that of the Hamitic Berbers who have lived in the vales of the Atlas from the remotest times. In attributing the megalithic monuments of western Europe and northern Africa exclusively to Celtic and Germanic peoples, he proceeds beyond what archæologists have conceded. The difficult problem of the conflicting physical types among the Celtic nations — the one short in stature, brachycephalic, and brown, the other tall, dolichocephalic, and blond — he summarily solves by supposing either an intermixture with other types or a change in mode of life and climatic environment. The Celtic language he places, as do now all leading linguists, within the Aryan group and in that category most closely allied to the Italic stock.

The same topic is discussed very ably by the French anthropologist, Dr. R. Collignon, in one of the recent bulletins of the Société d'Anthropologie. After setting forth in strong lights the embarrassing nature of the evidence, he finally leans to Broca's opinion, that the small, brown, brachycephalic Celts are a mixed type; while the true and primitive type, which we may call the Kymric, was one of tall stature, with reddish or blond hair and dolichocephalic crania. An interesting portion of Dr. Collignon's memoir is where he points out the persistency of various physical types in portions of France for many centuries, even for thousands of years, as an examination of ancient sepulchres has proved.

MOTION AND HEAT.

[Continued from p. 135.]

BUT nature has other means of compensation for the molar motion converted into heat. Incalculable units of heat-energy are stored up in vegetable and animal organisms; and in evaporation still more countless units of heat-energy are converted first into molecular, and then into molar motion, in its most terrific forms.

Evaporation and the function it performs in the economy of nature are as yet little understood. It appears to be a form of expansion, and, like expansion, it increases with elevation of temperature; but it does not stop when expansion ceases, for it is well known that ice continues to evaporate below zero C.

It is undoubtedly the great instrumentality for converting heat into motion. It is constantly acting, and in the trade wind region eleven feet of the ocean's depth is annually lifted up and carried off by this silent process. Molecule by molecule the aqueous vapor is torn from the liquid mass, each one carrying or embodying so much heat and thus reducing temperature; in other words, each molecule moved in evaporation furnishes work in the form of motion for so much of the force or energy which was dynamic in the form of heat.

Molecular motion, evidenced by gaseous expansion in a closed vessel, is governed by the general laws of motion;[1] and it seems incredible and anomalous to hold that the inert molecule moved in evaporation, which unites with its fellows as aqueous vapor, and comes down again as rain, is not governed by the same laws of the motion which this force or energy, in the form of heat, imparts to it in the atmosphere.

If these laws of motion do apply to the motion imparted by converted heat to evaporated molecules, we have an origin for the trade winds far more simple than the generally supposed convection. The trade winds blow over the tropical water where convection is smallest, and not over tropical land, where it is greatest.

But it is sufficient for the present purpose to show that heat is converted into motion in the process of evaporation; and that even if the force or energy which, in the form of molar motion, is directly converted into heat by resistance, cannot be directly reconverted from heat into molar motion, there is in terrestrial nature a law of compensation which tends to convert any surplus of dynamic heat into dynamic motion, and thus preserve the equilibrium which has been observed.

Professor Tyndall has taught us how to trace radiant energy from one body to another, and how the dark or heat rays may be concentrated into the more intense light rays, after they have left the body which sent them forth. And Faraday, Joule, Mayer, Grove, and others have taught us the law of conservation, by which we know that this energy, when it disappears, is not annihilated, and when it reappears it is not a new creation. We see its manifestation in motion, molar and molecular; we feel it in heat, we see it in light and color, and hear it in sound. The motion may cease; light may be extinguished in darkness; colors may fade, and sound give place to profound silence; but the energy or force which caused all these phenomena was the same before they appeared as during their continuance, and its potential existence remains after their disappearance with the same measurable units as when it was dynamic, and subject to observation.

When the demon was cast out of the man and went into the swine, and they ran into the sea, it was the swine, and not the demon, who were drowned. He doubtless passed out into demon land, ready to again become dynamic when occasion offers.

This force, or energy, we are trying to trace, while dynamic, can only do so much work at one time. If it is entirely occupied in moving a mass, it cannot do other mechanical work; and if entirely occupied in molecular motion it cannot elevate temperature, nor become radiant as heat or light. And when rendered entirely potential, as when a ball thrown up is lodged on the roof of a house, or when heat becomes latent in liquefaction or evaporation, or when the sun's energy is locked up in the molecular structure of vegetable and animal organisms, it can do no work at all until again rendered dynamic. Its power and capacity when released is identically the same, neither more nor less, than when it was locked up. This is true whether it was locked up as motion or locked up as heat.

It has always seemed to me to be unfortunate and misleading that Professor Tyndall should have adopted "Heat a Mode of Motion" as the title of the book in which he gives to the world an account of his great and valuable researches in the delimitation of this force. Like the term "Mechanical Equivalent of Heat," it results from mistaking the thing done for the thing doing it, the effect for the cause. Heat is not a mode of motion, and it would be just as inaccurate to call gravity a mode of weight, or magnetism a mode of pull, and even less inaccurate to call motion a mode of heat. Motion and heat are forms or manifestations of the same force or energy, and when radiant, as heat and light, it is more nearly disconnected from ponderable matter than when it assumes the form of molar or molecular motion.

