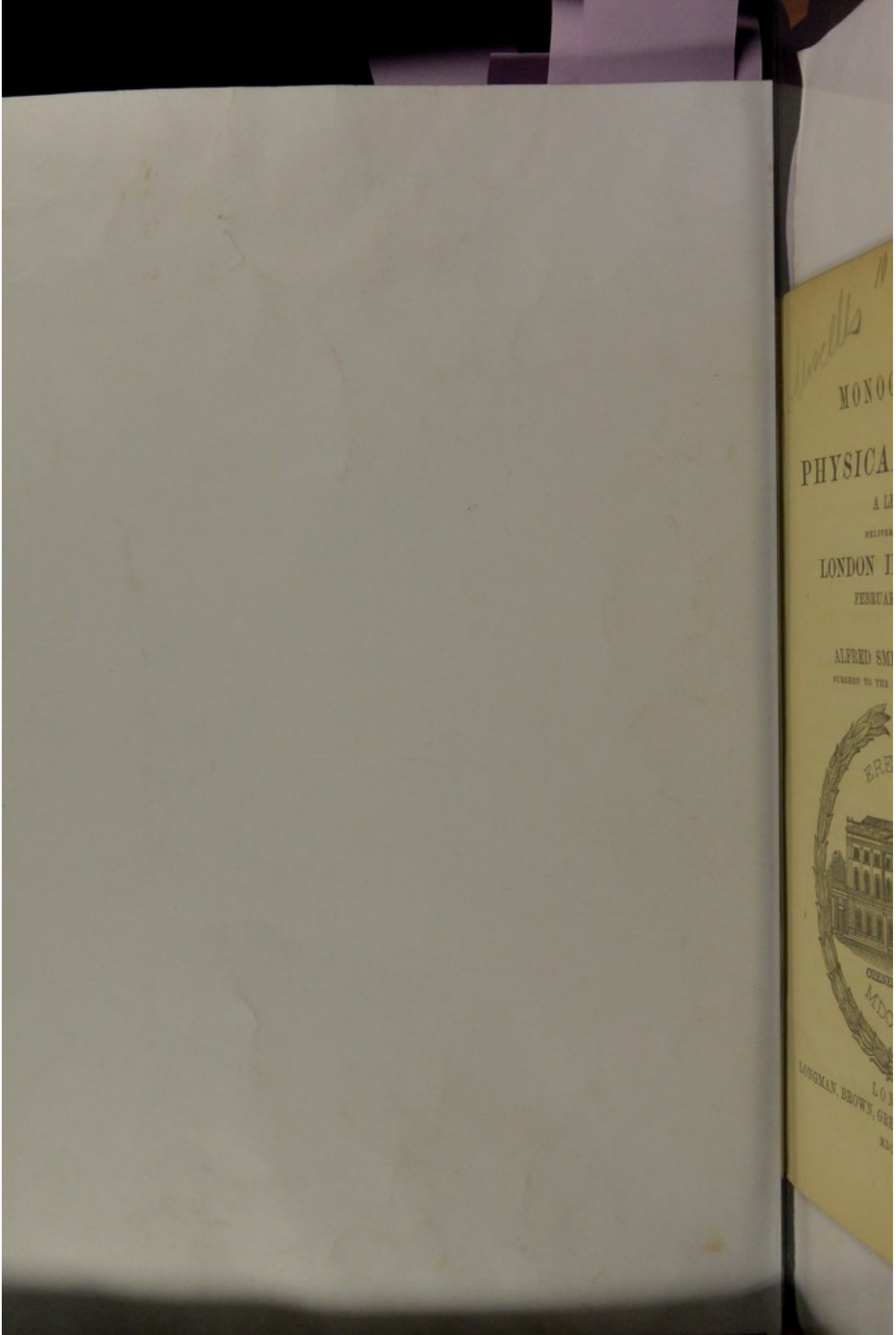
The monogenesis of physical forces : a lecture delivered at the London Institution, February 18th, 1857 / by Alfred Smee.



