change of density of 133 parts per million, or 0.027 unit of atomic weight.

The evidence that a separation has actually been obtained rests in the quantitative agreement between our results and those of Bronsted and von Hevesy, with respect to the rate of separation (efficiency of process). If we consider the efficiency of our more ideal apparatus as 100 per cent., that of the other investigators is 75 per cent. while that of our less ideal apparatus used in the greater part of the work in order to save the expense of carbon dioxide as a cooling agent, was 93 per cent. when the vaporization was slow, and as low as 80 per cent. for a rapid vaporization. We have obtained evidence that there is a slight separation of isotopes produced when mercury is *distilled* slowly at a sufficiently low pressure.

The rate of separation of two isotopes varies as the *square* of the difference of their atomic (or molecular) weights, and the product of their mol fractions, as the logarithm of the cut, and inversely as the atomic (or molecular) weight.

A diffusion coefficient has been calculated to represent the relative separation of isotopes attained in terms of the atomic weight change, when a definite cut is made. The values are 0.00843 for neon, 0.00868 for magnesium, 0.00450 for lithium, 0.00758 for nickel, while the experimentally determined coefficient for mercury is 0.00570. For chlorine the coefficient is 0.00950 for hydrogen chloride, 0.00690 for methyl chloride, 0.00494 for chlorine, 0.00413 for methylene chloride, 0.00295 for chloroform, and 0.00229 for carbon tetrachloride.

It is of interest to note that there are 9 isotopic forms of $MgCl_2$ (or more if there is a chlorine of atomic weight equal to 39), 7 of $C_6Cl_6$, and if mercury consists of 6 isotopes, there are 63 isotopic forms of $Hg_2Cl_2$. In addition to this most of the isotopic forms of $C_6Cl_6$ consist of a number of space isomers.

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August 30, 1921

## AN ARTIFICIAL NERVE

Physiologists are keenly interested in all attempts to discover an explanation or an analogy for the passage of the nerve stimulus. Most enlightening suggestions have recently been presented by Lillie[1] in his studies of passivity phenomena in pure iron wires. It seems that the transmission of the momentary wave of activity which occurs in a passive iron wire on activation in 70% nitric acid is closely analogous both chemically and electrically to the passage of the nerve impulse.

The general similarity of the two phenomena was apparently first noticed by Wilhelm Ostwald and subsequently elaborated by his student Heathcote.[2] In a paper published in 1907 under the caption "Transmission along a nerve" (p. 909) Heathcote writes as follows:

> In 1900, then, Prof. Ostwald called our attention to the possibility of nerve transmission being a process akin to the transmission of activity. . . . It is to be expected . . . that transmission of activity would be slower immediately after the first transmission owing to products of reaction around the iron. This has been confirmed by direct experiments in the case of iron in nitric acid. An effect of this kind in a nerve would explain the nature of "fatigue" so far as it concerns nerves.

After discussing the small amount of energy consumption in both transmissions Heathcote summarizes his conclusions as follows:

> There is nothing in the structure of nerve which renders it impossible to regard transmission as occurring in a way which is analogous to the transmission of activity along passive iron. . . . It appears possible too that the network in protoplasm may be a layer capable of transmitting changes in a similar way and which manifest themselves as an essential part of the mechanism of irritability.

It is not surprising that Heathcote's paper should have escaped the attention of physiolo-

[1] Lillie, R. S., '18, Science, 43, 51; '20, *J. General Physiol.*, 3, 107.

[2] Heathcote, H. L., '07, *J. Soc. Chem. Industries*, 26, 899.

gists. Lillie's independent rediscovery of this analogy, however, and his detailed studies and analysis strengthen the probability of a fundamental relation subsisting between the two phenomena.

The passage of the wave of activation over the surface of a short wire is so rapid, that it is not easily demonstrated to a large group of students. The simple arrangement here described is clearly visible at a considerable distance and has been used successfully as a lecture table demonstration.

Nine and a half meters of a ten-meter piece of number 20 piano wire are wound by hand on a machine lathe into a spring small enough to slip easily into a 100 c.c. burette. After stretching the spring sufficiently to insulate the individual turns, a glass tube is inserted in the spring and the remaining half meter of wire is returned through this tube. When set into the burette the upper end of this tube should just reach the burette top (Fig. 1). The two free ends of the piano wire are now connected through thin iron wires with a demonstration galvanometer or voltmeter which registers both positive and negative variations. After filling the burette three quarters with 70 per cent. c.p. nitric acid (by volume) the spring coil is lowered into it until about an inch of the lower end of the coil is submerged in the acid. The submerged inch of wire immediately begins to dissolve but if the coil is held in this position until chemical action ceases, the entire wire may be lowered into the acid without further action. In other words by passifying one end of a wire and then slowly lowering the remainder of that wire into acid the entire piece is passified. To prevent activation the wire must be lowered slowly and steadily. The coil is now ready to be tested at intervals with a zinc or copper "stimulus" applied just at the surface of the nitric acid at the top of the burette. After a somewhat variable latent period the entire spring becomes activated. The wave of activation passes down the coil and back through the return wire registering a diphasic "action current" on the galvanometer.

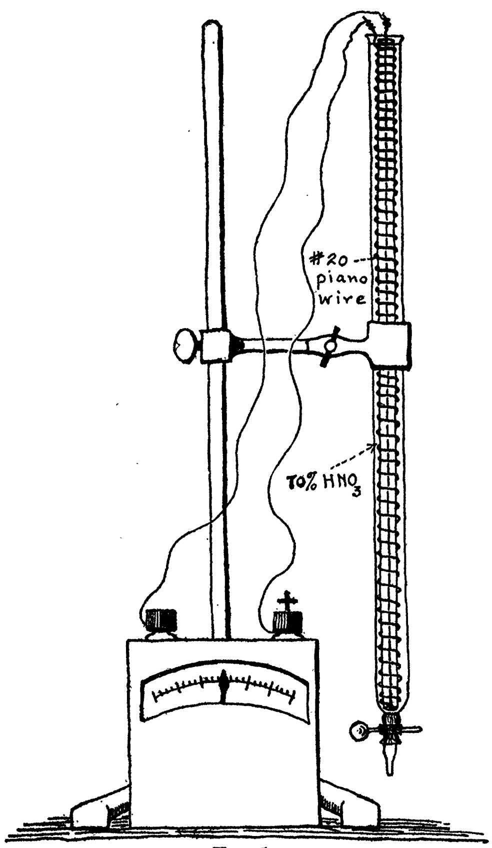


FIG. 1

In its passage down the spring the activation wave sets free a shower of minute bubbles which change the color of the acid sufficiently to make the wave of activity clearly visible even at some distance from the preparation. This preparation recovers rapidly at room temperature and may be used repeatedly to demonstrate mechanical, chemical and electrical stimulation as well as the time required for the passage of a single activation wave over a distance of ten meters. At the close of the demonstration the coil should be removed from the burette, thoroughly rinsed in slightly alkine water and alcohol and rubbed briskly with a rough cloth. With these precautions it may be used repeatedly.

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