JAMES WEIR

THE ENERGY SYSTEM OF MATTER: A DEDUCTION FROM TERRESTRIAL ENERGY PHENOMENA

James Weir

The Energy System of Matter: A Deduction from Terrestrial Energy Phenomena

http://www.litres.ru/pages/biblio_book/?art=34336098
The Energy System of Matter: A Deduction from Terrestrial Energy Phenomena:

Содержание

active 1883-1912 James Weir The Energy System of Matter: A Deduction from Terrestrial Energy Phenomena

PREFACE

An intimate study of natural phenomena and a lengthened experience in physical research have resulted in the formation of certain generalisations and deductions which I now present in this volume. I have reached the conclusion that every physical phenomenon is due to the operation of energy transformations or energy transmissions embodied in material, and takes place under the action or influence of incepting energy fields. In any instance the precise nature of the phenomena is dependent on the peculiar form of energy actively engaged, on the nature of the material to which this energy is applied, and on the nature of the incepting field which influences the process. In the course of the work several concrete cases are discussed, in which these features of energy are illustrated and explained by the use of simple experimental apparatus. It is hoped that, by this means, the distinctive differences which exist in the manifestations of

energy, in its transformation, in its transmission, and in its incepting forms will be rendered clear to the reader. I have to express my indebtedness to Mr. James Affleck, B.Sc., for his assistance in the preparation of this work for publication.

JAMES WEIR.

Over Courance,
Lockerbie, Scotland.

INTRODUCTION

The main principles on which the present work is founded were broadly outlined in the author's *Terrestrial Energy* in 1883, and also in a later paper in 1892.

The views then expressed have since been amply verified by the course of events. In the march of progress, the forward strides of science have been of gigantic proportions. Its triumphs, however, have been in the realm, not of speculation or faith, but of experiment and fact. While, on the one hand, the careful and systematic examination and co-ordination of experimental facts has ever been leading to results of real practical value, on the other, the task of the theorists, in their efforts to explain phenomena on speculative grounds, has become increasingly severe, and the results obtained have been decreasingly satisfactory. Day by day it becomes more evident that not one of the many existing theories is adequate to the explanation of the known phenomena: but, in spite of this obvious fact, attempts are still constantly being made, even by most eminent men, to rule the results of experimental science into line with this or that accepted theory. The contradictions are many and glaring, but speculative methods are still rampant. They have become the fashion, or rather the fetish, of modern science. It would seem that no experimental result can be of any value until it is deductively accommodated to some preconceived

hypothesis, until it is embodied and under the sway of what is practically scientific dogma. These methods have permeated all branches of science more or less, but in no sphere has the tendency to indulge in speculation been more pronounced than in that which deals with energetics. In no sphere, also, have the consequences of such indulgence been more disastrous. For the most part, the current conceptions of energy processes are crude, fanciful, and inconsistent with Nature. They require for their support—in fact, for their very existence—the acceptance of equally fantastic conceptions of mythical substances or ethereal media of whose real existence there is absolutely no experimental evidence. On the assumed properties or motions of such media are based the many inconsistent and useless attempts to explain phenomena. But, as already pointed out, Nature has unmistakably indicated the true path of progress to be that of experimental investigation. In the use of this method only phenomena can be employed, and any hypothesis which may be formulated as the result of research on these lines is of scientific value only in so far as it is the correct expression of the actual facts observed. By this method of holding close to Nature reliable working hypotheses can, if necessary, be formed, and real progress made. It is undeniably the method of true science.

In recent years much attention has been devoted to certain speculative theories with respect to the origin and ultimate nature of matter and energy. Such hypotheses, emanating as they do from prominent workers, and fostered by the

inherent imaginative tendency of the human mind, have gained considerable standing. But it is surely unnecessary to point out that all questions relating to origins are essentially outside the pale of true science. Any hypotheses which may be thus formulated have not the support of experimental facts in their conclusions; they belong rather to the realm of speculative philosophy than to that of science. In the total absence of confirmatory phenomena, such theories can, at best, only be regarded as plausible speculations, to be accepted, it may be, without argument, and ranking in interest in the order of their plausibility.

Of modern research into the ultimate constitution of matter little requires to be said. It is largely founded on certain radio-active and electrical phenomena which, in themselves, contribute little information. But aided by speculative methods and the use of preconceived ethereal hypotheses, various elaborate theories have been formulated, explaining matter and its properties entirely in terms of ethereal motions. Such conceptions in their proper sphere—namely, that of metaphysics—would be no doubt of interest, but when advanced as a scientific proposition or solution they border on the ridiculous. In the absence of phenomena bearing on the subject, it would seem that the last resort of the modern scientist lies in terminology. To the average seeker after truth, however, the term "matter," as applied to the material world, will still convey as much meaning as the more elaborate scientific definitions.

It is not the purpose of this work to add another thread to the already tangled skein of scientific theory. It is written, rather, with the conviction, that it is impossible ever to get really behind or beyond phenomena; in the belief that the complete description of any natural process is simply the complete description of the associated phenomena, which may always be observed and co-ordinated but never ultimately explained. Phenomena must ever be accepted simply as phenomena—as the inscrutable manifestations of Nature. By induction from phenomena it is indeed possible to rise to working hypotheses, and thence, it may be, to general conceptions of Nature's order, and as already pointed out, it is to this method, of accepting phenomena, and of reasoning only from experimental facts, that all the advances of modern science are due. On the other hand, it is the neglect of this method—the departure, as it were, from Nature—which has led to the introduction into the scientific thought of the day of the various ethereal media with their extreme and contradictory properties. The use of such devices really amounts to an admission of direct ignorance of phenomena. They are, in reality, an attempt to explain natural operations by a highly artificial method, and, having no basis in fact, their whole tendency is to proceed, in ever-increasing degree, from one absurdity to another.

It is quite possible to gain a perfectly true and an absolutely reliable knowledge of the properties of matter and energy, and the part which each plays, without resorting to speculative aids.

All that is required is simply accurate and complete observation at first hand. The field of research is wide; all Nature forms the laboratory. By this method every result achieved may be tested and verified, not by its concurrence with any approved theory, however plausible, but by direct reference to phenomena. The verdict of Nature will be the final judgment on every scheme.

