most observers, according to Schoene, are liable to confound the odors of ozone and hyponitric acid. It is alleged further that ozone is not produced by the electric spark in a mixture of oxygen and nitrogen, but only oxide of nitrogen, and it is probably to the latter substance and not to ozone that we must attribute the odor sometimes observed after lightning discharges and sparks from an electric machine. Ozone, however, would appear to be produced by the silent discharge of electricity; but it has been justly observed that we know too little of this form of electrical action as an atmospheric phenomenon to justify our regarding it as a probable source of supply of ozone.

In view of all these uncertainties touching the occurrence and action of ozone in the air, it may be prudent to wait a while before admitting ozone to be quite so powerful a factor of individual or national genius, health, or social development as Dr. Linsley and others would have us believe.

PUBLIC WORKS IN NEW YORK CITY.

The report of the New York Commissioner of Public Works for the last quarter of 1880 contains many facts of more than local interest.

New York now has, south of Harlem River, 334½ miles of paved streets, classed as follows: Stone-block pavements, 229½ miles; cobble stone, 80 miles; macadam, 24½ miles; concrete, ½ mile. There were laid last year 244,807 square yards of pavement, covering twelve miles of streets. During the past four years $1,100,000 have been spent upon new pavements and in restoring old ones, 641,957 square yards of worn out and rotten pavements having been replaced by stone blocks.

An appropriation of $400,000 will be devoted this year to the substitution of stone-block pavement for the old cobble stones, which are all to be removed as fast as they can be. More than nine-tenths of the streets of New York will be paved with stone-blocks when the plan is carried out. All plans for concrete and wooden pavements have been dismissed as unadapted to the city, and the macadam roadbed is used to only a very limited extent.

The sewerage system of the island embraces 376½ miles of sewers, with 4,573 receiving basins. Over 5 miles of sewers and culverts, with 62 receiving basins, were added last year. In the older and more densely populated parts of the city the sewers are in anything but a suitable or desirable condition.

A large amount of work in the way of grading, curbing, guttering, and flagging new streets was done during the year, and a large area of new ground was made available for building.

Over 402 miles of streets are lighted, besides 2½ miles of piers and 61 acres of parks. The number of public lamps was 23,511, an increase of 374. Nearly 14 miles of new gas mains were laid, the entire length of gas mains now exceeding 874 miles. The cost of the public lamps was a little short of half a million dollars. The gas consumed was 321,583,860 cubic feet. One mile of Broadway has been lighted by electric lamps on the Brush system, and many private electric lamps help to illuminate the streets.

THE NATIONAL ACADEMY OF SCIENCES.

The annual meeting of the National Academy of Sciences began in Washington, April 19, the venerable President of the Academy, Professor W. B. Rogers, of Boston, in the chair. The list of papers read included: "The Domain of Physiology," T. Sterry Hunt; "The Compass Plant of the Western Prairie," B. Alvord; "The Solar Constant," S. P. Langley; "The Color of the Sun," S. P. Langley; "On Mountain Observations," S. P. Langley; "On the Relation of Soils to Health," R. Pumpelly; "Reduction to Sea Level of Barometric Observations made at Elevated Stations," Professor Abbey; "Electric Light Photometry" George F. Barker; "On the Relations between Strain and Impact," and "On the Structure of the Feet of Mammals," E. D. Cope; "On the Progress of Pendulum Work," C. S. Peirce; "The Production of Sound by Radiant Energy," A. G. Bell; "On the Carbon Lamp Fiber in the Thermo Balance," G. F. Barker; "Memoir of Count S. F. de Pourtales," Alexander Agassiz; "On the Utilization of the Sun's Rays in Heating and Ventilating," E. S. Morse; "On the Later Tertiary of the Gulf of Mexico," E. W. Hilgard; "An Account of the Land Ice of Kotzebue Sound," W. H. Dall.

At the Executive Session of Thursday, Professor A. W. Wright, of Yale College, and Professor H. A. Rowland, of Johns Hopkins University, were elected members, and the following were elected members of the council; Professor S. F. Baird, Professor Wolcott Gibbs, Cambridge; Professor A. Hall, United States Navy; Professor J. E. Hilgard, Coast Survey; Professor Clarence King, Professor Fairman Rogers, Philadelphia. Professor Simon Newcomb was elected Home Secretary, and Professor J. H. C. Coffin, United States Navy, Treasurer.

THE DATE OF THE GLACIAL ERA IN EASTERN NORTH AMERICA.