THE

MONOGENESIS

OF

PHYSICAL FORCES:

A LECTURE

DELIVERED AT THE

LONDON INSTITUTION,

FEBRUARY 18TH, 1857,

BY

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THE

MONOGENESIS OF PHYSICAL FORCES.

In our intercourse with nature and natural phenomena, we, each of us, according to the peculiarity of our minds, view the same phenomena in a somewhat different manner; some of us perceive more vividly by our organs of sensation, whilst others with less powers of perception store up facts more accurately. Some generalize simple facts into extensive laws, whilst it is permitted to a few to compare and bring into relation numerous generalizations at first sight apparently distinct. From this diversity in the powers of the human mind, I have always strongly felt that society is benefitted by each person unfolding the impressions which his own mind receives, as by that means all are made acquainted with the various aspects from which external nature may be viewed.

This evening it will be my endeavour to carry out the suggestion, that this year the soireé lectures should be undertaken by amateurs, and chiefly by the

Managers of your Institution. I have chosen for my theme, the "Production of Physical Forces," and this lecture will be a cursory glance of that view of natural phenomena which I published in the year 1843, in a work entitled "The Sources of Physical Science," and which constitutes one of that series of metaphysical works which I have made it the business of my life to develop from nature. Some of these views you have done me the honor on former occasions to allow me to unfold in this room, and from the kind manner you received those speculations, I venture to hope that you will neither be surprised nor offended in my submitting this view of nature, especially as I have myself practically applied it for a period of fourteen years in the ordinary transactions of life, and I trust not altogether without some advantage to the public.

We live in a material world, but we can neither make nor destroy matter. However many times matter may be combined or acted upon by other matter, it remains the same in amount, and even when it is so changed that it possesses no vestige of its former state, yet it is neither increased nor diminished.

When our great poet in his lofty flight says—

> "Imperious Cæsar dead and turned to clay,
> Might stop a hole to keep the wind away";

the change is not more wonderful than the daily transmutations in our manufactories, where offensive offal is converted into beautiful pigments for the dresses

of our fairest daughters, and noxious residues are changed into exquisite flavors for sweetmeats.

In every case in which we observe matter, we notice that it possesses a power whereby two portions are drawn together or mutually attracted. From this we deduce a law, "That whatever attracts is matter, and whatever cannot attract is not matter." To my mind, attraction is an inherent property of matter, which it has possessed as long as matter has existed, and will possess till matter ceases to exist, by the fiat of an Immaterial Power.

We know not how far matter is divisible, because we can readily separate it into particles far below what our senses can appreciate; nevertheless, it is convenient to assume that matter is divisible into definite particles which can no longer be divided, and hence called atoms. We know not, moreover, how many kinds of matter there are, or whether there is more than one kind. It by no means follows because we cannot decompose the so-called sixty elements that they are separate bodies. We must remember that it is possible, as every element has a different combining number, that each may be only a number of atoms attracted together so firmly as to resist our powers of separation. These considerations are entirely within the boundary of speculation, and not at present of fact; yet, this view meets all the known facts of the case, and when two theories, equally

expressing all the circumstances, are offered for our consideration, it is more consistent with natural science to choose that which involves the fewest hypothesis. One of the most subtle divisions of solid matter is to be found in the black pulverulent state of metals, such as employed for my form of battery. It has been supposed that all matter is black when extensively divided, because the particles are too small to reflect light; but the form of the black particles is unknown to us, because the highest powers of the microscope are insufficient to render them visible to the eye. At the last Bakerian lecture Professor Faraday made known methods for dividing gold to an extreme amount. He precipitates the metal from its solution by bi-sulphuret of carbon, and obtains a ruby-colored liquid, in which metallic gold is so minute that the particles are invisible by any microscopic power. This distinguished philosopher satisfied himself that the ruby glass owes its color, to gold in a metallic state in an infinite division, and by adding gelatine to the ruby solution he obtained a ruby jelly precisely similar.

