pushing them hard for that honor. With the Germans the cause is found in three things: Abominable type, insufficient illumination, and poor hygienic conditions, all of which they are making terrific struggles to overcome. They went at their schools and applied their principles in the right way, and every German scientific publication of to-day is published in the Gothic type, and they are trying very hard to use it in their textbooks. The average person who studies Greek or German is in danger of becoming near-sighted.

lowing one another at certain intervals in the path made by the first discharge. The writer was unaware at the time that others had experimented in the same line and had published their results.

The camera was moved by hand, being swung from right to left and back again, each swing lasting about one second and covering an angle of about 60 deg., which was also the angle of the lens. The apparatus employed was an ordinary magazine plate camera, which for all ordinary purposes is the most convenient

0.5 millimeter apart, and from there for a distance of 10 millimeters are a series of discharges close together, forming a broad band. The dark space which divides this flash is a cloud through which the discharge is passing. Another interesting fact about this flash is that the path of it is spiral shaped, the motion is from right to left, or opposite to the motion of the hands of a clock, looking downward from the cloud. Fig. 3 was obtained October 1, 1903. We have here a flash composed, first, of two bright discharges close to-

FIG. 1.—LIGHTNING FLASH TAKEN JULY 17, 1902.

FIG. 3.—LIGHTNING FLASH TAKEN OCTOBER 1, 1903.

It is evident that we are developing a large proportion of near-sighted young people in our schools, and the ratio of those who are far-sighted is much lower than it ought to be. Every schoolhouse ought to be constructed to get the greatest amount of light consistent with the safety of the building. For the minimum amount of light there should be not more than five square feet of floor space for each square foot of glass. The German government intends creating a commission of architects or engineers to decide how the lighting of schools shall be carried out, and this question will receive attention as schools are built.

PHOTOGRAPHING LIGHTNING WITH A MOVING CAMERA.*

By ALEX LARSEN.

LIGHTNING, with its accompaniment of thunder, has always exerted a fascinating influence on the thinking mind. It is not strange that a people living in an age when the laws of nature were less perfectly understood should have associated this beautiful and awe-inspiring natural phenomenon with the powers and attributes of their gods.

The ancient Norsemen recognized in the rumbling of the thunder the approach of Thor, their most powerful god, in his heavenly chariot, drawn by his two he goats; and in the lightning flash they saw the path cleaved through the air by the never-failing hammer "Mjolner," wielded by the mighty arm of Thor when battling with the enemies of the gods, the hammer always returning to his hand. The myth is beautiful, and it would seem as if its authors had noticed the peculiar flickering of most lightning flashes and associated it with the forward and return movement of the hammer.

The principal object of this paper is to place before

FIG. 2.—LIGHTNING FLASH TAKEN JULY 11, 1903.

its readers certain facts to account for this flickering of lightning flashes.

In the latter part of the summer of 1901, while taking some ordinary pictures of lightning, the idea occurred to the writer while noticing this flickering that if the camera be moved in a circle at right angle to the flash the picture ought to show a widening of the flash, if it was composed of separate parts, and thereby also determine its duration. The attempt to do this was made that year, but without success. It was repeated again in 1902, and on July 17 several successful exposures were made which clearly showed that most flashes are composed of several discharges fol-

lowing one another at certain intervals in the path made by the first discharge. The writer was unaware at the time that others had experimented in the same line and had published their results.

Several more pictures were obtained in 1903. The three most interesting ones up to that year are shown in Figs. 1, 2, and 3. Fig. 1 shows a flash obtained on July 17, 1902. The discharge took place between two clouds. It will be noticed that it is composed of a number of separate discharges (or rushes) and bands; as many as thirty-four can be counted on the negative. As the flash covers about half of the plate, and as the approximate speed of the camera was about one second to cover the plate, or 60 deg., it follows that the approximate duration of this flash was about half a second. Fig. 2 shows a flash obtained on July 11, 1903. This flash is interesting for several reasons. It is composed of fourteen separate discharges, the

together, then there appears to be an interval of about a fourth of a second, which in all probability was filled in with a number of fainter oscillations (the lines running across seem to indicate that), and at the conclusion of the flash are four fairly bright rushes.

In the summer of 1904 copies of some of the photographs were sent to the Smithsonian Institution for examination, and through the suggestions and assistance of the experts of that Institution a new method of moving the camera was devised.

