little better than chaotic, many species being unknown or else grouped under a specific name mostly noteworthy because of its comprehensiveness. We think all will agree that Professor Theobald has done a large amount of valuable pioneer work, though we may not adopt all of his taxonomic views. The British Museum is to be congratulated upon having published such an admirable work, of which the volume under consideration forms only a part, consisting of five good-sized volumes, illustrated by a large series of figures, there being over 1,200 text illustrations and 88 magnificent plates, and characterizing practically all the known species in this important family. It is perhaps needless to add that this monograph on the Culicidæ, possibly not even yet completed, must be the major foundation for all subsequent studies in this group and therefore nearly indispensable to the systematist.

E. P. FELT

SPECIAL ARTICLES

NEW PHENOMENA OF ELECTRICAL DISCHARGE

AT a meeting of the Academy of Science of St. Louis on December 5, the writer gave further results of work on electrical discharge. It had been previously shown that oscillations of widely varying frequency, attended by musical tones, could be brought about, by means of small spark gaps of variable length, in the lines leading from the terminals of an influence machine to the main gap across which the discharge is to pass. In a former paper it had been suggested that the striæ in a vacuum tube were in the nature of waves in an organ pipe.

These results suggested the idea of imposing resonance vibrations in a column of air contained in a glass tube, which also contained terminals from the influence machine. The air vibrations were produced by means of a blast of air from a pressure tank, which was directed across the mouth of another tube. It has been found that with very careful adjustments, the electric discharge across a small gap in the glass tube could be affected in a marked way by the impressed sound waves. A luminous discharge was apparently converted into a dark discharge.

The line within the tube containing this gap was in multiple with another line containing an adjustable gap. This system was in the positive side of a circuit which contained a long discharge gap. Placed transversely in this gap was an insulated sheet of copper, which served to prevent disruptive discharges. Attempts are now being made to cause an organ pipe to sound a musical tone by means of periodically varying electrical stresses within the air-column. The response of the air-column is not as marked as when the vibrations are produced in the ordinary way. Some effects have however been secured, and there is every reason to believe that the attempt will meet with success. These results can only be considered as preliminary.

Several friends have suggested that the term drainage column as applied to the positive or luminous end of a discharge, was another name for an ionized mass of air. If we say that air is ionized by X-rays passing through it, this term does not represent the conditions at either terminal of an influence machine.

In a mass of air ionized by X-rays, the average charge of a molecule is the normal charge. Those which have a greater than normal charge mingle with those which have a less than normal charge. Such a mass of air will respond to the demands of an electrometer placed within it, whether its leaves have a greater or a less than normal charge. The supercharged molecules will deliver the excess to those whom they have robbed, or to any others which may be in a like condition. A similar statement may be made concerning the molecules which have less than the normal charge. But such a mass of air is not a drainage column. It is in a condition which promotes the formation of a drainage column, if the terminals of some "source" of electricity like an influence machine are placed within the ionized mass of air. This mass of air is then made a part of the conducting circuit, by the starting of the machine into action. The fact that it behaves differently from the rest of the circuit is incidental to the fact that it is in gaseous condition. The apparent discharge into the air from the positive terminal was shown by phenomena described in my paper of February 18, 1910,[1] to be an inflow of negative electricity to that terminal. The electric fluid is thus drained from a column of air which begins at the positive terminal and extends towards the negative or compression terminal. After this drainage has been brought about, the air within this column is in a very different condition from that of air ionized by X-rays. The average charge per molecule of air is then less than the normal amount. By placing an insulated sheet of copper between the terminals, the drainage or conduction column is prevented from reaching the mass of supercharged air in front of the negative terminal. Loud disruptive discharges will pass when the plate is removed, and they cease at once when the plate is placed midway between the terminals. On moving the copper plate nearly to the negative glow, the drainage column follows it, and a torrent of sparks will pass.

The so-called positive ions do not emerge from the wire at the positive terminal, and they do not enter the wire at the negative terminal. When this air is nearly all removed from the discharge gap, as is done in the Crookes tube, the cathode discharge still continues. The drainage column has disappeared at the anode. When the air is partially removed, thus increasing the mean free path, the drainage column may have a great length, and it follows all of the windings and bends of the tube. It would not do this if it were an outward discharge like that from the negative terminal.

This drainage column constitutes the canal rays, in a tube where the gas has been partly exhausted, so that the mean free path has been increased. In a paper to be published by the Academy of Science of St. Louis, phenomena of canal rays in air of ordinary pressure will be presented, in connection with phenomena involved in vibrations imposed upon the air column.

[1] *Trans. Acad. of Sc. of St. Louis*, Vol. XIX., No. 1, Plates II. to VIII.

If any trace of a positive fluid capable of moving through a wire as an electric current must move could be found, and if the two-fluid theory could furnish an adequate and rational explanation of these and other phenomena, there would be no objection to its use in an exposition of the subject, as has been the custom heretofore.