Ultimate particles of matter are aggregated or attracted into masses, of which we may observe many varieties. Look at ice: how different is its appearance at different times; and in our electro-metallurgic deposits, where we build up our objects atom by atom, we obtain many very different kinds of aggregation.

The copper electrotype from which the Bank of England note is printed, is so excellent, that a portion I tried was found capable of being drawn into three-and-a-half miles of wire, whilst under certain circumstances, copper deposited breaks with a concoidal fracture with the greatest ease.

We are ignorant whether there is any difference in the mode of attraction between the ultimate particles of solid, fluid, and gaseous particles, but having regard to the entire range of physical knowledge, we may assume that the particles are most firmly attracted in the solid, and more in the fluid than the gaseous state as by different amounts of attraction we obtain the difference between the solid and gaseous states. I have speculated whether one atom might not by itself have boundless expanse, and fill the firmament—a limitation of extent being due to the attraction between two or more atoms of matter.

Masses of matter aggregated together still have the power of attracting each other into one uniform mass, by adhesion, as when two pieces of lead or glass are brought into contact they mutually adhere, and sometimes greatly to the manufacturer's discomfort.

Liquids and solids in contact have a power of mutual attraction, as in capillary attraction.

Gases and liquids have also this power of attraction, as in the case of muriatic acid gas and water.

I will now shew you a very beautiful experiment,

proving that attraction is existent between gases and solids. Some years ago I discovered that coke or charcoal might have so much hydrogen firmly attracted to it, that when plunged into solutions of gold, silver, or copper, an extensive deposition of metal takes place, and I have found that it would retain the gas for many days.

Attraction is also exerted between gaseous bodies, according to the law of diffusion so elegantly developed by Graham; and even carbonic acid (a very heavy gas) passes into the atmospheric air.

Lastly, liquids attract each other by a law very similar to that of the diffusion of gases.

Hitherto, we have considered the attraction of particles of matter in indefinite quantities, or of the attraction of masses already aggregated; but particles of two or more different kinds of matter may be attracted to produce a totally new substance, having none of the properties of former particles: thus chlorine and sodium form common salt; oxygen and hydrogen, water.

Attracted matter, either in masses or in the most attenuated particles, attracts other masses at any distance, and by this power of gravity everything in the universe is kept in position; to this power the sun, the moon, the earth, the stars in the firmament, and every substance in the world, owes its position.

In the cases of attraction already described the

power appears to be exercised promiscuously, but there are cases in which attraction is exerted in definite directions. Crystals are masses of attracted matter of this character, as their particles are attracted unequally in different directions. In consequence of this they yield to mechanical force in some directions, not in others; they expand unequally by heat, they are acted upon unequally by magnetism, and they have very curious properties in relation to light. Not only in crystalline bodies do we observe that attraction is exercised in definite direction, but we observe a direction in the power of attraction during the magnetic state. A bar of iron, when it suddenly assumes this state, appears to have its former attractions altered, for under favorable circumstances it will sound a distinct musical note. When a magnetic body attracts another body capable of assuming the magnetic state, the second substance also evinces a similar direction in the exercise of the power of attraction. From these views we deduce that the idea of magnetism is derived from certain kinds of matter, under certain circumstances, evincing the power of attraction in a definite direction.

We have considered the mode in which attraction acts to unite particles of matter, and thus construct the various objects of which the material universe is composed. Now let us pause to consider the earth at rest. The quiet which gives the loveliness to evening,

and soothes the mind after the business of the day, forms but a dim shadow of that awful quiet which would exist were attracted matter not capable of being acted upon, when there would be neither heat to cheer, light to gladden, sound to enliven, or motion to excite.