It is on these principles, allied with the great generalisations with respect to the conservation of matter and energy, that this work is founded. As the result of a long, varied, and intimate acquaintance with Nature, and much experimental research in many spheres, the author has reached the conclusion, already foreshadowed in *Terrestrial Energy*, that the great principle of energy conservation is true, not only in the universal and generally accepted sense, but also in a particular sense with respect to all really separate bodies, such as planetary masses in space. Each of these bodies, therefore, forms within itself a completely conservative energy system. This conclusion obviously involves the complete denial of the transmission of energy in any form across interplanetary space, and the author, in this volume, now seeks to verify the conclusion by the direct experimental evidence of terrestrial phenomena.

Under present-day conditions in science, the acceptance of the ordinary doctrine of transmission across space involves likewise the acceptance of the existence of an ethereal substance which pervades all space and forms the medium by which such transmission is carried out. The properties of this medium

are, of course, precisely adapted to its assumed function of transmission. These properties it is not necessary to discuss, for when the existence of the transmission itself has been finally disproved, the necessity for the transmitting medium clearly vanishes.

PART I
GENERAL STATEMENT

1. *Advantages of General View of Natural Operations*

The object of this statement is to outline and illustrate, in simple fashion, a broad and general conception of the operation and interaction of matter and energy in natural phenomena.

Such a conception may be of value to the student of Nature, in several ways. In modern times the general tendency of scientific work is ever towards specialisation, with its corresponding narrowness of view. A broad outlook on Nature is thus eminently desirable. It enables the observer to perceive to some extent the links uniting the apparently most insignificant of natural processes to those of seemingly greater magnitude and importance. In this way a valuable idea of the natural world as a whole may be gained, which will, in turn, tend generally to clarify the aspect of particular operations. A broad general view of Nature also leads to the appreciation of the full significance of the great doctrines of the conservation of matter and energy. By its means the complete verification of these doctrines, which appears to be beyond human experiment, may be traced on the

face of Nature throughout the endless chain of natural processes. Such a view also leads to a firm grasp of the essential nature and qualities of energy itself so far as they are revealed by its general function in phenomena.

2. *Separate Mass in Space*

In the scheme now to be outlined, matter and energy are postulated at the commencement without reference to their ultimate origin or inherent nature. They are accepted, in their diverse forms, precisely as they are familiar from ordinary terrestrial experience and phenomena.

For the purpose of general illustration the reader is asked to conceive a mass of heterogeneous matter, concentrated round a given point in space, forming a single body. This mass is assumed to be assembled and to obtain its coherent form in virtue of that universal and inherent property of matter, namely, gravitative or central attraction. This property is independent of precise energy conditions, its outward manifestation being found simply in the persistent tendency of matter on all occasions to press or force itself into the least possible space. In the absence of all disturbing influences, therefore, the configuration of this mass of matter, assumed assembled round the given point, would naturally, under the influence of this gravitative tendency, resolve itself into that of a perfect sphere. The precise magnitude or dimensions of the spherical body thus constituted are of little moment in the discussion, but, for illustrative purposes, it may, in the meantime, be assumed that in mass it is equivalent to our known solar system. It is also assumed to be completely devoid of energy, and as a mass to be under the influence of no external constraint.

Under these conditions, the spherical body may obviously be assumed as stationary in space, or otherwise as moving with perfectly uniform velocity along a precisely linear path. Either conception is justifiable. The body has no relative motion, and since it is absolutely unconstrained no force could be applied to it and no energy expenditure would be required for its linear movement.

3. *Advent of Energy—Distortional Effects*

Nature, however, does not furnish us with any celestial or other body fulfilling such conditions. Absolutely linear motion is unknown, and matter is never found divorced from energy. To complete the system, therefore, the latter factor is required, and, with the advent of energy to the mass, its prototype may be found in the natural world.

This energy is assumed to be communicated in that form which we shall term "work" energy (§§ 13, 31) and which, as a form of energy, will be fully dealt with later. This "work" energy is assumed to be manifested, in the first place, as energy of motion. As already pointed out, no expenditure of energy can be associated with a linear motion of the mass, since that motion is under no restraint, but in virtue of the initial central attraction or gravitative strain, the form of energy first communicated may be that of kinetic energy of rotation. Its transmission to the mass will cause the latter to revolve about some axis of symmetry within itself. Each particle of the mass thus pursues a circular path with reference to that axis, and has a velocity directly proportional to its radial displacement from it.

This energised rotating spherical mass is thus the primal conception of the energy scheme now to be outlined. It will be readily seen that, as a primal conception, it is essentially and entirely natural; so much so, indeed, that any one familiar with

rotatory motion might readily predict from ordinary experience the resulting phenomena on which the scheme is, more or less, based.

When energy is applied to the mass, the first phenomenon of note will be that, as the mass rotates, it departs from its originally spherical shape. By the action of what is usually termed centrifugal force, the rotating body will be distorted; it will be flattened at the polar or regions of lowest velocity situated at the extremities of the axis of rotation, and it will be correspondingly distended at the equatorial or regions of highest velocity. The spherical body will, in fact, assume a more or less discoidal form according to the amount of energy applied to it; there will be a redistribution of the original spherical matter; certain portions of the mass will be forced into new positions more remote from the central axis of rotation.

4. *The Gravitation Field*

These phenomena of motion are the outward evidence of certain energy processes. The distortional movement of the material is carried out against the action and within the field of certain forces which exist in the mass of material in virtue of its gravitative or cohesive qualities. It is carried out also in virtue of the application of energy to the sphere, which energy has been, as it were, transformed or worked down, in the distortional movement, against the restraining action of this gravitation field or influence. The outward displacement of the material from the central axis is thus coincident with a gain of energy to the mass, this gain of energy being, of course, at the expense of, and by the direct transformation of, the originally applied energy. It is stored in the distorted material as energy of position, potential energy, or energy of displacement relative to the central axis. But, in the distortive movement, the mass will also gain energy in other forms. The movement of one portion of its material relative to another will give rise (since it is carried out under the gravitational influence) to a fractional process in which, as we know from terrestrial experience, heat and electrical energy will make their appearance. These forms of energy will give rise, in their turn, to all the phenomena usually attendant on their application to material. As already pointed out also, the whole mass gains, in varying degree, energy of

motion or kinetic energy. It would appear, then, that although energy was nominally applied to the mass in one form only, yet by its characteristic property of transformation it has in reality manifested itself in several entirely different forms. It is important to note the part played in these transformation processes by the gravitation field or influence. Its action really reveals one of the vital working principles of energetics. This principle may be generally stated thus:—

Every Transformation of Energy is carried out by the Action of Energised Matter in the Lines or Field of an Incepting Energy Influence.

