RAREFIED AIR AS A CONDUCTOR OF ELECTRICITY

Edlund continues his researches upon the subject. A number of experiments are described to show that the phenomena of the opposition to the passage of sparks from terminal to terminal in rarefied air cannot be explained by the theory that a vacuum does not conduct electricity. He carefully discusses the question of the contrary electro-motive force which is developed at the terminals. "It is not the resistance of the gas, but this electro-motive force, increasing with the rarefaction and connected with the electrodes, that presents an obstacle to the passage of the current. Everything is in favor of the hypothesis that vacuum opposes a very feeble resistance to the propagation of electricity." Without the employment of electrodes, one can excite an induction current in a Geissler tube, which is sufficient to produce light. This would be impossible if the highly rarefied gas or vacuum were an insulator —*Phil. Mag.*

Mr. G. R. Howell, New York, in a recent paper before the Albany Inst., favored the open Polar Sea theory for the following reasons 1. Water-fowl go regularly each spring northward from Greenland for nesting. As the ice-barrier from 73° to 82° is too cold for birds to raise their young, their nesting place must be north of this barrier, and in a milder climate. 2. The occurrence of warm winds from the circumpolar regions, as verified by explorers in high latitudes. 3. The occurrence of furious gales during the long arctic winters, which would be unaccountable if the region for ten degrees around the pole were as cold as the zone of the ice-barrier, and therefore as calm as the equatorial belt.

The class-experiment commonly employed for demonstrating chemical decomposition consists in heating mercuric oxide, and showing that oxygen is given off while mercury remains behind. An easier and beautiful experiment may be performed with crystallized copper formate. This salt, when heated over gas-flame in a dry test-tube, readily decomposes; oxides of carbon are evolved, and a brilliant residue of metallic copper is left. The formate is easily prepared by boiling copper oxide with formic acid, and filtering, On cooling, fine blue crystals are deposited. Although this experiment involves no new facts, I believe its applicability to class-room purposes has been generally overlooked. *F. W. C. in Science.*

AN ASPHALT MORTAR.

The *Centralblatt der Bauverwaltung* describes a patented composition made at a factory in Stargard, Pomerania, which has for some years past been used with perfect success on the Berlin Stettin railway for wall copings, water-tables, and similar purposes requiring a water-proof coating. The material is composed of coal-tar, to which are added clay, asphalt, resin, litharge, and sand It is, in short, a kind of artificial asphalt, with the distinction that it is applied cold, like ordinary cement rendering. The tenacity of the material, when properly laid, and its freedom from liability to damage by the weather are proved by reference to an example in the coping of a wall which has been exposed for four years to the drainage of a slope 33 feet high. This coping is still perfectly sound, and has not required any repair since it was laid down. Other works have proved equally satisfactory. In applying this mortar, as it is termed, the space to be covered is first thoroughly dried, and after being well cleaned is primed with hot roofing varnish, the basis of which is also tar. The mortar is then laid on cold, to the thickness of about three eighths of an inch, with either wood or steel trowels, and is properly smoothed over. If the area covered is large, another coating of varnish is applied and rough sand strewn over the whole. The waterproof surface thus made is perfectly impregnable to rain or frost, and practically indestructible. The cost of the material laid is estimated at not more than 10 cents per square foot, and it is stated that this price can be reduced by at least two cents for large quantities put down by experienced workmen.

Steel Water Pipes —The Chameroy Co. makes pipes of steel plate for conveying water under high pressure. The steel plates are coated with lead on both sides by immersion or otherwise, then rolled to form, riveted, and soldered the whole length, and covered with pitch. The first cost of the steel is not much greater than that of iron, and the steel pipes possess considerable advantages over those of iron. The lead coating is superior on account of the fineness of grain in the steel; the resistance to tensile strain and internal pressure is 50 and 60 times, and the resistance to deformation longitudinally from 30 to 40 times greater, while the superior elasticity of the steel plate permits of the pipes receiving tolerable hard knocks without being permanently deformed. For equal thickness the steel tubes stand twice the internal pressure of the iron, and being both light and strong, they are admirably adapted for laying down temporarily and taking up again.—*Iron.*