Nature, however, abhors quiet, and delights in action. In every case where attraction is exerted, it can be destroyed by a new attraction ; and thus, whilst attracted matter exhibits cohesion, composition, position, so a new attraction can cause disintegration, decomposition, and motion. Hence we deduce the law, "that a new attraction can destroy a former attraction."

For a study of the effect of a new attraction acting upon attracted matter, the voltaic battery stands forth pre-eminently as an instrument well calculated to exemplify the phenomenon. For a voltaic circuit it is essential to have a fluid-compound built up of two atoms only ; this compound is decomposed by any matter either in a solid, fluid, or gaseous state capable of setting up a powerful attraction between itself and one element of the compound : this is the positive pole. The second element is evolved at the negative pole, and the two points may be connected together by matter extending for miles and miles ; a fact on which depends the electric clock and telegraph. In a single battery there is but one point at which the new attraction is excited. In the compound battery there

are as many points as there are cells in the series. A single voltaic battery may act through a series of similar troughs, provided that in these secondary troughs the tendency to destroy the former attraction is nearly equal to the tendency to maintain it. I place before you an example, in which one battery is reducing gold, silver, copper, tin, lead, iron, zinc, in separate cells, having solutions of the positive poles of those metals. In this case, one grain of zinc in the battery reduces $6\frac{1}{4}$ grains of gold, $3\frac{1}{2}$ of silver, $3\frac{1}{4}$ lead, $1\frac{8}{10}$ tin, 1 copper, $\frac{9}{10}$ of a grain iron, these being the relative weight of one atom of each of these metals.

By the voltaic battery, especially if we employ the platinized silver battery, as is now almost invariably used for heavy work, we obtain results equivalent to the original attraction within a very trifling per-centage, a result which must be regarded as a glorious triumph of human skill. On account of this perfection of result I have been enabled to construct an instrument which I call a battery-meter, in which every degree shews that a grain of zinc has entered into combination and become sulphate of zinc. By this we can tell the amount and thickness of metal reduced in our precipitating trough. This instrument is the first instance in which man has estimated work done by the primary attraction or source of power. In the steam-engine the coals burnt do not point out so accurately the result obtained; and I have elsewhere observed that

even in the animal, the most perfect of all machines, the food the soldier eats will not of necessity indicate the number of miles traversed, nor of the enemy killed.

This instrument was designed for the Bank of England. You are all doubtless, aware, that upon my proposition, the entire system of printing the Bank of England notes has been changed, and that they are now printed from surface: a change which has contributed so much to give identity to the note. The original dies are cut in copper, steel, or brass; from these, moulds are made, which again are electrotyped to make the cast for printing. The battery-meter, placed in the battery, shews us the thickness of our deposited metal in the trough; and though our practised eye enables us to dispense with extraneous aids, I can but think this little instrument is a very beautiful practical application of profound physical laws.

The cause of all voltaic phenomena is referable to a new attraction, and when this is opposed by obstacles tension is manifested. Tension, to use a figurative expression, is "a desire for action ungratified," and thus, as soon as the tension is increased, or the obstacles are diminished, action results, and disintegration decomposition or motion occurs.

It was from the long-continued and close study of the voltaic battery, requisite to enable me to write my treatise on "Electro-Metallurgy," that I was led, step

by step, to develop the system of physical philosophy upon which this lecture is based. I could, therefore, tarry and dwell upon this beautiful instrument, did I not remember that on this evening it will be my endeavour to compress into one lecture a slight sketch of the entire range of physical phenomena.

Passing from the study of the action of a new attraction upon binary fluid compounds, we may next, with advantage, consider its effect upon solid substances, or substances under the attraction of aggregation, and the electrical machine is well adapted for this purpose. In this case, force is applied to a solid body, whereby, tension far exceeding that which is readily obtainable by a voltaic battery, is manifested. Whenever the electrical machine is excited by any force, the origin of that force is due to some new attraction, and hence the new attraction is the primary cause of the electrical tension; and when this is increased sufficiently, or the obstacles decreased, action ensues by a destruction of attractions, such as disintegration decomposition or motion, and is frequently accompanied by light, heat, and sound.