In the particular case we have just considered, the incepting field is simply the inherent gravitative property of the energised mass. This property is manifested as an attractive force between portions of matter. This, however, is not of necessity the only aspect of an incepting influence. In the course of this work various instances of transformation will be presented in which the incepting influence functions in a guise entirely different. It is important to note that the incepting influence itself is in no way changed, altered, or transformed during the process of transformation which it influences.

5. *Limits of Rotational Energy. Disruptional Phenomena*

It is clear that the material at different parts of the rotating spheroid will be energised to varying degrees. Since the linear velocity of the material in the equatorial regions of the spheroid is greater than that of the material about the poles, the energy of motion of the former will exceed that of the latter, the difference becoming greater as the mass is increasingly energised and assumes more and more the discoidal form.

The question now arises as to how far this process of energising the material mass may be carried. What are its limits? The capacity of the rotating body for energy clearly depends on the amount of work which may be spent on its material in distorting it against the influence of the gravitative attraction. The amount is again dependent on the strength of this attraction. But the value of the gravitative attraction or gravitation field is, by the law of gravitation, in direct proportion to the quantity of material or matter present, and hence the capacity of the body for energy depends on its mass or on the quantity of matter which composes it.

Now if energy be impressed on this mass beyond its capacity a new order of phenomena appears. Distortion will be followed by disruption and disintegration. By the action of the disruptive forces a portion of the primary material will be projected

into space as a planetary body. The manner of formation of such a secondary body is perhaps best illustrated by reference to the commonplace yet beautiful and suggestive phenomenon of the separation of a drop of water or other viscous fluid under the action of gravitation. In this process, during the first downward movement of the drop, it is united to its source by a portion of attenuated material which is finally ruptured, one part moving downwards and being embodied in the drop whilst the remainder springs upwards towards the source. In the process of formation of the planetary body we are confronted with an order of phenomena of somewhat the same nature. The planetary orb which is hurled into space is formed in a manner similar to the drop of viscous fluid, and under the action of forces of the same general nature. One of these forces is the bond of gravitative attraction between planet and primary which is never severed, and when complete separation of the two masses finally occurs, the incessant combination of this force with the tangential force of disruption acting on the planet will compel it into a fixed orbit, which it will pursue around the central axis. When all material links have thus been severed, the two bodies will then be absolutely separate masses in space. The term "separate" is here used in its most rigid and absolute sense. No material connection of any kind whatever exists, either directly or indirectly, between the two masses. Each one is completely isolated from the other by interplanetary space, and in reality, so far as material connection is concerned, each one might be the

sole occupant of that space. This conception of separate masses in space is of great importance to the author's scheme, but, at the same time, the condition is one which cannot be illustrated by any terrestrial experimental contrivance. It will be obvious that such a device, as might naturally be conceived, of isolating two bodies by placing them in an exhausted vessel or vacuous space, by no means complies with the full conditions of true separation portrayed above, because some material connection must always exist between the enclosed bodies and the containing vessel. This aspect is more fully treated later (§ 30). The condition of truly separate masses is, in fact, purely a celestial one. No means whatever are existent whereby such a condition may be faithfully reproduced in a terrestrial environment.

In their separate condition the primary and planetary mass will each possess a definite and unvarying amount of energy. It is to be noted also, that since the original mass of the primary body has been diminished by the mass of the planet cast off, the capacity for energy of the primary will now be diminished in a corresponding degree. Any further increment of energy to the primary in any form has now, however, no direct influence on the energy of the planet, which must maintain its position of complete isolation in its orbit. But although thus separate and distinct from the primal mass in every material respect, the planet is ever linked to it by the invisible bond of gravitation, and every movement made by the planet in approaching or receding from the primary is made in the field or influence

of this attraction. In accordance, therefore, with the general principle already enunciated (§ 4), these actions or movements of the energised planetary mass, being made in the field of the incepting gravitative influence, will be accompanied by transformations, and thus the energy of the planet, although unvarying in its totality, may vary in its form or distribution with the inward or outward movement of the planet in its orbital path. As the planet recedes from the primary it gains energy of position, but this gain is obtained solely at the expense, and by the direct transformation of its own orbital energy of motion. Its velocity in its orbit must, therefore, decrease as it recedes from the central axis of the system, and increase as it approaches that axis. Thus from energy considerations alone it is clear that, if the planetary orbit is not precisely circular, the velocity of the planet must vary at different points of its path.

6. *Passive Function and General Nature of Gravitation Field*

From the phenomena described above, it will be observed that, in the energy processes of transformation occurring in both primary and planet, the function of the gravitation field or influence is entirely passive in nature. The field is, in truth, the persistent moving or directing power behind the energy processes, the incepting energy influence or agency which determines the nature of the transformation in each case without being, in any way, actively engaged in it. In accelerating or retarding the transformation process it has thus absolutely no effect. These features are controlled by other factors. Neither does this incepting agency affect, in any way, the limits of the transformation process, these limits being prescribed by the physical or energy qualities of the acting materials. In general nature the gravitation field appears to be simply an energy influence—a peculiar manifestation of certain passive qualities of energy. This aspect will, however, become clearer to the reader when the properties of gravitation are studied in conjunction with those of other incepting energy influences (§§ 17, 18, 19).

