STRATIFICATION IN VACUO: ITS PRODUCTION WITH THE INFLUENCE MACHINE.

BY HOWARD B. DAILEY.

Every experimenter in electricity who has had to do with Geissler tubes has at one time or another marveled at the beauty and the mystery of the phenomena of stratification. In producing the stratified light *in vacuo* the Ruhmkorff coil has been generally regarded as the only practically available means for the illumination of the vacuum. So common has been this impression that few experimenters, nor even the makers themselves of the tubes, have seemed aware of the valuable possibilities of the influence machine for this particular form of experiment. This, of course, has not been without its reason. While no special precaution or nicety of manipulation is required in exhibiting stratified tubes with the coil, when such a tube is essayed to be used with the static machine the first experiences are usually disappointing. As the vacuous space merely lights up with the familiar unbroken glow of the ordinary Geissler tube, without any traces of striation, the experimenter naturally concludes the desired effect to be impossible of attainment with the static machine. However, with attention to a few simple details of technique, striations can be developed with the influence machine having a distinctness and beauty, uniformity, and fixity of position never realized with the coil method of excitation.

In bringing out the striæ with the static machine two vital conditions are to be observed; namely, sufficient, though not excessive current through the tube; and the careful avoidance of all sparking, even of the minutest character, at possible imperfect contacts in any part of the circuit outside the tube. The first implies a generator of sufficient size, to begin with, whose output can then be diminished or increased by regulation of its speed. In exciting stratification tubes with machines of the Holtz type it is generally only necessary to connect their terminals direct to the poles of the machine, with careful attention to perfect metallic contacts; the minutest break where disruptive sparking can occur destroys the striation and diffuses the light. This precaution attended to, the proper strength of current must next be found by experimental regulation of the speed of the generator. As the machine slowly starts, the light within the tube is first seen as a thick nebulous line along the axis of the tube between the electrodes. This, at first continuous and steady, soon shows signs of uneasiness as the machine speeds up, and presently wavers and breaks into a beautiful series of brilliant, evenly spaced, isolated bands or strata which, when the current strength attains a certain value, settle into fixed positions and remain perfectly motionless. It is significant of this feature of steadiness that it is one specially remarked by De la Rue as characteristic of the striæ developed in his vacuum tubes by direct galvanic currents, during his now historical experiments with high-potential batteries of many hundred cells; thus, again, suggestion of the probable ultimate identity of the natures of static and voltaic forms of electrical action is here vividly brought to mind. In the study of striation by the present method, the almost total absence of the violent oscillatory movements, frequent blurring and overlapping, and uneven spacing of the striæ so characteristic of coil excitation, is an obvious advantage. The remarkable constancy of the stratification renders easy the making of photographic studies, with time exposures. Fig. 1 illustrates the beautiful uniformity, even spacing and perfect segregation of the striæ produced with a Wimshurst machine in a 12-inch tube, the effect being photographed with a three-minute exposure. In exciting stratification with the Wimshurst machine (which has probably been more largely made and used by amateurs than any other type), a simple device which from its function might be termed an atmospheric rheostat is required in conjunction with the tube. This necessity arises from a well-known peculiarity of Wimshurst machines, especially those of the sectorless type. If such machines are attempted to be run on closed circuit, or on a circuit having too little resistance, such, for example, as might be offered by a single Geissler's tube, their fields suffer such a diminution of potential as to cause a serious falling off of the output of the generator; thus, a tube may not receive sufficient energy even from a large generator to establish the stratification. This is obviated by supplementing the resistance of the tube by that of two air gaps, one on each side of the tube in series with it. But as these gaps must not be *spark* gaps, the construction shown in Fig. 2 is adopted. Two smooth metallic disks three or four inches in diameter with well rounded edges are mounted in vertical positions on short insulating standards. Opposite the center of each disk and facing it is an insulated sliding rod terminating in a fine sharp point capable of longitudinal adjustment through a space of two or three inches. The tube to be exhibited is connected as shown between the two middle posts; the two outer posts are in unbroken metallic connection with the opposite poles of the generator. With this arrangement the current passes the air gaps between the points and disks as a silent, continuous, non-sparking discharge and the stratifications within the tube are beautifully developed. In using the device, proper polarity is of vital importance. The point at the left must be connected to the *negative* side of the generator—that side which shows the *brush* effect on the collecting combs; the disk at the right is wired to the positive pole. If this order be reversed, sparking occurs at the resistance gaps and the effect is destroyed.

