records? Evidently there was no attempt at sound ranging.

The typographical work on the book is excellent except that the photographs, charts and diagrams are poorly lettered and not up to the rest of the book.

A. M.

SPECIAL ARTICLES

VARIATIONS IN THE ELECTRICAL POTENTIAL OF THE EARTH

AT a meeting of the Academy of Science of St. Louis, held on March 17, the writer presented diagrams representing variations in gravitational attraction between the masses of the Cavendish apparatus in the second story of the physics building at Washington University.

This apparatus is composed of a shield in which the smaller masses are suspended on a bi-filar suspension of silk fibers. The top, bottom and ends of this shield are of wood, covered within and without with tin-foil. The sides are of sheet metal, clamped to the wood frame by bars of wood and the joints sealed with wax. The wood clamps are covered by tin-foil. The whole is then surrounded by two end caps of metal which meet at the middle of the shield and are sealed together with tin-foil. The position of the suspended masses is determined by a telescope and scale in the usual manner. The mirror is observed through a narrow slit in the two metal screens which surround the suspended masses, and which is closed by a strip of glass sealed to the inner sheet of metal. The suspended masses are electrically charged by means of a wire armed with a pin which is thrust through a glass tube which is passed through a small opening in the end of the shield. When connected with the electrical machine in an adjoining room the air within the shield and the suspended masses were charged. This operation was made to come about gradually by having a gap armed with pins in the line leading to the machine. In some cases the suspended masses would swing into contact with the metal sheets forming the sides of the screen. It was arranged that they should be deflected towards the large masses. It was found that on withdrawing the glass tube and pin and closing the opening in the screen with tin-foil, the small masses could be liberated with an initial velocity approaching zero, by connecting the large masses and screen directly with the machine terminal, eliminating all gaps in the line. The impression thus created was that gravitational attraction was thus diminished until the torsional effect of the bi-filar suspension could detach the small masses from the screen, to which they were held by an electrical attraction.

After the suspended masses had come to rest in the center of the screen, which was usually on the following day, the large masses were directly connected with a large copper rod on the outer wall of the building, which served as lightning protection for the building. This rod was the ground connection for a steel tower on the roof of the building, which formerly was part of a system for wireless telegraphy. The top of this tower is 100 feet above the ground. This tower and the earth replaced the electrical machine, in the electrification of the large masses.

On clear days when there was practically no wind, the gravitational attraction of the large masses for the suspended masses has sometimes been diminished, until it has apparently become a repulsion. All artificial heat was cut off from the room, so that its temperature increased during the day not more than two or three degrees centigrade. The temperature of the air in contact with the large masses was under constant observation, the recording being made by means of a telescope. The temperature could be read accurately to tenths of a degree Centigrade, and hundredths of a degree could be estimated with fair precision.

When the masses were not in connection with the lightning rod, the rise in temperature during the day caused a very slow increase in the reading which determined the position of the suspended masses. This change was due to convection currents within the shield surrounding those masses.

These convection effects have been very carefully examined. They are distinctly appreciable when the temperature of the room

increases by two degrees in six or seven hours. They are very marked when a door opening into the hallway is opened for four or five minutes, allowing warmer air to enter the room. The entrance door used when this work is being done is in an adjoining room. When a window is raised for a few minutes, allowing colder air to enter, a sudden decrease in the scale reading results. The convection effect increases as the rate of change of temperature increases.

When the suspended masses have been positively charged, and the large masses have been connected with the lightning rod marked effects have been observed on clear days when there was little or no wind. Sometimes the effect was to eliminate convection effects. In all cases there was an apparent decrease in gravitational attraction. The maximum decrease was usually in the afternoon at about three or four o'clock. The decrease varied from twenty-five to near two hundred per cent. In other words, gravitational attraction was apparently converted into a repulsion.

These results seem to indicate that there is a daily variation in the electrical potential of the earth. The atmosphere, ionized by solar radiation, acts inductively upon that part of the earth which is exposed to sunlight. Lightning flashes from cloud to cloud or from clouds to earth furnish abundant evidence that there are also local variations in the potential of the earth. There is no reason why we should not continue to assume the potential of the earth to be zero, as we assume the level of the ocean to be zero in altitude, but there is evidence that there is a condition of matter such that its electrical potential may be defined as zero absolute. It is the condition or potential of two masses having a like potential due to charges upon them when their gravitational attraction for each other is a maximum.

It seems very probable that the free terminal of a machine having the other terminal grounded in a pond of water, may be at times, nearer to a potential zero absolute, than the grounded terminal, when the machine is in active operation. This would fully account for different results obtained when the electrical machine is used in the electrification of the large masses. These results appear to furnish a complete explanation of the phenomenon known as St. Elmo's fire.

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THE BUFFALO MEETING OF THE AMERICAN CHEMICAL SOCIETY. IV

Division of Physical and Inorganic Chemistry

W. E. Henderson, *Chairman*
W. A. Patrick, *Secretary*

Action of perchloric acid on metals and non-metals: H. H. Willard and A. H. Huisken.

Perchloric acid as an oxidizing agent in the determination of chromium and vanadium: H. H. Willard and W. E. Cake.

Perchloric acid as a dehydrating agent in the determininination of silica: H. H. Willard and W. E. Cake.

The arrangement of electrons in atoms and molecules: Irving Langmuir. Starting from Rutherford's and Lewis' theory and from chemical data, a theory of atomic and molecular structure is developed in which the electrons are symmetrically arranged about the nucleus in concentric shells. From some simple postulates the broad features of the physical and chemical properties of all the elements (including eighth group and rare earths) are derived. There follows a new and rational theory of valency called the octet theory, identical with the ordinary theory for organic compounds and for inorganic compounds giving Werne's theory as a special case. The theory also explains the magnetic properties of the elements.

Preferential catalysis and the purification of hydrogen: H. S. Taylor.

New measurements on the direct synthesis of ammonia (lantern): L. H. Adams.

Application of the thermionic amplifier to conductivity measurements (lantern): L. H. Adams and R. E. Hall.

Electrometric titrations, with special reference to the determination of ferrous and ferric iron (lantern): J. C. Hostetter and H. S. Roberts. Conditions are given under which very small, as well as large, amounts of ferrous and ferric iron can be readily determined. Ferrous iron is titrated directly with potassium dichromate (0.002 N to 0.10 N) following the change in potential against