7. *Limit of Gravitation Transformation*

In the case of a planetary body, there is a real limit to the extent of the transformation of its orbital energy of motion under the influence of the gravitation field. As the orbit of the planet widens, and its mean distance from the primary becomes greater, its velocity in its orbital path must correspondingly decrease. As already pointed out (§ 5), this decrease is simply the result of the orbital energy of motion being transformed or worked down into energy of position. But since this orbital energy is strictly limited in amount, a point must ultimately be reached where it would be transformed in its entirety into energy of position. When this limiting condition is attained, the planet clearly could have no orbital motion; it would be instantaneously at rest in somewhat the same way as a projectile from the earth's surface is at rest at the summit of its flight in virtue of the complete transformation of its energy of motion into energy of position. In this limiting condition, also, the energy of position of the planet would be the maximum possible, and its orbital energy zero. The scope of the planetary orbital path is thus rigidly determined by the planetary energy properties. Assuming the reduction of gravity with distance to follow the usual law of inverse squares, the value of the displacement of the planet from the central axis when in this stationary or limiting position may be readily calculated if the various constants are known. In any given case it is obvious

that this limiting displacement must be a finite quantity, since the planetary orbital energy which is being worked down is itself finite in amount.

8. *Interactions of Two Planetary Bodies—Equilibrium Phenomena*

Up to the present point, the cosmical system has been assumed to be composed of one planetary body only in addition to the primary mass. It is clear, however, that by repetition of the process already described, the system could readily evolve more than one planet; it might, in fact, have several planetary masses originating in the same primary, each endowed with a definite modicum of energy, and each pursuing a persistent orbit round the central axis of the system. Since the mass of the primary decreases as each successive planet is cast off, its gravitative attractive powers will also decrease, and with every such decline in the central restraining force the orbits of the previously constituted planets will naturally widen. By the formation in this way of a series of planetary masses, the material of the original primary body would be as it were distributed over a larger area or space, and this separation would be accompanied by a corresponding decrease in the gravitative attraction between the several masses. If the distributive or disruptive process were carried to its limit by the continuous application of rotatory energy to each separate unit of the system, this limit would be dependent on the capacity of the system for energy. As is shown later (§ 20), this capacity would be determined by the mass of the system.

For simplicity, let us consider the case in which there are two planetary bodies only in the system in addition to the primary. In virtue of the gravitative attraction or gravitation field between the two, they will mutually attract one another in their motion, and each will, in consequence, be deflected more or less out of that orbital path which it would normally pursue in the absence of the other. This attraction will naturally be greatest when the planets are in the closest proximity; the planet having the widest orbit will then be drawn inwards towards the central axis, the other will be drawn outwards. The distance moved in this way by each will depend on its mass, and on the forces brought to bear on it by the combined action of the two remaining masses of the system. Moving thus in different directions, the motion of each planet is carried out in the lines of the gravitation field between the two. One planet, therefore, gains and the other loses energy of position with respect to the central axis of the system. The one planet can thus influence, to some extent, the energy properties of the other, although there is absolutely no direct energy communication between the two; as shown hereafter, the whole action and the energy change will be due simply to the motion carried out in the field of the incepting gravitation influence.

It is clear, however, that this influence is exerted on the distribution of the energy, on the form in which it is manifested, and in no way affects the energy totality of either planet. Each, as before, remains a separate system with conservative energy

properties. That planet which loses energy of position gains energy of motion, and is correspondingly accelerated in its orbital path; the other, in gaining energy of position, does so at the expense of its own energy of motion, and is retarded accordingly. The action is really very simple in nature when viewed from a purely energy standpoint. It has been dealt with in some detail in order to emphasise the fact that there is absolutely nothing in the nature of a transmission of energy between one planet and the other. Taking a superficial view of the operation, it might be inferred that, as the planets approach one another, energy of motion (or energy of position) is transmitted from one to the other, causing one to retard and the other to accelerate its movement, but a real knowledge of the energy conditions shows that the phenomenon is rather one of a simple restoration of equilibrium, a redistribution or transformation of the intrinsic energy of each to suit these altering conditions. Each planet is, in the truest sense, a separate mass in space.

9. *Axial Energy—Secondary Processes*

Passing now to another aspect of the energy condition of a planetary body, let the planet be assumed to be endowed with axial energy or energy of rotation, so that, while pursuing its orbital path in space, it also rotates with uniform angular velocity about an axis within itself. What will be the effect of the primary mass on the planet under these new energy conditions? We conceive that the effect is again purely one of transformation. In this process the primary mass functions once more as an entirely passive or incepting agent, which, while exerting a continuous transforming influence on the planet, does not affect in any way the inherent energy properties of the latter. Up to the present point we have only dealt with one incepting influence in transformation processes, namely, that of gravitation, which has always been manifested as an attractive force. It is not to be supposed, however, that this is the only aspect in which incepting influences may be presented. Although attractive force is certainly an aspect of some incepting influences, it is not a distinctive feature of incepting influences generally. In many cases, the aspect of force, in the sense of attraction or repulsion, is entirely awanting. In the new order of transformations which come into play in virtue of the rotatory motion of a planetary mass in the field of its primary, we shall find other incepting influences in action entirely different

in nature from the gravitation influence, but, nevertheless, arising from the same primary mass in a similar way. Now the application of energy to the planet, causing it to rotate in the lines or under the influence of these incepting fields of the primary, brings into existence on the planet an entirely new order of phenomena. So long as the planet had no axial motion of rotation, some of the incepting influences of the primary were compelled, as it were, to inaction; but with the advent of axial energy the conditions are at once favourable to their action, and to the detection of their transforming effects. In accordance with the general principle already enunciated (§ 4), the action of the planetary energised material in the lines of the various incepting fields of the primary is productive of energy transformations. The active energy of these transformations is the axial or energy rotatory of the planet itself, and, in virtue of these transformations, certain other forms of energy will be manifested on the planet and associated with the various forms of planetary material. These manifestations of energy, in fact, constitute planetary phenomena. Since the action or movement of the rotating material of the planet through the incepting fields of the primary is most pronounced in the equatorial or regions of highest linear velocity, and least in the regions of low velocity adjoining the poles of rotation, the transforming effect may naturally be expected to decrease in intensity from equator to poles. Planetary energy phenomena will thus vary according to the location of the acting material. It will be clear,

also, that each incepting agency or influence associated with the primary mass will give rise to its own peculiar transformations of axial energy on the planetary surface. These leading or primary transformations of axial energy, in which the incepting influence is associated with the primary mass only, we term primary processes. But it is evident that the various forms of energy thus set free on the planet as a result of the primary processes will be communicated to, and will operate on, the different forms of planetary material, and will give rise to further or secondary transformations of energy, in which the incepting agency is embodied in or associated with planetary material only. The exact nature of these secondary transformations will vary according to the circumstances in which they take place. Each of them, however, as indicated above, will be, in itself, carried out in virtue of some action of the energised planetary material in the lines or field of what we might term a secondary incepting influence. The latter, however, must not be confused with the influences of the primary. It is essentially a planetary phenomenon, an aspect of planetary energy; it is associated with the physical or material machine by means of which the secondary process of transformation is carried out. The nature of this secondary influence will determine the nature of the secondary transformation in each case. Its precise extent may be limited by other considerations (§ 15).