The "stratified" tube, without which no collection of vacuum tubes is complete, is a specially prepared Geissler tube exhausted to just the proper degree, and containing some particular residual gas or vapor whose molecular movement has been found especially compliant to certain conditions of vibration, in the peculiar ordering of which the phenomena of "resonance" has had strong suggestion of probable participation.

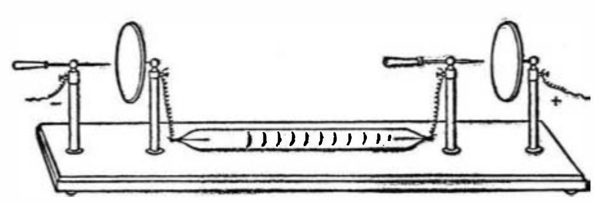

Fig. 2.—ATMOSPHERIC RHEOSTAT FOR STRATIFICATION IN VACUO WITH WIMSHURST MACHINE.

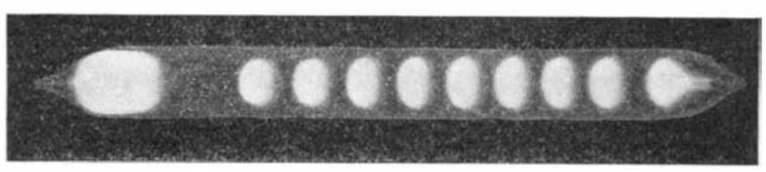

Fig. 1.—STRIATION PRODUCED WITH INFLUENCE MACHINE.

Chromatic Photography in Negative Colors.

It is a well-known fact that natural colors are reproduced by using a sensitive layer of any kind, provided it be transparent and in contact with a mercury mirror, when the colors of the object will be visible by reflection after the plate has been developed. If the sensitive layer be a bichromatic membrane, it is fixed by simply washing it with water. The colors will be visible as long as the layer is moist, but are made to disappear by drying and to reappear each time the plate is rendered moist. This phenomenon is doubtless due to the action exerted by the hydroscopic properties of the membrane, the moisture which penetrates throughout the mass producing a physical and optical heterogeneity in the plate.

In the August number of the Journal de Physique, Prof. G. Lippmann records some experiments he has performed with a view to replacing the water by solid matter. The author impregnated the plate with an aqueous solution of potassium iodide. After drying the colors were found still to exist, though quite faintly. The potassium iodide had thus remained in the plate, distributing itself unequally over the maxima and minima of interference. If, however, a solution of silver nitrate of about 20 per cent be poured out on this sensitive layer impregnated with dry potassium iodide, the colors will assume an extreme brilliancy. The plate can then be washed and dried without in any way diminishing the brilliancy of the colors. The author thinks that there has been formed silver iodide which remains unequally distributed throughout the thickness of the membrane. The latter, however, remains transparent, the iodide being contained in the state of solution in the solid matter.

An interesting feature is that the colors as seen by transparency are changed into the complementary colors, so as to produce most brilliant negatives. If the same result could be obtained by means of gelatine bromide membranes, which are much more sensitive and isochromatic, it might be possible to reproduce chromatic photographs by simple printing as in the case of ordinary photography.

A New Atlantic Cable.

The steamer "Colonia," which sailed from Canso, N. S., September 23, paying out the Commercial Company's new Atlantic cable, arrived at 6 o'clock, October 2, at a point 187 miles from the Irish coast, where she will make the final splice between the 2,000 miles of cable she has laid from the American side and the 187 miles laid from the Irish coast by the steamer "Cambria" last June.