A spring-motor movement (of the kind used to operate revolving stands for exhibiting goods in show windows) was procured and mounted inside a table specially constructed for the purpose, and a stand for supporting the cameras was fitted to the central shaft.

As the speed of the motor was too slow, the fly-vane shaft was removed and the vane moved to the next shaft, which was lengthened so as to extend under the table. Thus arranged the fly-vane could be made to

FIG. 4.—MOVING CAMERA APPARATUS FOR TAKING LIGHTNING FLASHES.

first one being the brightest, and having side branches pointing downward, proving that the first discharge passed from the cloud to the earth and that the resistance which it had to overcome must have been excessive (the side branches prove that). At a distance of 3 millimeters from the first rush is another discharge following the same path, but without side branches (what appear as such are really branches from the first rush). At a distance of 12.5 millimeters from the last discharge will be seen two rushes

revolve in a liquid placed in a vessel under the table, thereby preventing much of the vibration and getting a more uniform speed. Fig. 4 shows the arrangement of the apparatus. The table top is removed in order to show how the motor movement is placed; the fly vane is seen under the table. The stand is usually revolved at a speed of one revolution in ten seconds, which the writer has found to be the most suitable for ordinary purposes. The reason for employing a motor movement with a uniform speed to move the camera

* The study of lightning flashes herewith presented was aided by a grant from the Hodgkins fund of the Smithsonian Institution. The paper is republished from the annual report of the Smithsonian Institution.

is to ascertain the exact duration of a flash or the intervals between the rushes.

If the angle of the lens and the speed of the camera be known, it is a simple matter of measurement to

FIG. 5.—LIGHTNING FLASH TAKEN SEPTEMBER 1, 1905—9 P. M.

Two reproductions, to show separate rushes and black discharge.

ascertain the duration of a flash. The formula employed is as follows:

$$\begin{aligned} \text{Call the angle of the lens (in degrees)} &= A^\circ \\ \text{Time for one rotation of stand (in seconds)} &= T \\ \text{Width of plate (in millimeters)} &= W \\ \text{Width of flash measured on plate (in mm.)} &= N. \\ &\frac{A^\circ}{360} \times T \\ \text{Then time for flash (in seconds)} &= \frac{W}{N} \times N. \end{aligned}$$

The measurements should be taken from the middle of the plate, owing to the distortion of the lens.

A number of photographs have been taken by this method, and about nine out of ten show the multiplicity of a flash. The average number of rushes for each flash is about five or six, and the time varies from an almost instantaneous value up to about half a second for a complete discharge.

The most interesting discharge obtained is shown in Fig. 5. It was taken September 1, 1905, at 9 P. M. The storm during which this flash was photographed

FIG. 6.—SPECTRUM PHOTOGRAPH OF LIGHTNING FLASH, JUNE 18, 1905.

began about 7 P. M., with the wind northeast, which is something very unusual for Chicago. The wind gradually changed to north and northwest. The temperature during the storm was about 24 deg. C., and the barometer varied between 29.89 and 29.92. The flash

was obtained when the storm was most severe and while it was raining very hard.

This flash is composed of forty separate discharges, made up of one band, which in all probability is composed of a number of separate rushes or oscillations very close together and one black discharge. It is this dark discharge which makes this flash interesting, and the photograph shows it running parallel and on both sides of the first bright rush, extending 0.6 millimeter on one side and 0.1 millimeter on the other, the boundary line on the latter side not being very marked. From this black discharge issue several side branches on both sides, a large one spreading out over the other rushes quite prominently. These side branches all pointing downward indicate that the black flash was a downward stroke, and they also tend to prove that it must have had a good deal of resistance to overcome. It must have cleared the way for the first bright discharge, which in all probability proceeded from the ground upward. The difference in width of the bright flash, measured at its lower and upper part, would confirm this opinion, being for the lower part 0.38 millimeter and for the upper part 0.22 millimeter.

An interesting question here presents itself. Have we here two separate discharges with different rates of oscillation traveling the same path? Can such a condition be possible? To the writer's mind the most plausible explanation would be that the two discharges occupied two separate paths, one inside of the other, one discharge forming, so to speak, a tube through which the other passed.