Mr. G. F. Wright, in a paper read before the American Association for the Advancement of Science, and published in the February number of the *American Journal of Science and Arts*, has made an attempt to calculate approximately the date of the glacial era in Eastern North America, by studying the depth of one of the bowl-shaped depressions which abound in the moraines and kames of New England. These depressions are of all shapes and sizes, from symmetrical "kettle holes" to ponds and lakes of no mean dimensions. It is evident that they cannot always exist, for they are wearing down at the top and filling up at the bottom. For the same reason we know that they cannot always have been in existence.

The basin chosen by Mr. Wright for his investigations was one located near Pomp's Pond, in Andover, Mass., with a diameter of 380 feet, and having an accumulation of peat 96 feet in diameter at the bottom. It is evident that since the first formation of the crater-like depression no material can have reached the bottom except from three sources: (1) The wash from the sides; (2) the decay of the vegetation growing within the rim; and (3) the dust brought by the winds. The problem is to determine the time it would require these three agencies to fill the bottom of this bowl to a depth of 24 feet, which would be equal to a depth of only 8 feet over its present surface—the present depth (17 feet) being estimated from the angle of declivity. Mr. J. Geikie, following the lead of Mr. Croll and others, who look to astronomical data alone, supposes that the so-called glacial period, whose marks we now study in these low latitudes, synchronized with the last period of high eccentricity of the earth's orbit, which closed about 80,000 years ago, and whose maximum influence must have been exerted about 200,000 or 210,000 years since. But once in 21,000 years the astronomical conditions dependent upon the precession of the equinoxes for a glaciation of the northern latitudes occur, though owing to the present low eccentricity of the earth's orbit this influence is now at its minimum.

The question with the crater-like depression above-mentioned is: Could this have stood with so little change for 80,000 years? or even for 40,000 years, as supposed by Prof. Hitchcock? If the close of the great glacial period be so far back as Mr. Croll and Mr. Geikie estimate, we must believe that detritus could accumulate, in the situation above described, over a surface of the area of the present peat bog, only at the rate of one inch in 1,000 years; while, if we put the close of this period back 10,000, the rate of accumulation would seem as slow as the imagination can well comprehend—one inch in 100 years. These considerations have led Mr. Wright to look with increasing distrust upon the astronomical calculations which are made concerning the glacial period, unless the moraines mark the limit reached at the last semi-revolution of the earth's equinoxes about 10,000 years ago. He believes it evident that the glacial phenomena of New England are comparatively recent in their origin.

PHOTOPHONIC AND SPECTROPHONIC DISCOVERIES.

At the meeting of the National Academy of Sciences, April 21, Prof. A. Graham Bell read an important paper describing at great length the recent investigations made by Mr. Tainter and himself in the field so brilliantly opened by them a year ago. After referring to their earlier observations on the production of sound by radiant energy, Prof. Bell said that at his suggestion and during his absence in Europe, Mr. Tainter had pursued the investigation of the sonorousness of matter under the influence of radiant energy, employing a vast number of substances inclosed in test tubes in a simple empirical search for loud effects. He was thus led gradually to the discovery that cotton-wool, worsted, silk, and fibrous materials generally, produced much louder sounds than hard rigid bodies like crystals or diaphragms, such as had hitherto been used.

Mr. Tainter next collected silks and worsteds of different colors, and speedily found that the darkest shades produced the best effects. Black worsted especially gave an extremely loud sound. As white cotton wool had proved itself equal, if not superior, to any other white fibrous material before tried, he was anxious to obtain colored specimens for comparison. Not having any at hand, however, he tried the effect of darkening some cotton wool with lampblack. Such a marked re-enforcement resulted that he was induced to try lampblack alone. About a teaspoonful of lampblack was placed in a test tube and exposed to an intermittent beam of sunlight. The sound produced was much louder than any heard before. Upon smoking a piece of plate glass and holding it in the intermittent beam, with the lampblack surface toward the sun, the sound produced was loud enough to be heard, with attention, in any part of the room. With the lampblack surface turned from the sun the sound was much feebler.

The experiments were repeated when Prof. Bell returned, and were continued by the two gentlemen together. It was found that when the beam was thrown into a resonator, the interior of which had been smoked over a lamp, very curious alternations of sound and silence were observed. The interrupting disk was set rotating at a high rate of speed, and was then allowed to come gradually to rest. An extremely feeble musical tone was at first heard, which gradually fell in pitch as the rate of interruption grew less. The loudness of the sound produced varied in an interesting manner. Minor re-enforcements were constantly occurring, which became more and more marked as the true pitch of the resonator was neared. When at last the frequency of the interruption corresponded to the frequency of the fundamental of the resonator, the sound produced was so loud that it might have been heard by an audience of hundreds of people.

