THE EFFECT OF NOISE ON HEARING

Referring to the effect of noise on hearing, Correspondent "B" in Science of March 6, 1925, page 260, proposed a theory which, to use his words, "seemed reasonable." For his information, and for the information of others who have been interested in the discussion, I shall present a couple of cases in which "a more or less regular succession" of vibrations is employed to jar a mechanism having a vibration of its own, to a state of higher sensitivity.

The power delivered by a steam turbine is governed by a valve controlling the admission of steam to the turbine. If the demand made upon the turbine must be continually varied in accordance with varying conditions of the system of which the turbine is a part, the movable part of the valve must function quickly and smoothly, in order to supply the turbine with the proper amount of steam at any instant. This part has therefore been made to move, in many such turbines, with a continuous oscillatory motion, at all times. In this way the response is quickened and sticking avoided. The actual or total motion consists of a sort of high frequency wave of small amplitude superposed upon an irregular wave of greater amplitude. The amount of steam admitted is practically the same as if only the larger wave were followed, but it is found that the auxiliary agitation augments the sensitivity.

The second example of the application of the same principle is connected with my own work.

Signals from ocean cables are ordinarily recorded by means of a "siphon recorder" upon a moving paper tape. The incoming impulses are weak, and the friction of the "pen," or siphon, upon the paper, is comparatively great. Consequently an arrangement is provided whereby the siphon can be kept constantly agitated with infinitesimal vibrations. The friction is thus considerably reduced, and the sensitivity increased. Greatest sensitivity is obtained when the direction of the vibrations is perpendicular to the plane of the paper.

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A LUMINOUS SPIDER

One day in Central Burma the trail in the jungle was exceptionally difficult. It was long past noon when I realized that the return journey would be equally long and tiring.

Camp lay on the other side of a long range of hills and there was a short cut from the main trail that would save several miles, but this trail was faint. I reached the supposed cut-off about dusk and followed it upward. Darkness came on swiftly and my pony began to stumble. Somewhere we had missed the trail, for at intervals I could still glimpse the crest of the hills and I knew my general direction.

Fireflies sparkled here and there. Presently a few feet away I saw a ball of light as large as one's thumb. It was stationary. Tying the horse, I approached it as carefully as possible, finding it surrounded by thorny bushes. It did not move and I pressed the brush aside until I was directly over it and then struck a match. There in full view was a spider, his large oval abdomen grayish, with darker markings. Still he did not move, and as the match died out his abdomen again glowed to full power, a completely oval light, similar in quality to that of the fireflies. Remembering native tales of poisonous insects, I wrapped a handkerchief around one hand, parted the brush with the other, and when close enough made a quick grab. Alas! The handkerchief caught on a stick before I could encircle him and my treasure scurried away. I followed as quickly as possible, but the light soon disappeared under stones, brush or in some burrow, for I never saw it again.

Many nights I searched in the jungle and questioned natives and white officers who had passed through that district, but apparently no one else had reported a luminous spider, nor can I find record of any known elsewhere.

Burmese never leave their houses after dark on account of their fear of spirits, so it is not surprising that the natives had never seen one, but some other traveler may be so fortunate as to capture one of these spiders.

The place where I saw the specimen was between the villages of Kyawdaw and Thitkydaing, Pakkoku District, about one hundred and twenty miles west of Mandalay, Burma, in April, 1923.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR OBTAINING DIRECTLY THE SECOND DERIVATIVE OF A CURRENT-VOLTAGE CHARACTERISTIC CURVE[1]

There has been much discussion of the criteria to be adopted for determining critical potentials from the current-voltage curves of the hot-cathode discharge. Most of the refinements which have been proposed have been little used. In general, the attempt is made to locate as precisely as possible the

[1] Published by permission of the director of the Bureau of Standards of the U. S. Department of Commerce.

position of a maximum, a flex or a "kink," as the case may require. It is often difficult to judge accurately the position of such points. To locate maxima, the device of drawing the curve $\frac{di}{dv}$ is sometimes adopted. (i and v are the current and potential, respectively.) This is unsatisfactory, because the values of $\frac{di}{dv}$ in the vicinity of a maximum are obtained as a small difference of two large numbers.