As an example, assume a portion of the axial energy to be primarily transformed into heat in virtue of the planet's rotation

in the field of an independent thermal incepting influence exerted by the primary. To the action of this agency, which we might term the thermal field, we assume are due all primary heating phenomena of planetary material. Now the secondary transformations will take place when the heat energy thus manifested is applied to some form of matter. It is obvious, however, that this application might be carried out in various ways. Heat may be devoted to the expansion of a solid against its cohesive forces. It may be expended against the elastic forces of a gas, or it may be worked down against chemical or electrical forces. In every case a transformation of energy will result, varying in nature according to the peculiar conditions under which it is carried out. In this or a similar fashion each primary incepting influence may give rise to a series of secondary actions more or less complex in nature. These secondary transformation processes, allied with other processes of transmission, will, in fact, constitute the visible phenomena of the planet, and in their variety will exactly correspond to these phenomena.

With regard to the gravitation field, its general influence on the rotating mass may be readily predicted. The material on that part of the planetary surface which is nearest to or happens to face the primary in rotation is, during the short time it occupies that position, subjected to a greater attractive influence than the remainder which is more remote from the primary. It will, in consequence, tend to be more or less distorted or elevated above its normal position on the planetary surface. This distorting

effect will vary in degree according to the nature of the material, whether solid, liquid, or gaseous, but the general effect of the distortional movement, combined with the rotatory motion of the planet, will be to produce a tidal action or a periodical rise and fall of the more fluid material distributed over the planetary surface. The distortion will, of course, be accompanied by energy processes in which axial energy will be transformed into heat and other forms, which will finally operate in the secondary processes exactly as in previous cases.

10. *Mechanism of Energy Return*

But the question now arises, as to how this continuous transformation of the axial energy can be consistent with that condition of uniformity of rotation of the planet which was originally assumed. If the total energy of the planetary mass is limited, and if it can receive no increment of energy from any external source, it is clear that the axial energy transformed must, by some process, be continuously returned to its original form. Some process or mechanism is evidently necessary to carry out this operation. This mechanism we conceive to be provided by certain portions of the material of the planet, principally the gaseous matter which resides on its surface, completely enveloping it, and extending outwards into space (§ 38). In other words, the atmosphere of the planet forms the machine or material agency by which this return of the transformed axial energy is carried out. It has already been pointed out (§ 9) how the working energy of every secondary transformation is derived from the original axial energy of the planet itself. Each of these secondary transformations, however, forms but one link of one cyclical chain of secondary transformations, in which a definite quantity of energy, initially in the axial form, passes, in these secondary operations, through various other forms, by different processes and through the medium of different material machines, until it is eventually absorbed into the atmosphere

of the planet. These complete series of cyclical operations, by which the various portions of axial energy are carried to the atmosphere, may in some cases be of a very simple nature, and may be continuously repeated over very short intervals of time; in other cases, the cycle may seem obscure and complicated, and its complete operation spread over very long periods, but in all cases the final result is the same. The axial energy abstracted, sooner or later, recurs to the atmospheric machine. By its action in this machine, great masses of gaseous material are elevated from the surface of the planet against the attractive force of gravitation; the energy will thus now appear in the form of potential energy or energy of position. By a subsequent movement of these gaseous masses over the surface of the planet from the regions of high velocity towards the poles, combined with a movement of descent to lower levels, the energy of position with which they were endowed is returned once more in the original axial form.

This, roughly, constitutes the working of the planetary atmospheric machine, which, while in itself completely reversible and self-contained, forms also at the same time the source and the sink of all the energy working in the secondary transformations. In the ceaseless rounds of these transformations which form planetary phenomena it links together the initial and concluding stages of each series by a reversible process. Energy is thus stored and restored continuously. The planet thus neither gains nor loses energy of axial motion; so far as its energy properties are concerned, it is entirely independent of

every external influence. Its uniformity of rotation is absolutely maintained. Each planet of the system will, in the same way, be an independent and conservative unit.

11. *Review of Cosmical System —General Function of Energy*

Reviewing the system as a whole, the important part played by energy in its constitution is readily perceived. The source of the energy which operates in all parts of the system is found in that energy originally applied (§ 3). When the system is finally constituted, this energy is found distributed amongst the planets, each of which has received its share, and each of which is thereby linked to the primary by its influence. It is part of this same energy which undergoes transformation in virtue of the orbital movements of the planets in the field of the gravitative influence. Again, it is found in the form of planetary axial energy, and thence, under the influence of various incepting agencies, it passes in various forms through the whole gamut of planetary phenomena, and finally functions in the atmospheric machine. Every phenomenon of the system, great or small, is, in fact, but the external evidence either of the transformation or of the transmission of this energy—the outward manifestation of its changed or changing forms. Its presence, which always implies its transformation (§ 4), is the simple primary condition attached to every operation. The primal mass originally responded to the application of energy by the presentation of phenomena. Every material portion of the system will similarly respond according to circumstances. Energy is, in fact, the working spirit of the whole

cosmical scheme. It is the influence linking every operation of the system to the original transformations at the central axis, so that all may be combined into one complete and consistent whole. It is to be noted, however, that although they have a common origin the orbital energy of each planetary mass is entirely distinct from its energy of axial rotation, and is not interchangeable therewith. The transformation of the one form of energy in no way affects the totality of the other.

The disruption of the primary mass furnishes a view of what is virtually the birth of gravitation as it is conceived to exist between separate bodies. It may now be pointed out that the attractive influence of gravitation is, in reality, but one of the many manifestations of energy of the system. It is not, however, an active manifestation of the working energy, but rather an aspect of energy as it is related to the properties of matter. We have absolutely no experimental experience of matter devoid of energy. Gravitation might readily be termed an energy property of matter, entirely passive in nature, and requiring the advent of some other form in order that it may exercise its function as an incepting agency.