Motion, in all its forms, is the transference of material substance, ponderable or imponderable matter, from one place or part of space to another; it is the state of ponderable matter in which the forces acting on it are not in equi-

[1] "Molecular Motion in the Radiometer," etc., p. 16.

librium. *Rest* is the opposite of motion; it is the state of matter in which the physical forces acting on it are in equilibrium; that is when the force impelling motion in a given direction is counteracted by an equivalent force impelling motion in the opposite direction; or is resisted by a superior force. A stone *rests* on the surface of the earth because the force of gravity acting on the stone is resisted by the force of cohesion in solid matter; but the force continues although there is no motion resulting from it. The stone *sinks* in water, that is, it moves from the force of gravitation because the force of cohesion in the molecules of water is insufficient to counteract the force impelling motion; but when the force of cohesion in the molecules is sufficiently increased by congellation, the stone *rests* on the surface of the ice. So a top spun rapidly *rests* on its peg, because the force giving it horizontal motion counteracts the pull of gravity which causes it to fall when the rotation ceases.

Dr. Mayer defines force as "Something which is expended in producing motion; and this something which is expended is to be looked upon as a cause equivalent to the effect, namely to the motion produced."[1]

This is obviously too narrow to include even dynamic energy. Two horses pulling a vehicle in opposite directions with the same force would produce no motion; divide the force by unhitching one of the horses, and the vehicle moves. Then, according to this definition, we have the absurdity that the whole force is nothing, but half of it is something.

A correct definition of phpsical force is that it is something producing the state of ponderable matter in which it is subject to human observation. Whether the state be one of motion or rest, hot or cold, solid, liquid, gaseous, colored, etc., it is the result of force. We only know physical force from its effects on ponderable matter, and we only know ponderable matter as affected by force.

The supposed difficulty in the concept of an element in nature entirely distinct from, but inseparably connected with, ponderable matter, is entirely factitious. Time and space are such elements, entirely distinct from, and inseparably related to, ponderable matter; and the concept of force as above defined is as absolute and imperative as the concept of time, the concept of space, or the concept of matter itself. The progress of science in tracing a force through its various manifestations, as has been done to some extent with gravity, confirms the primal concept of force which comes with the very dawn of intelligence.

The still more abstract concept of law by which any force is what it is, is also primal, absolute, and inevitable in every human intelligence.

Whether all ponderable matter is one as claimed by some philosophers, or whether all force is one as claimed by other philosophers, are speculations which, with our present knowledge of these elements, are idle if not mischievous.

It is undoubtedly from phenomena resulting from the apparent differences in ponderable matter, and the apparent differences in the forces acting on it, that real progress in unravelling nature has been made.

We need a specific name for this force of which molar motion, molecular motion, heat, and light, are manifestations. There seems to be no doubt that positive electricity is also one of its forms. Electricity, like heat, is developed by friction and by chemical reaction; and its mechanical equivalent, or, more accurately, the electric equivalent of molar motion, doubtless is the same as the heat equivalent of molar motion, or differs from it by some law which will prove the identity of the force. Dr. Mayer suggested that whether friction, which of course is resisted molar motion, developed heat or electricity, depended on the character of the substances used in the friction, homogeneous substances developing heat and heterogeneous substances electricity. There appears to be no essential difference in the chemical reactions which develop heat and those which develop electricity; the difference apparently being in the mode of applying the force or energy and the substances to which it is applied.

Electricity passes from dynamic to potential under not precisely the same conditions as heat, but not more essentially different than the conditions under which motion passes from dynamic to potential, and its dynamic power is exhausted in doing work. This feature of electrical energy has been utilized by Mr. Hodges in his new lightning-rod, constructed of copper ribbon, so arranged that the copper will be dissipated by the electric current.

But I must leave this branch of the subject to those better informed as to the phenomena.

There may be still other forces, or rather forms of force, which may be found to have equivalence and mutual convertibility with heat. It is equivalence and mutual convertibility which warrants the assumption that motion and heat are phenomena resulting from, or, more accurately, are manifestations of, the same force.

In speaking of the force itself, I have used the expression "force or energy" because these words have several meanings, and the sense in which they are synonymous comes nearer the expression of the concept sought to be presented than any other phrase that has occurred to me. But it would facilitate induction if we could call it "Ergic Force," or "Ergism," or give it some other specific designation to distinguish it from other forces, or force generally, including under the term "Ergism" every manifestation of force for which a heat equivalent may be found. This name seems appropriate because it suggests the element in nature which is the basis of work It enables us to grasp a concept of the force distinct from its manifestation in any one of its forms; and if the delimitation itself is correct we can class as "Antergic" the forces, like cohesion, which have no heat equivalent, but which, under certain conditions, render dynamic "Ergism" potential. DANIEL S. TROY.

[1] "Correlation and Conservation of Forces," D. Appleton & Co., 1890, p, 335.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

On request in advance, one hundred copies of the number containing his communication will be furnished free to any correspondent.

The editor will be glad to publish any queries consonant with the character of the journal.

Further Notes on the Loup and Platte Rivers.

SEVERAL years since it was my privilege to spend several weeks studying the peculiar drainage of central Nebraska. I have therefore been much interested in the papers of Professors Hicks and Davis in recent numbers of *Science*. I trust I shall not be intruding if I call attention, at this time, to a few additional facts which seem to have a bearing on the discussion.

1. The streams north of the Platte, from Kearney to Fremont, have their courses first quite regularly south-east, then, as they near the Platte, they turn to the east-north-east, adopting the direction of that stream. Not only is this true of the Loup system, as Professor Hicks has well shown, but also of Shell Creek and Maple Creek further east.

2. There are dry channels, but little above the streams, connecting the Loup with Shell Creek, and Shell Creek with the Maple, which are known as Lost Creek and Dry Creek. These lie in the