Dymond[2] has devised a method for recording directly and precisely a curve which is practically identical with that of $\frac{di}{dv}$ plotted against voltage. A small alternating potential Δv is superposed on the potential v by means of a commutator. During one half revolution of the commutator the current has the value $i + \Delta i$; during the other half, it is $i - \Delta i$. The current is now passed through a second commutator rotating on the same shaft as the first. The commuted current is $i + \Delta i$ during the first half-cycle and $-i + \Delta i$ during the second. Thus, it is equivalent to an alternating current i superposed on a steady current Δi, and gives deflections proportional to Δi on a long-period galvanometer. Dymond suggests that a transformer or a bridge could be used to suppress the current i before the commutation, but in practice he found that this current was not large enough to injure his galvanometer and that it did not affect his readings.

This note describes a method for recording directly the curve $\frac{d^2i}{dv^2}$. Of course, the zeros of this curve give the positions of flexes of the $i - v$ curve. Suppose that an alternating potential Δv, obtained either from a transformer or from the first commutator, is superposed on v as before and that the second commutator is omitted from the circuit. Let the steady current i be carefully balanced out. Then the currents passing through the galvanometer during the first and second parts of the commutator cycle are, respectively,

$$\Delta_1 i = \frac{di}{dv} \Delta v + \frac{1}{2} \frac{d^2i}{dv^2} (\Delta v)^2 + \frac{1}{6} \frac{d^3i}{dv^3} (\Delta v)^3 + \ldots$$

and

$$\Delta_2 i = -\frac{di}{dv} \Delta v + \frac{1}{2} \frac{d^2i}{dv^2} (\Delta v)^2 - \frac{1}{6} \frac{d^3i}{dv^3} (\Delta v)^3 + \ldots$$

The corresponding expressions for the case of a sine wave are easily written down. The galvanometer will record $\frac{1}{2} \frac{d^2i}{dv^2} (\Delta v)^2$ with a high degree of approximation.

[2] Proc. Camb. Phil. Soc. 22, p. 405, 1924; Proc. Roy. Soc. A, 107, p. 291, 1925.

In addition to its applications to critical potential problems, which are limited only by the inconstancy of the currents to be measured, it is thought that this method may prove valuable in studying the characteristics of thermionic devices, where detecting ability depends essentially on $\frac{d^2i}{dv^2}$.

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SPECIAL ARTICLES

THEORY OF THE PROPAGATION OF SHORT RADIO WAVES OVER LONG DISTANCES

RECENT experiments by Taylor, to be published shortly, on the transmission of radio waves of wave-length from 3,000 to 16 meters over distances up to 10,000 miles, have brought to light new facts. Those of particular interest in the present preliminary note concern themselves with the change in the intensity of the received signal with the distance from the transmitter. It has been found that for wave-lengths shorter than 50 meters the received intensity decreased as the distance from the transmitter was increased, reaching a value too small to be observed at a distance of a hundred miles or so. With further increase of distance the received signal remained undetectable until a point was reached where the received signal became strong again, rising rapidly to a maximum and thereafter decreasing rather slowly. The length of the region of silence, which we may call the "skip distance," was found to increase rapidly as the wave-length decreased, being roughly 400 miles for wave-length 32 meters and 1,300 miles for 16 meters, for daylight transmission and specified conditions of transmission and reception.

In a simple theoretical explanation of these facts we distinguish two portions of the wave propagated from the transmitting antenna, one of which clings to the surface of the earth and decreases rapidly in intensity with the distance until it is lost, and the other which moves in an upward direction and experiences reflection from the Heaviside layer. This layer is assumed to be a dispersive medium with a critical frequency corresponding to a wave-length between 100 and 200 meters. This critical frequency results from the motions of the electrons in the earth's magnetic field as suggested by Appleton and by Nichols and Schelling. When plane polarized radiation with electric vector in the plane of incidence is reflected from such a medium into air anomalies will occur at the Brewster and Snell angles, the reflected intensity being zero at the Brewster angle and 100 per cent. at the Snell angle. It is assumed that the portion of the wave propagated upward is