LETTERS TO EDITOR

ESCHENHAGEN'S ELEMENTARY MAGNETIC WAVES.

The recent observations of Eschenhagen seem to have shown that his delicate magnetic needles oscillate in regular periods, sometimes in 12 or 15 seconds, but more frequently in 30 seconds. The normal rate of vibration of his needle in an undisturbed field is about 8 seconds. Experiments made with other needles gave similar results; but these also had a normal periodic vibration in 8 seconds. He concludes that these 30-second vibrations represent fundamental normal phenomena of terrestrial magnetism.

Those who recognize the possibility that electromagnetic waves emanate from the Sun, or that they in general permeate the space through which the Earth is traveling, must expect to find waves of very various preperiodic times affecting the Earth simultaneously, and in addition to periodic impulses there may sometimes occur non-periodic and violent impulses, which, however, may possibly be analyzable groups of concurrent waves. In order to detect the presence of complex combinations of waves, we need some arrangement that shall analyze such a group into its elements just as the prism analyzes the groups of short visual waves, or just as a series of resonators analyzes a complex group of acoustic waves. This same principle of a resonator was recently applied by J. Wilsing and J. Scheiner. (See *Wiedemann's Annalen*, Bd. LIX, p. 782, and also *Astronomische Nachrichten*, Band 142, No. 3386.) Their results were negative, and indeed, as was remarked by Professor John Trowbridge (*Monthly Weather Review*, November, 1896, Vol. XXIV, p. 409), "It is doubtful if such radiations can be detected by their arrangement unless it is made extraordinarily sensitive, in which condition it would be affected by slight jars and mechanical vibrations. One should repair to an isolated mountain peak to carry out such experiments."

An equivalent, but possibly more sensitive arrangement is the delicate magnetic needle when its indications are properly interpreted. A needle that has a normal period of vibration of 8 seconds is equally sensitive to all impulses or waves whose periods are harmonic with it, especially those of 1, 2, 4, 8, 16, 32, 64 seconds interval, while one having some other normal periodic time will be equally sensitive to its own harmonic set of waves. The fact that an 8-seconds needle, or strictly-speaking a 7.5-seconds needle, oscillates quite regularly in intervals of 30 seconds, merely demonstrates that it received impulses at regular intervals such as forced it from its normal 7.5 into its actual 30-seconds vibration, and these outside impulses must have come to it at regular intervals or

either 7.5 or 3.75 or other smaller subdivisions of the normal period. By the cumulative influence of these impulses the needle may be forced to make a large oscillation, even when the individual impulses are quite feeble, so that in this case the needle is more sensitive or rather more valuable than the apparatus of Wilsing and Scheiner.

If now we enlarge our magnetic apparatus into a battery of a hundred such needles, each having a normal period slightly different from its neighbor, and representing a given set of prime numbers, we shall be able to detect the presence of a large variety of periodic electromagnetic impulses. It is fair to presume that such a variety of impulses is always present in the terrestrial magnetic field, but I know of no reason to suppose that any special rate of vibration should occur at one time more than at another. The oscillations of Mr. Eschenhagen's magnet simply prove that on certain days and hours its particular harmonic wavelength happened to occur, and when his magnet made no record we may presume that other magnets having different periods would have done so.

Instead of a cumbersome arrangement of numerous magnets it would be simpler, and certainly very interesting, to attach a small bit of copper to his 8-seconds magnet so as to slightly alter its moment of inertia, and therefore its time of vibration. If the small mass be adjustable, one might by experiment so adjust the needle at any moment that it will respond to some other vibration; that is, the one active at the station.

United States Weather Bureau.

CLEVELAND ABBE.

The following reply to Professor's Abbe's criticism has been received by the editor:

"In meiner Abhandlung¹ ist der Beweis erbracht, dass mein aperiodisches Instrument auf künstliche Schwingungen reagirt ohne in Eigenschwingungen zu gerathen. Inzwischen habe ich erfolgreiche Versuche gemacht, allerlei verschiedene Perioden künstlich durch Drehen von Magneten hervorzubringen. Der Apparat zeichnet alle auf, ohne in Eigenschwingungen zu gerathen. Dasselbe thut übrigens auch die Natur. Es kommen alle Perioden von etwa 12 sec. an aufsteigend vor bis 100 sec. und mehr.

Es erscheint nun gar nicht nöthig sich die Aufgabe so zu stellen wie Herr Professor Abbe, nämlich viele Instrumente von verschiedener Schwingungsdauer aufzustellen, sondern nachzuweisen, dass *ein* Instrument auf *alle* mögliche Perioden reagirt.

Wir verfolgen jetzt die Sache mit neuen, noch empfindlicheren Apparaten mit bestem Erfolg. Ich denke für Bristol eine Mittheilung auszuarbeiten."

M. ESCHENHAGEN.

Potsdam, 5. Juni, 1898.

¹ Cf. Vol. II, pp. 105-114.