On September 23 the weather on the Irish coast and the American coast was fine, but the "Colonia" was laying cable in a hurricane in latitude 55 minutes 55 seconds north, longitude 42 minutes 10 seconds east, blowing with the greatest force from the southeast.

This will make the fifth Atlantic cable laid by the Commercial Company.

Photographic Records of the Action of N-Rays.

The much-discussed problem of the existence of N-rays could be settled only by an objective demonstration of their effects. As these rays exert no immediate action on photographic plates, Prof. Blondlot some time ago endeavored to obtain indirect photographic records, by taking a view of the same spark first without "N" rays, and afterward with "N" rays. In the latter case a more intense impression on the photographic plate was observed. Opponents of the French scientist contended that the electric sparks were not of sufficient constancy to warrant him in drawing any definite conclusions from these experiments. Prof. Blondlot therefore continued his efforts in this direction, and in a memoir published in a recent issue of the Revue Générale des Sciences describes a few further experiments where every care has been taken to avoid any uncertainty. These experiments really demonstrate the objective existence of the radiations. The process used was practically the same as that employed previously, but for a telephone inserted in the secondary circuit of the induction coil. The assistant, by keeping the telephone receiver close to his ear, was in a position to check the regularity of the spark throughout the duration of the photographic experiments. If the spark was extinguished owing to an excessive distance of the points, the sound in the telephone was also discontinued. If, on the contrary, the points touched each other, the sound became much more intense. Any irregularities in the spark might thus be detected, and if any were observed during a photographic experiment, the photographs were rejected.

In a series of thirty-five experiments carried out with every care, twenty-three tests showed a most striking difference between the images obtained with and without N-rays, while eight tests gave a rather noticeable contrast, and four tests a contrast still visible though less marked. All the plates did show the action of N-rays, and if the difference between the two photographic impressions was not always of the same intensity, this must be ascribed to the impossibility of obtaining an absolutely exact regulation of the small spark.

It is of great importance that exceedingly feeble sparks should be employed, the brilliancy of which is little more than the minimum luminous intensity capable of producing some impression on the plate. Under these conditions a small variation in luminous intensity will result in a great variation in the intensity of the photographic image, while in the case of a stronger illumination only a very small variation is obtained.

In the experiments referred to, the N-rays were produced by a Nernst lamp inclosed in a sheet-metal lantern. The N-rays traversed successively an aluminium foil constituting the front wall of the latter, a pinewood plank two centimeters in thickness, another aluminium foil, an aluminium lens, a zinc foil, a board of whitewood two centimeters in thickness, an aluminium foil, constituting an electric screen to protect the spark, and finally the wall of the pasteboard box inclosing the spark.

With all these experiments one second more has been allowed for the total duration of the exposure made without N-rays so as to make sure that this exposure was somewhat longer than the other. Instead of simply taking two successive exposures with and without N-rays, another method, consisting in cross-wise fractional photography, has been chosen in some instances. The exposure with N-rays was made either before or after the other, either on one side of the plate or on the other, and the experiments were varied in many other ways. Metal screens were used so as to eliminate any disturbances likely to be produced by electrical influence. Checking experiments were made from time to time either by withdrawing the moist paper or by moistening it with salt water, when equivalent images were obtained in each case.

These experiments seem to be free from any objection. While the results practically agree with those obtained in connection with former researches, the following interesting fact was discovered incidentally:

If N-rays be made to strike the primary spark of a Hertz oscillator, the secondary spark will decrease in brilliancy. This shows that N-rays modify the electric phenomenon itself, and the intimate alteration of the spark is doubtless the cause for which the photographic experiments on the action of N-rays can give no decisive results in case a spark is used as illuminant, whereas no result is obtained with other sources of light.

In order to demonstrate that, if necessary, agricultural operations can be carried out day and night continuously with a gasoline motor, an interesting trial was recently carried out in England on a farm near Biggleswade. A field was illuminated by acetylene gas, and two 6-foot mowers were attached to an Ivel gasoline tractor. Under these conditions fifteen acres were cut in the short time of 3 hours, 35 minutes.