In 1895 the writer showed that the velocity of flow of the electric fluid in a pumping service then discussed, must be very great. Imagine two spheres having radii equal to that of the earth. Suppose electricity to be pumped from one into the other, until their difference in potential is 50 volts. Connect them by means of a 50-volt one-ampere lamp. It would begin to glow with normal brightness. In order to keep the voltage constant the radii of the two spheres must be diminished with a uniform velocity of more than half the velocity of light. This store of electricity would maintain this lamp at normal candle power for 0.035 second. The operation must be repeated 28 times a second. The time for one stroke of the piston is in seconds, $t = Rr$, where r is the radius of the spheres in cm. and R is the resistance of the lamp in electrostatic units. If the sphere from which the electric fluid were pumped, by some adequate means, had an infinite capacity, the other sphere must then be charged to a potential of 50 volts, and the above results would remain unchanged. The surface of the charged sphere would then be the piston of an electrical pump, and its velocity would be as given above. All of this store of electricity must pass through the lamp in 0.035 second.

We may learn much about the constitution of matter by a study of what are called the positive ions when an electric discharge is passed through a column of gas. But nothing has yet been learned to indicate that these ions play any part in a lamp circuit, except that they then constitute the solid conductor.

Wheatstone's work now shows us that when half a mile of copper wire is placed centrally in the spark gap, we have compression and rarefaction waves in Franklin's fluid, which meet at or near the middle of the wire. The positive ions are in some way linked together, and transmit Thomson's corpuscles with immense velocity. There is a certain amount of shaking up involved in this transfer. It is the Joule effect. The positive ions remain at rest, and there are, therefore, no canal rays. When this wire is removed from the spark gap, the gas molecules receive the same compression and rarefaction waves, if the man who turns the crank of the machine continues his work. At the negative terminal the air molecules are loaded with the corpuscles, in the region of negative glow. They are then urged by convection as carriers, across the Faraday dark space. At the positive terminal the corpuscles pass from the gas into the metal conductor by a rarefaction or drainage process. Photographic plates reproduced in former papers[2] show that the drainage lines begin at the positive terminal. In this drainage column the carriers of the discharge move in a direction opposite to that in which the discharge is being urged. Cakes of ice floating on water would behave in a similar way, if a runner should jump from one to another, although the mechanism would be different. Nevertheless, such behavior of cakes of ice appears to be related to the athletics of the foot race, in somewhat the same way that positive ions in a gas are related to the flow of electricity in a power circuit.

FRANCIS E. NIPHER

[2] *Trans. Acad. of Sc. of St. Louis*, XIX., Nos. 1 and 4, Plates X., B, XX., A, B and C, and XXI., A.

JOINT MEETING OF MATHEMATICIANS AND ENGINEERS AT MINNEAPOLIS

THREE years ago in connection with the convocation of the American Association for the Advancement of Science in Chicago, a joint meeting of mathematicians and engineers was arranged through a committee of the Chicago Section of the American Mathematical Society. This meeting aroused much interest and resulted in the appointment of a committee of twenty, under the chairmanship of Professor E. V. Huntington, of Harvard University, to consider the whole question of the teaching of mathematics to students of engineering in this country, and to report its recommendations to the Society for the Promotion of Engineering Education at its summer meeting to be held at Madison, Wis., in June, 1910. This committee was constituted as follows: Philip R. Alger, professor of mathematics, U. S. Navy, Annapolis, Md.; Donald F. Campbell, professor of mathematics, Armour Institute of Technology, Chicago, Ill.; Edmund A. Engler, president of the Worcester Polytechnic Institute, Worcester, Mass.; Charles N. Haskins, assistant professor of mathematics, Dartmouth College, Hanover, N. H.; Charles S. Howe, president, Case School of Applied Science, Cleveland, Ohio; Emil Kuichling, consulting civil engineer, New York City; William T. Magruder, professor of mechanical engineering, Ohio State University, Columbus, Ohio; Ralph Modjeski, civil engineer, Chicago, Ill.; William F. Osgood, professor of mathematics, Harvard University, Cambridge, Mass.; Charles S. Slichter, consulting engineer of the U. S. Reclamation Service, professor of applied mathematics, University of Wisconsin, Madison, Wis.; Charles P. Steinmetz, consulting engineer of the General Electric Company, professor of electrical engineering, Union University, Schenectady, N. Y.; George F. Swain, consulting engineer, professor of civil engineering, Harvard University, Cambridge, Mass.; Edgar J. Townsend, dean of the College of Science and professor of mathematics, University of Illinois, Urbana, Ill.; Frederick E. Turneaure, dean of the College of Mechanics and Engineering, University of Wisconsin, Madison, Wis.; Clarence A. Waldo, head professor of mathematics, Washington University, St. Louis, Mo.; Gardner S. Williams, consulting engineer, professor of civil, hydraulic and sanitary engineering, University of Michigan, Ann Arbor, Mich.; Calvin M. Woodward, dean of the School of Engineering and Architecture and professor of mathematics and applied mechanics, Washington University, St. Louis, Mo.; Robert S. Woodward, president of the Carnegie Institution of Washington, Washington, D. C.; Alexander Ziwet, professor of mathematics, University of Michigan, Ann Arbor, Mich.

In the early part of its investigation the committee collected a large amount of information in regard to the present status of mathematical instruction for engineering students. Since that time, however, a much more inclusive inquiry has been undertaken by the International Commission on the Teaching of Mathematics, of which the American Commissioners are Professors D. E. Smith, J. W. A. Young and W. F. Osgood. In