From a general consideration of the features of this system, in which every phenomenon is an energy phenomenon, it seems feasible to conclude also that every property of matter is likewise an energy property. It is certain, indeed, that no reasonable or natural concept of either matter or energy is possible if the two be dissociated. The system also presents a direct and clear

illustration of the principles of conservation in the working of the whole, and also in each planetary unit.

12. *Natural Conditions*

It will be noted that, up to the present point, the cosmical system has been discussed from a purely abstract point of view. This method has been adopted for a definite reason. Although able, at all points, to bring more or less direct evidence from Nature, the author has no desire that his scheme should be regarded in any way as an attempt to originate or describe a system of creation. The object has been, by general reasoning from already accepted properties of matter and energy, to arrive at a true conception of a possible natural order of phenomena. It is obvious, however, that the solar system forms the prototype of the system described above. The motion of the earth and other planets is continuously occurring under the influence of gravitation, thermal, luminous, and other incepting fields which link them to the central mass, the sun. As a result of the action of such fields, energy transformations arise which form the visible phenomena of the system in all its parts, each transformation, whether associated with animate or inanimate matter, being carried out through the medium of some arrangement of matter hereafter referred to as a material machine. The conditions are precisely as laid down above. The system is dominated, in its separate units, and as a whole, by the great principle of the conservation of energy. Each planetary mass, as it revolves in space, is, so far as its energy properties are concerned, an

absolutely conservative unit of that system. At the same time, however, each planetary mass remains absolutely dependent on the primary for those great controlling or incepting influences which determine the transformation of its inherent energy.

In the special case of the earth, which will be dealt with in some detail, it is the object of this work to show that its property of complete energy conservation is amply verified by terrestrial phenomena. The extension of the principle from the earth to the whole planetary system has been made on precisely the same grounds as Newton extended the observed phenomena to his famous generalisation with respect to gravitation.

PART II
PRINCIPLES OF INCEPTION

13. *Illustrative Secondary Processes*

In this part of the work, an attempt will be made to place before the reader some of the purely terrestrial and other evidential phenomena on which the conclusions of the preceding General Statement are founded. The complete and absolute verification of that Statement is obviously beyond experimental device. Bound, as we are, within the confines of one planet, and unable to communicate with the others, we can have no direct experimental acquaintance with really separate bodies (§ 5) in space. But, if from purely terrestrial experience we can have no direct proofs on such matters, we have strong evidential conclusions which cannot be gainsayed. If the same kind of energy operates throughout the solar system, the experimental knowledge of its properties gained in one field of research is valuable, and may be readily utilised in another. The phenomena which are available to us for study are, of course, simply the ordinary energy processes of the earth—those operations which in the foregoing Statement have been described as secondary energy processes. Their variety is infinite, and the author has

accordingly selected merely a few typical examples to illustrate the salient points of the scheme. The energy acting in these secondary processes is, in every case, derived, either directly or indirectly, from the energy of rotation or axial energy of the earth. In themselves, the processes may be either energy transformations or energy transmissions or a combination of both these operations. When the action involves the bodily movement of material mass in space, the dynamical energy thus manifested, and which may be transmitted by the movement of this material, is termed mechanical or "work" energy (§ 31); when the energy active in the process is manifested as heat, chemical, or electrical energy, we apply to it the term "molecular" energy. The significance of these terms is readily seen. The operation of mechanical or "work" energy on a mass of material may readily proceed without any permanent alteration in the internal arrangement or general structure of that mass. Mechanical or "work" energy is dissociated from any molecular action. On the other hand, the application of such forms of energy as heat or electrical energy to material leads to distinctly molecular or internal effects, in which some alteration in the constitution of the body affected may ensue. Hence the use of the terms, which of course is completely arbitrary.

The principal object of this part of the work is to illustrate clearly the general nature, the working, and the limits of secondary processes. For this purpose, the author has found it best to refer to certain more or less mechanical contrivances.

The apparatus made use of is merely that utilised in everyday work for experimental or other useful purposes. It is essentially of a very simple nature; no originality is claimed for it, and no apology is offered for the apparent simplicity of the particular energy operations chosen for discussion. In fact, this feature has rather led to their selection. In scientific circles to-day, familiarity with the more common instances of energy operations is apt to engender the belief that these processes are completely understood. There is no greater fallacy. In many cases, no doubt, the superficial phenomena are well known, but in even the simplest instances the mechanism or ultimate nature of the process remains unknown. A free and somewhat loose method of applying scientific terms is frequently the cloak which hides the ignorance of the observer. No attempt will here be made to go beyond the simple phenomena. The object in view is simply to describe such phenomena, to emphasise and explain certain aspects of already well-known facts, which, up to the present, have been neglected.

In some of the operations now to be described, mechanical or "work" energy is the active agent, and material masses are thereby caused to execute various movements in the lines or field of restraining influences. For ordinary experimental convenience, the material thus moved must of necessity be matter in the solid form. The illustrative value of our experimental devices, however, will be very distinctly improved if it be borne in mind that the operations of mechanical energy

are not restricted to solids only, but that the various processes of transformation and transmission here illustrated by the motions of solid bodies may, in other circumstances, be carried out in a precisely similar fashion by the movements of liquids or even of gases. The restrictions imposed in the method of illustration are simply those due to the limitations of human experimental contrivance. Natural operations exhibit apparatus of a different type. By the movements of solid materials a convenient means of illustration is provided, but it is to be emphasised that, so far as the operations of mechanical energy are concerned, the precise form or nature of the material moved, whether it be solid, liquid, or gaseous, is of no consequence. To raise one pound of lead through a given distance against the gravitative attraction of the earth requires no greater expenditure of energy than to raise one pound of hydrogen gas through the same distance. The same principle holds in all operations involving mechanical energy.

Another point of some importance which will be revealed by the study of secondary operations is that every energy process has in some manner definite energy limits imposed upon it. In the workings of mechanical or "work" energy it is the mass value of the moving material which, in this respect, is important. The mass, in fact, is the real governing factor of the whole process (§ 20). It determines the maximum amount of energy which can be applied to the material, and thus controls the extent of the energy operation.