It may also be claimed that the bright flash is probably part of the dark discharge for some reason rendered more luminous. This explanation may be the

FIG. 8.—SPECTRUM PHOTOGRAPH OF SPARK FROM STATIC MACHINE.

true one, although it appears as if the bright flash is entirely separate. The measurements of the width of the upper and lower parts of both flashes confirm this opinion, the difference in width of the bright flash being 40 per cent and for the dark discharge only 20 per cent. Authorities vary in their opinions as to the probable cause of these dark flashes. It has been suggested by some that there really are no black discharges, but what appear as such are excessively bright flashes causing a reversal of the image on the plate. This explanation may be the true one if we understand the word "brightness" to mean increased actinic power of the light. In the black flash represented this chemical effect must have been extremely high, owing to the fact that the smallest hair-like extremities of the side branches are well reproduced on the picture as black, in comparison with the broader and to all appearance more powerful discharges which followed after.

It was at first thought probable that we had to deal with an interference phenomenon, but that idea was discarded. Then it was suggested that the black discharge was probably due to slow oscillations (the width of it would tend to confirm this opinion), and

by the other rushes following. The effect of halation and solarization was also considered, but rejected. There was thus but one way to account for the phenomenon, namely, that the flash must have given out light of a wave length much shorter than the wave lengths of visible light and with a power sufficient to

FIG. 7.—SPECTRUM PHOTOGRAPH OF LIGHTNING FLASH, SEPTEMBER 1, 1905.

render the portion of the plate struck by it non-sensitive to ordinary light. Such a flash would appear black on a partially illuminated background or be invisible.

Dark flashes have been observed by the writer on

several occasions and only when raining very hard. They appear to the eye the same as the accidental image produced after looking at a bright flash. Such an image may be retained in the eye for quite a while after, but cannot easily be confounded with a real flash.

Two other pictures of dark discharges have been ob-

FIG. 9.—LARSEN BAROMETER.

tained with the moving camera, but are not so prominent; they likewise show the first rush as black, but without a bright core and with no side branches; one is of a horizontal and the other a vertical flash.

Below is a table of the measurements of this flash.

The angle of the lens was 60 deg. Time of rotation of camera, 1 revolution in 10 seconds. Width of plate, 127 millimeters. The width of the whole flash, 48 millimeters. Time for the whole flash, 0.624 second. The average distance between the rushes, 1.2 millimeters. Average time for each rush, 0.0156 second. The plate used was a "Standard" ordinary plate. The contrast of the picture has been increased by means of a double-contact print with lantern-slide plates. The developer was "rodinal." Time for developing, five minutes.

LIGHTNING FLASH (FIG. 5).

Designation.	Distance, Mm.	Time, Second.	Designation.	Distance, Mm.	Time, Second.
Width of black rush.	1 0 0	0.0130	From 24th to 25th rush	0 7 0	0.0091
From 1st to 2d rush...	2 6 0	0.038	From 25th to 26th rush	0 7 0	0.0091
From 2d to 3d rush...	0 20	0.0026	From 26th to 27th rush	0 8 0	0.0104
From 3d to 4th rush...	1 20	0 56	From 27th to 28th rush	1 0 0	0.0130
From 4th to 5th rush...	1 0 0	0 30	From 28th to 29th rush	0 5 0	0.0065
From 5th to 6th rush...	1 0 0	0.0130	Width of 29th rush...	0 4 0	0.0032
From 6th to 7th rush...	0 7 0	0.0091	From 29th to 30th rush	0 7 0	0.0091
From 7th to 8th rush...	0 9 0	0.0117	Width of 30th rush...	0 4 0	0.0032
From 8th to 9th rush...	0 9 0	0.0117	From 30th to 31st rush	1 3 0	0.0169
From 9th to 10th rush	1 7 0	0.0221	Width of 31st rush...	0 8 0	0.0104
From 10th to 11th rush	0 7 0	0.0091	From 31st to 32d rush...	0 3 0	0.0039
From 11th to 12th rush	0 9 0	0.0117	From 32d to 33d rush...	0 2 0	0.0026
From 12th to 13th rush	0 9 0	0.0117	Width of 33d rush...	0 6 0	0.0078
From 13th to 14th rush	1 1 0	0.0130	From 33d to 34th rush	0 9 0	0.0117
From 14th to 15th rush	0 7 0	0.0091	Width of 34th rush...	0 2 0	0.0026
From 15th to 16th rush	0 5 0	0.0045	From 34th to 35th rush	0 5 0	0.0045
From 16th to 17th rush	0 6 0	0.0078	Width of band...	0 4 0	0.0052
From 17th to 18th rush	0 5 0	0.0045	From 35th to 36th rush	1 6 0	0.0208
From 18th to 19th rush	1 3 0	0.0169	From 36th to 37th rush	1 6 0	0.0208
Width of 19th rush...	0 6 0	0.0078	Width of 37th rush...	0 9 0	0.0117
From 19th to 20th rush	1 4 0	0.0182	From 37th to 38th rush	0 4 0	0.0052
From 20th to 21st rush	0 7 0	0.0091	Width of 38th rush...	0 6 0	0.0078
From 21st to 22d rush...	1 4 0	0.0182	From 38th to 39th rush	0 4 0	0.0052
From 22d to 23d rush...	2 0 0	0.0260	Width of 39th rush...	0 4 0	0.0052
Width of 23d rush...	0 4 0	0.0052	From 39th to 40th rush	3 6 0	0.0468
From 23d to 24th rush...	0 6 0	0.0078			
Width of 24th rush...	0 4 0	0.0052	Total.....	48 0 0	0.6240