The extremely loud sounds produced from lampblack demonstrated the feasibility of using this substance in an articulating photophone in place of the electrical receiver formerly employed. In regard to the sensitive materials that can be employed, the experiment indicated that in the case of solids the physical condition and the color are two conditions that markedly influence the intensity of the sonorous effects. The loudest sounds were produced from substances in a loose, porous, spongy condition, and from those that had the darkest or moist absorbent colors. The materials from which the best effects have been produced are cotton-wool, worsted, fibrous materials generally, cork, sponge, platinum, and other metals in spongy condition, and lampblack.

The explanation suggested for the superior loudness of the sounds produced by a dark porous substance, for example, lampblack, was as follows. Said Professor Bell:—"I look upon a mass of this substance as a sort of sponge, with its pores filled with air instead of water. When a beam of sunlight falls upon this mass, the particles of lampblack are heated, and consequently expand, causing a contraction of the air spaces or pores among them. Under these circumstances a pulse of air should be expelled, just as we would squeeze out water from a sponge. The force with which the air is expelled must be greatly increased by the expansion of the air itself, due to contact with the heated particles of lampblack. When the light is cut off the converse process takes place; the lampblack particles cool and contract, thus enlarging the air spaces among them, and the inclosed air also becomes cool. Under these circumstances a partial vacuum should be formed among the particles, and the outside air would then be absorbed, as water is by a sponge when the pressure of the hand is removed. I imagine that in some such manner as this a wave of condensation is started in the atmosphere each time a beam of sunlight falls upon lampblack, and a wave of rarefaction is originated when the light is cut off. We can thus understand how it is that a substance like lampblack produces intense sonorous vibrations in the surrounding air, while at the same time it communicates a very feeble vibration to the diaphragm or solid bed upon which it rests."

As intimated above the lampblack proved to be an efficient as well as economical substitute for selenium and tellurium in the electrical receiver of the photophone.

The investigation of the influence of radiant energy upon various substances, solid, liquid, and gaseous, placed in different parts of the solar spectrum, resulted in the production of a new instrument of physical research which has been called the spectrophone. When different substances were used as receivers it was found that the loudness of the sound varied in point of position upon the spectrum in a remarkable manner. With the lampblack receiver a continuous increase in the loudness of the sound was observed upon moving the receiver gradually from the violet into the ultra red. The point of maximum sound lay very far out in the ultra red. Beyond this point the sound began to decrease, and then stopped so suddenly that a very slight motion of the receiver made all the difference between almost maximum sound and complete silence. With red worsted entirely different results were obtained. The maximum effect was produced in the green at that part where the red worsted appeared to be black. On either side of this point the sound gradually died away, becoming inaudible on the one side in the middle of the indigo, and on the other at a short distance outside the edge of the red. With green silk the maximum was found in the red, with the limits of audition in the blue on the one hand and the ulta red on the other. Hard rubber shavings gave a maximum in yellow. Vapor of sulphuric ether produced no audible effect, until a point far out in the ultra red was reached, when suddenly a musical tone became distinctly audible. Vapor of iodine disclosed its maximum in green. With peroxide of nitrogen distinct sounds were obtained in all parts of the visible spectrum, but no sounds were observed in the ultra red.

The repetition of these tests in connection with an undistorted spectrum, that is, one produced by a diffraction grating, will obviously be necessary before any positive conclusions can be arrived at touching the exact relations of color or wave-length to the sonorousness of different substances.

In its present form the spectrophone is a modification of the ordinary spectroscope, made by substituting for the eye-piece a sensitive substance placed at the focal point of the instrument behind an opaque diaphragm containing a slit, the sensitive substance being put in communication with the ear by means of a hearing tube. With reference to the probable utility of the spectrophone, Professor Bell said:

"Of course the ear cannot for one moment compete with the eye in the examination of the visible part of the spectrum, but in the invisible part beyond the red, where the eye is useless, the ear is invaluable. In working in this region of the spectrum, lampblack alone may be used in the spectrophonic receiver. Indeed, the sounds produced by this substance in the ultra red are so well marked as to constitute our instrument a most reliable and convenient substitute for the thermopile. . . . I recognize the fact that the spectrophone must ever remain a mere adjunct to the spectroscope, but I anticipate that it has a wide and independent field of usefulness in the investigation of absorption spectra in the ultra red."

HOT WATER COMPRESSES IN TETANUS AND TRISMUS.—Sporer has successfully treated cases of tetanus by merely applying to the nape of the neck and along the spine large pieces of flannel dipped in hot water, of a temperature just bearable to the hand (50-55° C.)—*Allg. med.-cent. Zeit.*