Astronomical Applications of Photography.—Professor E. C. Pickering described some photographic work which is now being undertaken at the Harvard observatory. Experiments are being made with various lenses, and on their completion it is intended to take photographs from the whole visible heavens north of 30° south. It is possible, also, that a map will be published. Measurements of the photographic energy of all the brighter stars will be made, down to, perhaps, the seventh magnitude. Besides this, it is proposed to obtain measurements of the color of the stars, by using a large lens of heavy flint-glass, giving as much chromatic aberration as possible. In the centre a circular disk of glass will be placed, slightly thinner at one edge than at the other. The effect will be, that every star will have two images placed side by side. By adjusting the sensitive plate at a certain distance from the lens the blue rays will be brought to a focus; but, in the case of the image formed by the rim of the lens, the violet and ultra-violet rays will be spread over so large an area as to produce comparatively little effect, while in the other image they will have nearly full power. By placing another plate somewhat nearer the lens the violet rays will be focused. A third plate will enable us to focus the ultra-violet rays. By comparing, in each case, the image formed by the edge of the lens with that formed by the centre, a series of quantitative results can be obtained, which will vary according to the spectrum of the star measured. By this method any variation of color as well as of magnitude could at once be detected.—(*Amer. acad. arts sc.*; *meeting Feb.* 14.)

PROCEEDINGS OF SOCIETIES.

The Institution of Civil Engineers: Mr. Brunlees, in the chair. A paper was read on "the Productive Power and efficiency of Machine-Tools, and of other Labour-Saving Appliances, worked by Hydraulic Pressure," by Mr. Ralph Hart Tweddell, M. Inst. C.E.

The Author stated that he had occasion to design a machine, which was required to exert great pressure in a confined space at a considerable distance from any shafting. The machine had to be portable, and to be capable of doing a large amount of work efficiently without the intervention of skilled labour. Such conditions were of common occurrence, and in this instance all were successfully fulfilled by the employment of hydraulic pressure. The Paper was an amplification of the subject of the application of this power to actuating machine-tools, and other labour-saving appliances in engineering works, and was divided under three heads, namely, the introduction and development of hydraulic-pressure machine-tools; the productive power and efficiency of machine-tools generally, and the modes of increasing them; and the increased productive power and efficiency obtainable by the employment of hydraulic-pressure for working machine-tools and other labour-saving appliances. Reference was made to the unpublished experience existing on these questions.

Under the first head an illustration was afforded by a small portable hydraulic apparatus for fixing the ends of boiler-tubes in tube-plates, the pressure of water employed varying from 1 to 1½ ton per square inch. Owing to the introduction of high steam-pressures, the scantlings of marine boilers had to be considerable increased, but the mechanical riveting-machines formerly in use were mostly inadequate to make steam-tight joints. In 1865 the Author designed a hydraulic riveting-plant to overcome the difficulty. It consisted of pumps, an accumulator, and a riveting-machine, and in operation was seven times more economical than hand-work; moreover its surplus power was available for hydraulic presses for "setting," or joggling, angle and tee-irons. In action it was found that the material was much less strained, and that the wear and tear of the moulds and dies was greatly reduced, besides which the machines were movable. Previous attempts to perform similar work by portable machines driven by steam had not been very successful. This, it was believed, was the first hydraulic-pressure riveting-machine which could readily be applied at different points and over considerable areas, and at the same time maintain an uninterrupted connection with the accumulator-pressure in the mains. The system had been extended to machinery of sufficient gap to span the deepest girders, the same hydraulic power which actuated the heavier machines being utilized for lifting them. The water driving these machines and their lifting apparatus was supplied under a pressure of 1,500lbs. per square inch. Amongst the first to employ them was the firm of Sir William Armstrong and Co. Several instances were then given of their application: for riveting *in situ* the lattice-girder bridge which carried Primrose Street over the Great Eastern Railway at Bishopgate Street Station; for riveting locomotive boilers; for fastening rivets in gun-carriages and in agricultural machinery; for railway waggon-work, and for riveting ships. The substitution of hydraulic machinery for punching and shearing metals had been more gradual, but it had proved economical, and had been employed for shearing the links of chain cables 3 inches in diameter, both sides at one time. To obtain the full advantages due to the application of hydraulic pressure to machine-tools, the system should be applied throughout the works. This had been first carried out completely at the French naval dockyard at Toulon for