In the summer of 1905 a new departure was undertaken by the writer at the suggestion of the secretary of the Smithsonian Institution, the object being to obtain spectrum photographs of lightning.

Spectroscopic examinations of lightning have been made by many, but most of these observations have been visual, which at their best can only be rough approximations of the number of lines and their relative positions. As far as the writer knows, only one institution in the country—the Harvard College Observatory—had undertaken any work in photographing the spectrum of lightning.

A crude apparatus was constructed, consisting of a camera with a 35-millimeter prism fitted in front of the lens, no slit being used, as a lightning flash is a relatively narrow streak of light yielding a practically parallel beam. By means of this arrangement a few photographs have been obtained, two of which are reproduced in Figs. 6 and 7. A spectrum photograph of a spark from a static machine, for comparison, is shown in Fig. 8.

The spectrum shown in Fig. 6 is from a vertical flash, the picture of which was obtained June 18, 1905. It was about 1½ miles distant and was taken at the end of a storm of local character. The spectrum of this flash resembles that from the static machine in most of its details.

Fig. 7 shows the spectrum of one of those horizontal meandering flashes often seen at the conclusion of a storm of long duration. It was obtained September 1, 1905. It differs considerably from Figs. 6 and 8, several lines being absent. The first line of this spectrum is probably the same as the eighth line of the spark spectrum.

No definite opinion can at present be offered by the writer as to the meaning of these changes of the lines in the spectra of different flashes; more material must be obtained before a positive statement can be made.

Below is a table of measurements of the three spectra and their probable relations. Several measurements have been taken, and the averages are here presented.

Spark (Fig. 8).					Lightning (Fig. 6).					Lightning (Fig. 7).				
Line.	Intensity.	Width, Mm.	Distance, Mm.	Wave Length.	Line.	Intensity.	Width, Mm.	Distance, Mm.	Wave Length.	Line.	Intensity.	Width, Mm.	Distance, Mm.	Wave Length.
1	2	0.1	0.87	Hβ 4,861	1	7	(?)	1.0	Hβ 4,861	1	2	0.15	0.5	
2	1	0.05	0.43		2	1	*	1.4		2	8	0.25	0.45	
3	3	0.1	0.62		3	15	0.37	0.70	Hγ 4,341	3	8	0.25	0.45	
4	3	0.15	0.5		4	10	0.25	0.72		4	6	0.2	0.55	
5	12	0.25	0.2		5	10	0.25	0.85		5	2	0.1	0.55	
6	8	0.15	0.68	Hγ 4,341	6	6	0.55	1.08		6	6	0.2	0.55	
7	6	0.3	0.74		7	10	0.28	0.75		7	5	0.25	0.4	
8	12	0.4	0.87		8	3	0.26	0.65		8	6	0.2	0.4	
9	6	0.2	0.68		9	3	0.2	0.75		9	4	0.3	1.3	
10	1	0.05	0.43		10	3	0.2	0.75		10	4	0.2	1.3	
11	10	0.25	0.40		11	2	0.2	0.65		11	2	(?)	1.3	
12	6	0.4	0.55		12	2	0.2	0.65						
13	4	0.25	0.85		13	2	0.65	1.3						
14	4	0.25	0.25											
15	10	0.3	0.5											
16	4	0.2	0.2											
17	4	0.2	0.9											
18	5	0.4	1.3											
19	5	0.6	1.6											
20	4	0.6												

* Band.

