in 1775; cobalt was shown to be magnetic as early as 1733, and nickel in 1750.

Concerning these and the many other strange facts scattered through the pages of this book, the surprising thing is to find how early in the game most of the known phenomena of electrostatics were discovered. One finds here dozens of illustrations of the well-known fact that nearly every great discovery in physics has been not only adumbrated but more or less clearly anticipated. Thus the law of inverse squares was distinctly enunciated by Lambert twenty years before the experiments of Coulomb. Nor is it less amazing to see what an enormous amount of fiction has been seriously reported as fact. A paper read before the Royal Society in 1749 explains earthquakes as caused by electricity; an eminent Frenchman, Boulanger, writes a treatise on electricity in 1750, in which he explains that black ribbons are more readily attracted than those of other colors, etc.

This collection of Dr. Mottelay is a veritable treatise on the embryology of electrical science, which will be wanted in every public library, and will be indispensable to students of the history of physics. So long as there is no *index expurgatorius* for electrical books there will ever remain the need for competent critics who can hand on the really essential features of each period, who can appraise the relative merits of various investigations, and who possess the perspective necessary to set forth, in their proper succession and relation to each other, the great discoveries of science. Such a developmental history means much economy of thought. A critical history of this type which would do for the entire subject of electricity and magnetism what Whittaker has done for a portion of the subject in Chapters II and III of his "History of the Theories of Aether and Electricity" would form a worthy companion-volume to that of Dr. Mottelay.

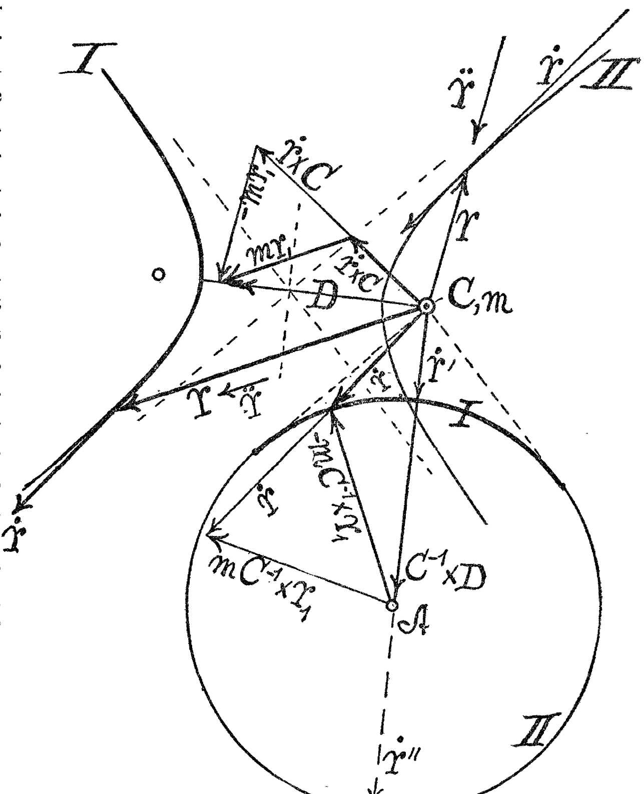
Henry Crew

SPECIAL ARTICLES

THE HODOGRAPH OF NEWTONIAN HYPERBOLIC REFLECTION

Apropos of Sir Oliver Lodge's recent treatment (*Nature,* January 5, 1924) of the reflection of atomic nuclei, a graphic exhibit of the hodograph of such cases which we have been considering in my classes may be given, as it contains many interesting features. The vector equations[1] taken in succession (if r is the radius vector, C the angular momentum per gram of planet, m the mass of the repulsive sun and D a vector along the major axis) are: $d^2\mathrm{r}/dt^2 = \mathrm{r}_1 m/\mathrm{r}^2$, $\mathrm{C} = \mathrm{r} \times d\mathrm{r}/dt$, $\mathrm{D} = (d\mathrm{r}/dt) \times \mathrm{C} + m\mathrm{r}_1$, $d\mathrm{r}/dt = \mathrm{C}^{-1} \times (\mathrm{D} - m\mathrm{r}_1)$, the subscript denoting a unit vector. For the case of hyperbolic motion subject to an attracting sun it is then merely necessary to change m into $-m$.

The figure gives the twin hyperbolas with their common axis and asymptotes. If a repelling mass is at m, and C is a normal vector erected there outward (the usual electrical symbol) the hyperbola *I* on the left is in question. The diagram gives all the vectors (heavy lines) for the construction of the hodograph with its center at *A*. It is interesting to see that only the part *I* of the hodograph is needed. This is limited by tangents parallel to the asymptotes and comprehending the smaller velocities (minimum primed in figure, being normal to D).



The hyperbola *II* (light lines) and the remainder of the hodograph belong together and these correspond to an attracting mass at m. Consequently the velocities are all relatively large with a maximum $(d\mathrm{r}/dt)''$, again normal to D. All vectors through m originate there. The aim is along the asymptotes.