But in actions involving the molecular energies, the operation

may be limited by other considerations altogether. For example, the application of heat to a solid body gives rise to certain energy processes (§ 27). These processes may proceed to a certain degree with increase of temperature, but a point will finally be attained where change of state of the heated material takes place. This is the limiting point of this particular operation. When change of state occurs, the phenomena will assume an entirely different aspect. The first set of energy processes will now be replaced by a set of operations absolutely different in nature, themselves limited in extent, but by entirely different causes. The first operation must thus terminate when the new order appears. In this manner each process in which the applied energy is worked will be confined within certain limiting boundaries. In any chain of energy operations each link will thus have, as it were, a definite length. In chemical reactions, the limits may be imposed in various ways according to the precise nature of the action. Chemical combination, and chemical disruption, must be looked on as operations which involve not only the transformation of energy but also the transformation of matter. In most cases, chemical reactions result in the appearance of matter in an entirely new form—in the appearance, in fact, of actually different material, with physical and energy properties absolutely distinct from those of the reacting constituents. This appearance of matter in the new form is usually the evidence of the termination, not only of the particular chemical process, but also of the energy process associated with it. Transformation of

energy may thus be limited by transformation of matter.

Examples of the limiting features of energy operations could readily be multiplied. Even a cursory examination of most natural operations will reveal the existence of such limits. In no case do we find in Nature any body, or any energy system, to which energy may be applied in unlimited amount, but in every case, rigid energy limits are imposed, and, if these limits are exceeded, the whole energy character of the body or system is completely changed.

14. *Incepting Energy Influences*

In experimental and in physical work generally, it has been customary, in describing any simple process of energy transformation, to take account only of those energies or those forms of energy which play an active part in the process —the energy in its initial or applied form and the energy in its transformed or final form. This method, however, requires enlarging so as to include another feature of energy transformation, a feature hitherto completely overlooked, namely, that of incepting energy. Now, this conception of incepting energy, or of energy as an incepting influence, is of such vital importance to the author's scheme, that it is necessary here, at the very outset, to deal with it in some detail. To obtain some idea of the general nature of these influences, it will be necessary to describe and review a few simple instances of energy transformation. One of the most illuminating for this purpose is perhaps the familiar process of dynamo-electric transformation.

A spherical mass A (Fig. 1) of copper is caused to rotate about its central axis in the magnetic field in the neighbourhood of a long and powerful electro-magnet. In such circumstances, certain well-known transformations of energy will take place. The energy transformed is that dynamical or "work" energy which is being applied to the spherical mass by the external prime mover causing it to rotate. As a result of this motion

in the magnetic field, an electrical action takes place; eddy currents are generated in the spherical mass, and the energy originally applied is, through the medium of the electrical process, finally converted into heat and other energy forms. The external evidence of the process will be the rise in temperature and corresponding expansion of the rotating mass.

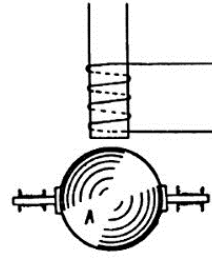

Fig. 1

Such is the energy transformation. Let us now review the conditions under which it takes place. Passing over the features of the "work" energy applied and the energy produced in the transformation, it is evident that the primary and essential condition of the whole process is the presence of the magnetic field. In the absence of this influence, every other condition of this particular energy operation might have been fulfilled without result. The magnetic field is, in reality, the determining agency of the process. But this field of magnetic force is itself an energy influence. Its existence implies the presence of energy;

it is the external manifestation of that energy (usually described as stored in the field) which is returned, as shown by the spark, when the exciting circuit of the electro-magnet is broken. The transformation of the dynamical or "work" energy (§ 31) applied to the rotating sphere is thus carried out by the direct agency, under the power, or within the field of this magnetic energy influence, to which, accordingly, we apply the expression, incepting energy influence, or incepting energy.

There are several points to be noted with regard to these phenomena of inception. In the first place, it is clear that the energy which thus constitutes the magnetic field plays no active part in the main process of transformation: during the operation it neither varies in value nor in nature: it is entirely a passive agent. Neither is any continuous expenditure of energy required for the maintenance of this incepting influence. It is true that the magnetic field is primarily due to a circulatory current in the coils or winding of the electro-magnet, but after the initial expenditure of energy in establishing that field is incurred, the continuous expenditure of energy during the flow of the current is devoted to simply heating the coils. A continuous heat transformation is thus in progress. The magnetic energy influence, although closely associated with this heat transformation, yet represents in itself a distinct and separate energy feature. This last point is, perhaps, made more clear if it be assumed that, without altering the system in any way, the electro-magnet is replaced by a permanent magnet of precisely

the same dimensions and magnetic power. There would then be no energy expenditure whatever for excitation, but nevertheless, the main transformation would take place in precisely the same manner and to exactly the same degree as before. The incepting energy influence is found in the residual magnetism.

If an iron ball or sphere were substituted, in the experiment, for the copper one, the phenomena observed on its rotation would be of an exactly similar nature to those described above. There is, however, one point of difference. Since the iron is magnetic, the magnet pole will now exert an attractive force on the iron mass, and if the latter were in close proximity to the pole (Fig. 1), a considerable expenditure of energy might be required to separate the two. It is evident, then, that in the case of iron and the magnetic metals, this magnetic influence is such that an expenditure of energy is required, not only to cause these materials to move in rotation so as to cut the lines of the field of the magnetic influence, but also to cause them to move outwards from the seat of the influence *along* the lines of the field. The movements, indeed, involve transformations of energy totally different in nature. Assuming the energy to be obtained, in both cases, from the same external source, it is, in the first instance, converted by rotatory motion in the field into electrical and heat energy, whereas, in the second case, by the outward motion of displacement from the pole, it is transformed and associated with the mass in the form of energy of position or energy of displacement relative to the pole. Since

the attractive force between the iron mass and the pole may be assumed to diminish according to a well-known law, the energy transformation per unit displacement will also diminish at the same rate. The precise nature and extent of the influence of the incepting agent thus depend on the essential qualities of the energised material under its power. In this case, the magnetic metals, such as iron, provide phenomena of attraction which are notably absent in the case of the dia-magnetic metals such as copper. Other substances, such as wood, appear to be absolutely unaffected by any movement in the magnetic field. The precise energy condition of the materials in the field of the incepting influence is also an important point. The incepting energy might be regarded as acting, not on the material itself, but rather on the energy associated with that material. From the phenomena already considered, it is clear that before the incepting influence of magnetism can act on the copper ball, the latter must be endowed with energy of rotation. It is on this energy, then, that the incepting influence exerts its transforming power. It would be useless to energise the copper ball, say by raising it to a high temperature, and then place it at rest in the magnetic field; the magnetic energy influence would not operate on the heat energy, and consequently, no transformation would ensue.