† Double.

It may not be out of place here to give a few brief hints as to the best method for obtaining lightning photographs, for the benefit of the large number of amateur photographers scattered over the world. Thunder storms are nearly always cyclonic in their

character, their diameter varying. When they extend over large areas it will usually be found that most of the vertical flashes are at the circumference of the circle through which the storm is passing. In the central part of a storm the flashes are usually horizontal, or passing between two strata of clouds, therefore the best time for obtaining photographs is either at the beginning or the end of a storm. At the beginning the wind is usually very strong, hindering the work, so that it is generally best to wait until the front of the storm has just passed overhead and then to expose the camera from a window or other suitable place facing a direction opposite to that of the wind. In this way the camera as well as the person will be protected from the wind and rain. This rule holds good in most cases, although there are many exceptions, especially when the storm is local in character and of small extent. A person must be on the lookout at all times and note the direction in which most of the downward strokes appear and direct the camera toward them.

It is useless to expose plates when there is nothing but sheet lightning, for it will only result in spoiling them. Oftentimes there is a mixture of sheet lightning and a few scattered ground strokes at uncertain points. When that be the case, the chances for obtaining pictures are slight, the sheet lightning soon fogging the plates, the time for fogging in such cases being from five to ten minutes, depending on the frequency of the reflections. The best rule to follow is to wait until a favorable opportunity presents itself, when the flashes are about half a mile distant, then act quickly, have plenty of plates ready to insert in place of the exposed ones, and trust to luck. The best way of holding the camera when swung by hand is to place it close to the body, tilting it somewhat upward, so as to get as much as possible of the sky in the picture, and swinging the body from side to side. The time and angle of the swing can be regulated with a little practice so as to be fairly accurate, say one second to the swing, although the writer has found by experience that when a sudden flash appears in front of the camera the evenness of the swing will be somewhat disturbed, particularly if the flash is close to the observer, unless the person be in possession of unusually strong nerves. When pictures of horizontal flashes are desired the camera must naturally have an up and down swing. These flashes are usually less intense and the pictures of them sometimes require a very long time to develop.

The developer preferred by the writer is "rodinal," being convenient and clean, although any good developer will do, particularly such contrast developers as "glycin" or "hydrochinon."

Different kinds of plates have been tried, but the writer has no special preference for any one of the standard plates. The orthochromatic plates do not seem to give better results than the ordinary ones. Films give trouble in developing, because each exposure must be developed separately.

Fig. 9 shows the barometer devised by the writer, which he has found very useful in the study of the variations of the atmospheric pressure preceding and during storms. The instrument recommends itself on account of the simplicity of its construction, its accuracy, and the ease with which the readings can be made, less than one two-hundredth part of an inch being easily read off without the aid of a vernier.

The instrument shown in the illustration consists of a glass tube, one-fourth inch inside diameter, 38 inches long, bent to an angle of 100 deg. at a distance of 8½ inches from the closed end, filled with mercury, and mounted with the open end dipping into a reservoir, which in this case is 1 inch in diameter. The open end can also be bent up to form a siphon barometer. The scale is placed along the upper slanting part of the tube. A pointer is fastened to the lower part of the instrument, the use of which is to indicate when it is in an exact vertical position, a mark on the wall indicating this position. The surface tension of the mercury is overcome by gently swinging the instrument and returning it to its vertical position. The calibration may be done by comparison with a standard instrument or by actual measurements. The bend of the tube may be made at a different angle, but should not be much less than 100 deg. owing to the surface tension of the mercury. With this angle the instrument will magnify about six times, which has been found by the writer to be sufficient for ordinary use. The range of the instrument described is about two inches, and if a greater range is desired the slanting portion of the tube may be made longer or a different angle of the bend be substituted, although the proportions given have been found by experience to give the best satisfaction. A tube with a small internal diameter does not give good satisfaction owing to the surface tension being greater.

A NEW GALVANOPLASTIC PROCESS.

By A. BREYDELL.