From the above views, the mind is led to suppose that electricity is not an immaterial essence, imponderable, or spirit attached to matter, to which the effects are due; but that the phenomena of electricity are entirely owing to the action of a new attraction upon matter aggregated or composed by former attractions.

By frictional electricity we can trace how repulsion is a phenomenon of attraction, and not an inherent power of matter; as by electricity we can readily suspend some of the numerous forces by which any body is held in position, when it moves in the resultant of the others. Two balls suspended close together, when similarly electrified, appear to repel each other; but in reality they are attracted to surrounding objects.

Carry the reasoning one step further, we find that which we term positive or negative electrical phenomena, is due to the direction in which the new attraction acts, and this direction is analagous to the polarity of the magnet or the condition of the electrolyte in the voltaic battery.

Passing from the known to the unknown, we may glance at the thunder cloud, the awful grandeur of which must for ever appal the human mind. From the dense black masses of clouds which usually accompany this grand natural phenomenon, we have seldom an opportunity of observing that which is taking place, yet on one occasion, on Forest Hill, I saw that which probably is the cause of the electric action. It was a damp day in June, and there had been much rain previously, (the entire sky being covered as it were with misty clouds, through which the sun was seen in an obscured form). Suddenly, without warning or the slightest apparent reason, clouds aggregated above our heads so rapidly, that within five minutes we were in comparative dark-

ness, when the most terrific flashes of lightning occurred, accompanied with peals of thunder. This was followed almost simultaneously by enormous hail-stones, so thick that we could scarce see a few yards before us. We had great difficulty in proceeding to the nearest house, which was scarce a hundred yards, and it was only after incessant ringing, that one of the inmates ventured out to open the gate to give us shelter.

In this case there was manifestly an instantaneous and rapid development of new attractions in the aggregation of aqueous vapor into large hailstones, and I believe that aggregation of vapour acting upon the attracted matter of the clouds, is the true source of the electric development.

The sublime phenomenon of the thunder cloud I have watched as it plays over the ocean's bed; I have been in the midst of it at the top of the mountain, I have seen it hovering over the lake, and heard the thunder reverberate from shore to shore of the castle-bearing hills of the Rhine, yet it is worthy of mention that in no place has it been so grand as in this Circus during the stillness of night. Here we have a multiple echo, and when the cloud is overhead, the crash is reverberated from side to side with a majesty unequalled by any other natural phenomenon, and which well marks the power which is acting during the electric discharge.

The capacity to produce action is called force, and

whenever a new attraction is set up, force results. Force differs from tension from being able to do that which tension is prevented, by a resistance, from accomplishing. Any kind of attraction gives rise to force. The attraction of gravitation, capillary attraction, the attraction of aggregation, or of chemical affinity, will produce force.

When a new attraction is exerted, the force emanating therefrom may be propagated through aeriform bodies, when it is termed pneumatic force; through fluid bodies, when it it is called hydrostatic force; through solid bodies, when it is called mechanical force.

I have heard it stated that whenever force is generated it is never annihilated. To such an extraordinary proposition my system not only gives an unqualified denial, but points out the manner in which force comes to an end. However long it may endure, however many bodies it may pass through, its final action is to destroy some pre-existing attraction, and either disintegrate, decompose, or move previously attracted matter.