It is easy to conceive, also, that in the course of an energy transformation, the material may attain an energy condition in which the incepting influence no longer affects it. Take once more the case of the iron ball. It is well known that, at a high

temperature, iron becomes non-magnetic. It would follow, then, that if the rotational transformation in the magnetic field could be carried out to the requisite degree, so that, by the continuous application of that heat energy which is the final product of the process, the ball had attained this temperature, then the other transformation consequent on the displacement of the ball from the attracting pole could not take place. No change has really occurred in the incepting energy conditions. They are still continuous and persistent, but the energy changes in the material itself have carried it, to a certain degree, beyond the influence of these conditions.

15. *Cohesion as an Incepting Influence*

Other aspects of incepting energy may be derived from the examples cited above. Returning to the case of the rotating copper sphere, let it be assumed that in consequence of its rotation in the magnetic field it is raised from a low to a high temperature. Due to the heating effect alone, the mass will expand or increase in volume. This increase is the evidence of a definite energy process by which certain particles or portions of the mass have in distortion gained energy of position—energy of separation—or potential energy relative to the centre of the sphere. In fact, if the mass were allowed to cool back to its normal condition, this energy might by a suitable arrangement be made available for some form of external work. It is obvious, however, that this new energy of position or separation which has accrued to the mass in its heated condition has in reality been obtained by the transformation of the "work" energy originally applied. The abnormal displacement of certain particles or portions of the mass from the centre of the sphere is simply the external evidence of their increased energy. Now this displacement, or strain, due to the heat expansion, is carried out against the action of certain cohesive forces or stresses existing between the particles throughout the mass. These cohesive forces are, in fact, the agency which determines this transformation of heat into energy of position. Their existence is essential to the process.

But these cohesive forces are simply the external manifestation of that energy by virtue of which the mass tends to maintain its coherent form. They are the symbol of that energy which might be termed the cohesion energy of the mass—they are, in fact, the symbol of the incepting energy influence of the transformation. This incepting energy influence of cohesion is one which holds sway throughout all solid material. It is, therefore, found in action in every movement involving the internal displacement or distortion of matter. It is a property of matter, and accordingly it is found to vary not only with the material, but also with the precise physical condition or the energy state of the material with which it is associated. In this respect, it differs entirely from the preceding magnetic influence. The latter, we have seen, has no direct association with the copper ball, or with the material which is the actual venue of the transformation. As an energy influence, it is itself persistent, and unaffected by the energy state of that material. On the other hand, the cohesion energy, being purely a property of the material which is the habitat of the energy process, is directly affected by its energy state. This point will be clearer by reference to the actual phenomena of the heat transformation. As the process proceeds, the temperature of the mass as the expansion increases will rise higher and higher, until, at a certain point, the solid material is so energised that change of state ensues. At this, the melting-point of the material, liquefaction takes place, and its cohesive properties almost vanish. In this fashion, then, a limit is clearly imposed

on the process of heat transformation in the solid body—a limit defined by the cohesive or physical properties of the particular material. In this limiting power lies the difference between cohesion and magnetism as incepting influences. Looking at the whole dynamo-electric transformation in a general way, it will be clear that the magnetic influence in no way limits or affects the amount of dynamical or "work" energy which may be applied to the rotating sphere. This amount is limited simply by the cohesive properties of the material mass in rotation. The magnetic influence might, in fact, be regarded as the primary or inducing factor in the system, and the cohesion influence as the secondary or limiting factor.

16. *Terrestrial Gravitation as an Incepting Influence*

The attractive influence of gravitation appears as an incepting agency in terrestrial as well as in celestial phenomena. In fact, of all the agencies which incept energy transformations on the earth, gravitation, in one form or another, is the most universal and the most important. Gravitation being a property of all matter, no mundane body, animate or inanimate, is exempt from its all-pervading influence, and every movement of energised matter within the field of that influence leads inevitably to energy transformation.

Let us take a concrete illustration. A block of solid material is supported on a horizontal table. By means of a cord attached, energy is applied to the block from an external source, so that it slides over the surface of the table. As a result of this motion and the associated frictional process, heat energy will make its appearance at the sliding surfaces of contact. This heat energy is obviously obtained by the transformation of that energy originally applied to the block from the external source. What is the incepting influence in this process of transformation? The incepting influence is clearly the gravitative attraction of the earth operating between the moving block and the table. The frictional process, it is well known, is dependent in extent or degree on the pressure between the surfaces in contact.

This pressure is, of course, due to the gravitative attraction of the earth on the mass of the block. If it be removed, say by supporting the block from above, the heat-transformation process at the surfaces at once terminates. Gravity, then, is the primary incepting influence of the process. The effect of gravitation in transformation has apparently been eliminated by supporting the block from above and removing the pressure between block and table. It is not really so, however, because the pressure due to the gravitative attraction of the earth on the block has in reality only been transferred to this new point of support, and if a movement of the block is carried out it will be found that the heat transformation has been also transferred to that point. But there are also other influences at work in the process. The extent of the heat transformation depends, not only on the pressure, but also on the nature of the surfaces in contact. It is evident, that in the sliding movement the materials in the neighbourhood of the surfaces in contact will be more or less strained or distorted. This distortion is carried out in the lines of the cohesive forces of the materials, and is the real mechanism of the transformation of the applied work energy into heat. It is obvious that the nature of the surfaces in contact must influence the degree of distortion, that is, whether they are rough or smooth; the cohesive qualities of the materials in contact will depend also on the nature of these materials, and the extent of the heat transformation will be limited by these cohesive properties in precisely the same way as described for other examples (§ 15

Конец ознакомительного фрагмента.