IN the ordinary galvanoplastic process the object which is to be electroplated is connected with the negative pole of a battery or dynamo and completely immersed in a solution of the plating metal, together with an electrode of this metal which is connected with the positive pole of the source of electricity. Hence it is necessary to use a bath large enough to contain and cover the whole of the object, a condition which becomes impracticable when the object is very large. Furthermore, in order to apply different metals to different parts of the same object it is necessary to use successive baths, in each of which certain parts are protected by an insulating varnish.

R. Goldschmidt has invented a process which avoids

some of the inconveniences, especially in cases where only a thin coating is required. It is not advocated as a substitute for the processes in current use but as a supplementary method, applicable to many cases occurring in practice. Besides, it is so simple that it enables any person to produce a great variety of galvanoplastic effects with a very modest equipment and the ordinary lighting circuit of 110 volts.

In Goldschmidt's process the bath is replaced by the small quantity of the electrolytic solution that can be carried by an ordinary paint brush. The brush, connected with the positive pole of the source of electricity by a wire of the plating metal which is wound tightly around the base of the bristles, thus becomes at once the plating bath and the anode. The object to be plated being connected with the negative pole it is merely necessary to pass the brush over it to obtain instantly, if the surface has been thoroughly cleaned, a regular and firmly adhering deposit.

The thickness of the deposit depends, of course, on the duration of the process and the number of times the brush is applied. The writer has obtained the best results by inserting the object, the brush and five or six incandescent electric lamps in series in a 110-volt circuit. This arrangement should give a current of about 1/10 ampere.

The new process promises to be very useful in both laboratory and commercial work. It provides a simple and expeditious method of protecting from atmospheric influences objects of any size which are either made of metal or have a conducting surface, and it enables the jeweler to produce polychrome effects easily and cheaply. Although the deposit is very thin it adheres perfectly and, if protected by a coat of lacquer, it is sufficient for most purposes.

The following solutions, which are often employed for ordinary plating baths, are found to give the best results:

	Silver.	Parts by Weight.
Silver nitrate		20.0
Potassium cyanide		30.9
Ammonia (90 per cent).....		0.4
Potassium formate		2.0
Water		1,000
Gold.		
Gold chloride		6
Potassium cyanide		13
Ammonia (90 per cent).....		2
Water		1,000
Dissolve and then add		
Potassium formate		2
Copper.		
Copper sulphate		180
Concentrated sulphuric acid.....		60
Water		1,000
Alcohol (90 per cent).....		10
Nickel.		
Nickel sulphate		60
Sodium sulphate		20
Sodium citrate		20
Water		1,000

For nickel plating a low voltage, 2 to 4 volts, gives the best results.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from Cosmos.

THE THEORY OF MOUNTAIN MAKING.*

THE Geological Survey of Pennsylvania made known the folded structure—the alternate anticlines and synclines—of the Appalachians. The beautiful sections of these folded strata, in the Atlas of that survey, reveal the thoroughness with which the structure of the mountains was investigated by Henry D. Rogers; and can be studied with delight to-day, in spite of the fantastic nomenclature, which the student has to translate into the familiar language of the New York Survey. In those sections it appears that, in general, each fold is unsymmetrical, the dip on the northwest side being steeper than that on the southeast, if, indeed, the dip on the northwest side is not carried beyond the perpendicular and reversed. While in each fold, as a rule, the dip is steeper on the northwest side than on the southeast, if we compare the successive folds, we find the dips growing more gentle as we go from southeast to northwest. The nearly vertical or overturned dips of the folds on the eastern border pass by a gradual transition into gentle undulations on the western border of the Appalachian zone.

While the stratigraphy was worked out so beautifully in the first Geological Survey of Pennsylvania, the dynamic conception derived from it was crude indeed. The conclusions of the author are summed up in the following sentences: "The wave-like structure of undulated belts of the earth's crust is attributed to an actual pulsation in the fluid matter beneath the crust, propagated in the manner of great waves of translation from enormous ruptures occasioned by the tension of elastic matter. The forms of the waves, the close plication of the strata, and the permanent bracing of the flexures, are ascribed to the combination of an undulating and a tangential movement, accompanied by an injection of igneous veins and dykes into the rents occasioned by the bendings. This oscillation of the crust, producing an actual floating forward of the rocky part, has been, it is conceived, of the nature of that pulsation which attends all great earthquakes at the present day." The wave-like form of the Appalachian anticlines and synclines is a beautiful generalization of accurate and conscientious ob-

* A abstract of a paper read by William North Rice before the American Association for the Advancement of Science.