The resistance of matter under attraction to a new attraction, leads to the production of various phenomena. Under certain circumstances, that which we call heat is evinced. For heat, it is necessary that a resistance to the new attraction should be afforded by the pre-existing attraction. In the voltaic circuit, if

any part is contracted heat is manifested, and in this way water may be boiled, or platinum (one of the most infusible of substances) may be made to fuse like wax. Mechanical force causes heat, when applied to solid bodies; and whenever attraction acts with sufficient energy upon attracted matter, heat results. Where we require intense heat we must employ an intense new attraction on an intense aggregation, and hence, every practical man uses light or strong coke according to the intensity of heat he requires. Whilst heat exists, the new attraction is merely attempting to destroy other attractions, and the force may be transferred to any other body; by conduction, that is, throughbodies in contact; or by radiation, that is, to bodies at a distance. In every case where heat ceases, either the new attraction ceases to exert itself, or the former attraction is destroyed and disintegration, decomposition, or motion is the result.

Some difficulty is presented to our knowledge of the actions and reactions which constitute heat, but, upon the whole, I am inclined to think that heat is best described as that action of matter which from a distance influences the nerves of sensation in the skin, or in other words, heat is that which is felt from a distance by the skin.

There is another range of actions and reactions which are not appreciated by the skin, but are alone seen by the eye. This range is termed light, and by

the prism we are enabled at once to distinguish that which is seen by the eye, or light, from that which is not seen by the eye. Chemistry indicates that there are actions both more refrangible than the violet ray on the one hand, and less refrangible than the red on the other. For the production of light the new attractions must be of the most powerful kind, so that they may act with great intensity upon matter attracted, and it is preferable to be in a solid state. The inflammation of hydrogen gives little or no light: add solid matter, and a beautiful light is the result. Hydro-carbons give us the most convenient light when they are burnt with such energy that the solid matter is first deposited to be acted upon by the new attraction, and subsequently burnt that it may yield no smoke; if all is burnt at once, so that no solid matter remains in the flame, light will not be produced. An illuminated body may communicate the force which is seeking to act upon the solid matter to other bodies, and finally decomposition disintegration, or some destruction of attraction takes place.

As the skin feels heat, the eye sees light; so, by the ear, are we made acquainted with the actions and reactions constituting sound. The vibrations constituting sound have been accurately measured by philosophers, and though different people differ in the power of appreciating the higher and lower notes, it may be generally stated that all vibrations from 8 in a

second to 24,000, are appreciated by the ear, and are consequently sound.

Sound, like light and heat, requires attracted matter; this is acted upon by a new attraction, and in the conflict between the old and new attractions vibrations ensue; whilst the vibration continues, the force may be propagated to other matter which may also take on vibrations.

I have always thought that odours constituted a further range of actions and reactions. I am the more confirmed in that view, the more I watch those animals, as the bloodhound, which have the nerves of the nose highly developed. Upon this matter, however, we are much in the same position as the man born blind, who can only receive his ideas of light through the medium of the eyes of others, for man has literally only a rudimentary nose, if it be compared with that of other animals.

A theory is not to be a mere mental creation, but a law or principle to guide our actions and bring forth fruit. The law which I have developed is so pre-eminently of practical application, that every human action may be regulated by it. When we desire to obtain any result, we begin by generating new attractions. For this purpose we select substances having the lowest equivalent, because the least weight would answer our purpose; hydrogen and carbon have the lowest equivalent, and coal being an hydro-carbon, is

that matter which is pre-eminently adapted to combine with oxygen, the more especially as the product of the new attraction is readily dissipated. If we compare zinc with coals, we find that it has an equivalent eight times higher, and its energy of combustion with oxygen is perhaps not more than one-third that of carbon: moreover, the cost of zinc is forty times dearer than coals; consequently, as a source of power, zinc would be 960 times dearer than coals.

Our theory thus indicates why we select coals for light, heat, motion, and chemical changes, instead of zinc; and this difference of cost prevents the voltaic battery, the most perfect human device, from universal application.

In animals, the hydrogen and carbon in the food they consume is the source of power, and the horse without hay and oats is as powerless as the steam engine without coals, or the battery without zinc.