Carl Barus

Brown University, Providence

STIMULATION OF THE VAGUS NERVE

Following a suggestion made to me by Professor W. B. Cannon, I have found that a definite relationship exists between frequency and strength of stimulation of the vagus nerve in the cat and the effects

[1] Vectors in roman.

produced on the lower end of the esophagus, the cardia and the fundus et corpus ventriculi. Relatively low frequencies and intensities of stimulation cause pronounced contraction. Increase in frequency or strength beyond that of the excitatory stimulation, on the contrary, after producing first an initial contraction, leads to relaxation during stimulation and strong after-contraction on cessation of stimulation. Repetition of the inhibitory stimulation during the after-contraction causes relaxation, and is followed again by contraction. These effects are produced most readily in the lower end of the esophagus. When this part of the gullet has been thrown into contraction by excitatory stimulation of the vagus, an increase either in frequency or strength of stimulation evokes relaxation. Conversely, relaxation gives place to contraction, when in a period of inhibitory stimulation either frequency or intensity is diminished.

The fundamental difference in effect produced by the two types of stimulation is illustrated further by simultaneous stimulation of both vagi. In the case of the lower end of the esophagus, excitatory stimulation of one vagus may have little or no effect if repeated during the relaxation caused by simultaneous inhibitory stimulation of the other vagus. Moreover, the strong contraction produced by excitatory stimulation of one vagus may be reduced practically to nothing by simultaneous inhibitory stimulation of the opposite vagus.

The above reactions are independent of the cardio-inhibitory action of the vagus.

The change from contraction to relaxation on increase in frequency or strength of vagal stimulation is analogous to the Wedensky effect,[1] and it may be explained on similar grounds. It may have important bearing on processes of inhibition in general. The reaction which occurs when stimulation of relatively high intensity or frequency is applied to the vagus stands in close relationship to such phenomena as reversal of the action of the vagus on the heart,[2] and reflex rebound.[3] It is quite typical also of reactions characterized by initial increase of activity of the effector on stimulation of its nerve, followed by decrease of activity during stimulation, and a second increase on cessation of stimulation. Such reactions are seen under certain conditions in the action of the chorda tympani on the submaxillary gland,[4] the nervus erigens on the bladder,[4] and the cervical sympathetic on the m. dilatator pupillae.[5] It is probable that the change from an excitatory to an inhibitory effect on increase in frequency or strength of stimulation of the vagus will throw light on these imperfectly understood phenomena.

A full account of this investigation will be published in the *American Journal of Physiology*.

H. O. VEACH
HARVARD MEDICAL SCHOOL

[1] Wedensky, N., *Archiv. f. d. ges. Physiol.*, 1885, XXXVII, p. 69; *Archives de Physiol.*, 1891, XXIII, p. 687.

[2] Dale, Laidlaw and Symons, *Journ. Physiol.*, 1910, XLI, p. 1.

[3] Sherrington, C. S., *Proc. Roy. Soc.*, 1908, B, LXXX, p. 53.

[4] Langley, J. N., *Journ. Physiol.*, 1911, XLIII, p. 125.

[5] Dale, Laidlaw and Symons, *Journ. Physiol.*, 1910, XLI, p. 16.

THE INDIANA ACADEMY OF SCIENCE

THE Indiana Academy of Science held its thirty-ninth annual meeting at DePauw University, Greencastle, Indiana, on December 6 to 8. The following program was presented:

GENERAL SESSION

Brief Business Session.

Presentation of Papers of General Interest.

Causes of and remedies for the inefficiency of locomotive whistles: ARTHUR L. FOLEY.

The southern Ute Indians of Pine River Valley, Colorado: ALBERT B. REAGAN.

Variations among Indiana counties in the death rate: S. S. VISHER.

A plea against over-standardization in scientific education: E. G. MAHIN.

Presidential Address: *Bacteriology and its practical significance:* CHARLES A. BEHRENS.

SECTIONAL MEETINGS

BOTANY–ZOOLOGY

Does Allium vineale L. produce seeds in Indiana? Recent Indiana weeds; A weed survey of Indiana: A. A. HANSEN.

Indiana fungi: J. M. VAN HOOK.

Plants new or rare to Indiana—XII: CHAS. C. DEAM.

Culture methods in the production of polyembryony in certain ferns (Polypodiaceae); Behavior of fern pro thallia under prolonged cultivation: D. M. MOTTIER.

Plant relations in Brazos County, Texas: ELMER GRANT CAMPBELL.

The trees of Vanderburg County: A. J. BIGNEY.

Some soil and water reactions in the dunes region of Porter County: M. W. LYON, JR.

Notes on grasses: PAUL WEATHERWAX.

Indiana plant diseases, 1923: MAX W. GARDNER.

Nitrate studies on Purdue rotation field number 6: I. L. BALDWIN, W. J. NICHTER, R. O. LINDSEY.

Cultural methods with rusts: E. B. MAINS.

Plants of White County—VI: LOUIS F. HEIMLICH.

Notes on the life history of the snapdragon rust, Puccinia antirrhini: E. B. MAINS.

An ecological view of wet waste land: BLANCHE MCAVOY.

Preliminary notes on comparative growth in grazed and ungrazed woodlots at Purdue: BURR N. PRENTICE.