In those cases where steel diaphragms were employed, there was always a notable induced current, even when the reading of the magnetometer was zero. This was probably due to a slight residual magnetization of the diaphragms.

The results stated in this paper may serve to explain a phenomenon which has seemed somewhat obscure. Frequent attempts have been made to increase the efficiency of a magneto-transmitter by polarizing the diaphragm as well as the magnet; a common way of doing this being to employ a horseshoe-magnet, one leg of which is in contact with the edge of the diaphragm, while the other, about which the coil is wound, is placed in its usual position opposite the centre. But as a general rule little or no gain has seemed to result therefrom, so far as can be judged by the performance of such instruments in actual practice. It is quite probable in this case that the increased approach to saturation of the diaphragm may have so great an effect as entirely to prevent the expected improvement.

It will also be seen from our results that an increase in the thickness of the diaphragm of a magneto-transmitter tends to allow of the use of a stronger magnet, and for a given amplitude of vibration to produce a stronger current. But it must be remembered, on the other hand, that the greater rigidity of the thick diaphragm will diminish this range of vibration under the action of the voice, a difficulty which may to a certain extent be remedied by using a diaphragm of large diameter.

XLVIII. *On Diamagnetism and the Concentration of Energy.*

By J. Parker, *B.A., late Scholar of St. John's College, Cambridge**.

MANY of the discoveries which have been made in Physical science in recent times may be classed under two great heads—the principle of the Conservation of Energy and Carnot's principle. These principles are closely related; the former being mainly an experimental conclusion, the latter a deduction from the first by means of Carnot's axiom. It follows, therefore, that whenever the principle of Energy ceases to hold, Carnot's principle will fail at the same time, but that the failure of Carnot's principle does not necessarily invalidate the principle of Energy.

Carnot's principle only holds when the material system which we are considering is restricted to receiving or losing energy from other systems in the forms of heat and mechanical work;

* Communicated by the Author.

but the passage of heat may take place either by conduction or radiation. The simplest case is obtained by supposing that there are only two external bodies with which the system can exchange heat. It was then assumed by Carnot that, in a complete cycle, it will be impossible, without an expenditure of mechanical work, to transfer heat by means of the system from the colder of the two bodies to the hotter. Mechanical work can therefore only be obtained from the system, during a complete cycle of operations, when it absorbs heat from the hotter of the two bodies and gives out heat to the colder. Consequently, if the energy of a material system consist entirely of heat of uniform temperature, it will be impossible to transform any of it into work.

Now it is found that all kinds of energy tend to pass into heat, and the passage of heat from a hot body to a colder (without the production of work) is an everyday occurrence. It has therefore been predicted with confidence that our universe is approaching a state in which the whole of its energy will be in the form of heat of uniform temperature, and all kinds of mechanical action impossible.

The following consideration, however, appears to offer a serious difficulty to the universal application of Carnot's principle. Thus, let A be a piece of permanently magnetized hard steel; and let B be a piece of a soft diamagnetic substance, as bismuth, which, when brought within the influence of A, becomes magnetized by induction and is *repelled* by A. Then suppose that the following cycles of operations are performed at constant temperature:—

(*a*) Let B be removed from a position P, remote from A, to a second position Q, near A, so slowly that at every instant the magnetization of B has its maximum value; and let the work expended be called W. Then let B return slowly to its original position P by the former path reversed. The work W, which had been expended, will be recovered; so that, on the whole, there will be neither gain nor loss of mechanical work.

(*b*) Let B be removed from P to Q so rapidly that the magnetization of B has not time to alter sensibly. The work done on B will be less than W. After allowing B to remain long enough in the position Q to attain its permanent magnetic state, let it return rapidly from Q to P by the first path reversed. The work restored by B will be greater than W. There is therefore a gain of work in this cycle performed at constant temperature, contrary to Carnot's principle.

There are three ways of looking at this difficulty:—

(1) We may suppose that the work which has been obtained

has been created from nothing. This would involve a contradiction both of the principle of Energy and of Carnot's principle, and is the view generally held at present.

(2) The development of magnetism in diamagnetic bodies may be instantaneous, unlike all other physical phenomena, which require *time*.

(3) The work which has been gained may have been produced from *heat*; so that the principle of Energy stands, while Carnot's principle falls. Employing this work to transfer heat from a cold body to a hotter, we have a means of producing inequalities of temperature—that is, a Concentration of Energy—without external assistance. Carnot's principle will then require to be modified.

It has been shown by Clausius that for any cycle which satisfies Carnot's principle in its usual form, we have $\int \frac{Q}{t} = 0$ if the cycle be reversible, and $\int \frac{Q}{t} < 0$ in other cases, Q being the heat absorbed when the absolute temperature is t. It seems probable that these results may be true for soft paramagnetic bodies, but that for diamagnetic bodies we should have $\int \frac{Q}{t} = 0$ for a reversible cycle, and $\int \frac{Q}{t} > 0$ in other cases. We might then obtain expressions for the energy and entropy of a magnetized system, and a thermodynamical theory could be formed for Magnetism as easily as for Electricity.

XLIX. *On the probable Cause of the Displacement of Shore-lines, an Attempt at a Geological Chronology.* By A. Blytt*.

THIS memoir is an attempt to further develop and establish ideas which I put forward five years ago. It contains an attempt to establish a chronology in geology. It sets forth what the English call "a working hypothesis," without claiming to be anything else. It was the distribution of plants which first introduced the author to this great question; but the problem of a chronology in geology cannot be solved without the co-operation, it may perhaps be said, of all naturalists. It certainly cannot finally be solved by any one man. In putting forth my hypothesis I must in the

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