Starting with the new attraction of hydrogen and carbon, with oxygen as a source of power, we must take care so to apply it upon attracted matter, that we may produce, according to our necessity, heat, light, motion or electricity, for it would not be difficult, in fact it constantly happens in practice, for one variety of force to be produced when another is desired, and whatever is thus improperly generated is wasted.

In physics and physiology, in mechanics and medicine, facts, no less than theory, declare that no effect

occurs without material cause, that no initial change takes place without equivalent result, and in all cases there is but one source, in fact a complete "Monogenesis of all Physical Forces."

In consequence of the "Monogetic Origin of Physical Forces," each possesses within itself the power of a new attraction, which, according to the amount of the initial change, can produce an equivalent or relational amount of any other Force. Electricity may produce Light, Heat or Motion. Motion may produce Heat, Light, Electricity; Light may produce Electricity; Motion, Heat; Heat may produce Motion, Electricity, Light; and so we may ring the changes of the convertibility of physical forces ad infinitum.

Whenever a new attraction acts upon matter under attraction, the attraction already existing seeks to maintain itself, and in consequence of this resistance time is occupied, and according to the energy of the change, so is the time diminished or increased.

I know no part of physical science which presents more important matter for consideration than the phenomenon of time: for let us suppose that a change of matter could take place without time; the coals in our grates would be consumed instantly—if our house caught light the whole would momentarily vanish—if we set in motion any body, it would arrive at its destination quicker than thought, and be dashed to pieces. Chemistry supplies us with substances, the

particles of which are held together so slightly, that upon the slightest application of force they are separated; iodide of nitrogen, for instance, separates upon the slightest agitation into its component parts. The safety of the proper use of gunpowder depends upon its progressive action, which is slow as compared with iodide of nitrogen, or with some varieties of gun cotton.

Man derives the idea of time from the resistance to change; if the total changes constituting an event are performed with energy, but little time is occupied; if the resistance to change is great, considerable time is evinced. The sum total of all time is the representation of all the events which have happened from the commencement of matter to the present moment; and the number of revolutions of the earth round the sun, or of the earth upon its axis, are generally the events which are counted as our measure of time.

From the nature of time, one preceded all subsequent events, namely, the first rushing together or attraction of particles of matter, which gave to every object its composition, form and position. We must look for the cause of this primary attraction to a source extrinsic from matter, as it could not have caused itself to take on that power. From this consideration the mind is led to contemplate an "IMMATERIAL POWER" to confer this property on matter. This argument is independent and altogether different from the argument of design, but this is not the proper place

to enter into this consideration, which I now leave to your own meditations, or refer you to the seventh chapter of my "Sources on Physics" for its further developement.

Every event from which we derive our ideas of time has a beginning, the generation of a new attraction; and an end, the destruction of a former attraction; and as events have followed since matter existed, and will continue till matter shall cease; time began with matter and will terminate when matter shall cease, and "The great globe, yea, all which it inherit, shall dissolve." From these views we find that time can have none, no, not even the feeblest quality of eternity; and that however exaggeratedly it may be increased, time never becomes eternity. Time is a mere repetition of events, each having a beginning and an end. Eternity is not made up of events, and has, therefore, no beginning and no end.

I have now completed, as far as the limited time will permit, a short sketch of the views of the "Monogenesis of Physical Forces," which my study of nature and natural phenomena has forced my mind to adopt. This doctrine has the merit of discarding the notions of æthers, essences, imponderables or a plurality of forces being attached to matter, and places such vague assumptions rather amongst the mental creations of the philosopher than amongst the realities of nature.

I am free to confess that this combination of physical facts and known laws, into one consistent doctrine, was a matter of intense study and profound thought; but should it fortunately have the same power on your minds, to render physical science of easy application, as it has had upon mine, you will pardon me for occupying your attention whilst I have endeavoured to teach, that attraction acting on attracted matter is the source of all force, and that, therefore, every physical force has a monogenetic origin, and when generated a truly equivalent power.