cause of political unrest and intrigue. On the other hand it may be that the Pope's advisers would regard his residence in Spain, or some other good Catholic country, simply as affording a more convenient centre of operation and a better leverage for working upon the sympathies of Catholic kings and courts. In any case it is pretty clear that if His Holiness voluntarily leaves the Vatican, the chances of return for him or his successor will be likely to become small by degrees and beautifully less. We do not know, however, that the final advancement of the claim to a worldly kingdom would greatly lessen the dangerous character of the Papal system. It might rather increase it. The most serious danger to national and civil liberties is involved in what Catholics would call the spiritual supremacy of the vicegerent of the King of kings. So long as adherents of the Catholic church can be made to believe that the claims of this spiritual despotism upon their allegiance transcend those of the highest civil authority, the doctrines of the Papacy will remain a standing menace to free institutions.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE Annual Meeting of this learned and influential body of Scientists was eagerly looked forward to by their Canadian confreres and the people of Toronto generally. The preparations and arrangements of the local committee were remarkably complete, and evoked hearty appreciation from the distinguished visitors.

In the absence of Professor Powell, Professor Mendenhall, of Washington, presided at the opening meeting of welcome. Professor Carpmael, of Toronto; the Hon. G. W. Ross, Minister of Education; Wm. Mulock, M.P., Vice-Chancellor of Toronto University, and E. F. Clarke, M.P.P., Mayor of Toronto, happily expressed the pleasure with which all classes of the citizens welcomed the presence of their illustrious guests. The receptions were tendered to the Association in the Horticultural Gardens, on Wednesday and Thursday evenings, and on Friday evening a large audience assembled in the Pavilion to hear Prof. Gilbert, Assistant Geologist in the U. S. Geological Department at Washington, lecture on the Glacial Period in Niagara and Lake Ontario.

MATHEMATICS AND ASTRONOMY.

Vice-President R. S. Woodward, of Washington, delivered an address before the section on the Mathematical Theories of the Earth. The paper, which was somewhat long, contained a great deal of well-arranged matter and many original observations that will, when published in the Annual Report, without doubt excite much interest.

Mr. Henry Farquhar, of the Coast Survey Office, Washington, read a paper on A Proposed Catalogue of Declinations.

Prof. William Harkness, of Washington, D.C., read a paper on The Solar Parallax and its Related Constants, which consisted of a brief account of an investigation soon to be published by the United States Naval Observatory.

Prof. Charles H. Chandler, Ripon, Wis., presented a paper called A Desideratum in the Presentation of Mathematical Truth.

Mr. Brathear, of the Astronomical and Physical Instrument Works, Alleghany, Pa., read three important papers, suggesting improvements for telescope glasses. The subjects of the papers were (1) New arrangement for an Astigmatic Eye-glass, (2) The Jena Optical Glass, and (3) The Hastings Acromatic Objective, which last was very interesting, and caused much discussion and inquiry.

Prof. Frank H. Bigelow, in treating on automatic photography, said that in the history of observations of precision there were three distinct periods, (1) an English school, of which John Pond was a type, (2) a German school represented by Bessel, and (3) a modern school of photography, as applied to transits. For the automatic observation of star transits by photographic record and consequent elimination of the personal equation an apparatus is described, whose method and operation seemed satisfactory. It was simple, and could be attached to the telescope now used with a little care, thus rendering them available for the old and the new methods.

Dealing with astronomical observations made with the great telescope of the Lick Observatory since June, 1888, Mr. Edward S. Holden, director of the observatory, said the instrument had now been in use for a year, and had given them data for sound judgment. He then gave a brief statement regarding the proportions of the dome and accessory apparatus. He explained the working of the dome and the elevating floor, which was first suggested to the Lick trustees by Sir Howard Grubb. He gave a brief summary of the work accomplished or begun with the large telescope during the year.

Mr. Geo. C. Comstock, Madison, Wis., gave a paper on the use of a floating mirror as an auxiliary to a meridian circle.

Mr. J. R. Eastman read a paper on the Relations between Stellar Magnitudes, Distances, and Motions.

Prof. Wm. A. Rogers read a paper on the Graduation of Meridian Circles *in situ*, which consisted of a description of this process by which a circle having a diameter of five feet was graduated to degrees with subdivisions to two. After the third time the greatest error of the 6° points, including the error of eccentricity, was found to be within 14″, while the average error was only 0.2″. The circle had an axis of six inches in diameter.

Prof. H. S. Carhart read a comprehensive paper called A Review of Theories of Electrical Action. Of the practical applications of electricity he would only say they bore witness of themselves. A million electric lamps nightly made more splendid the lustrous name of Faraday; a million messages daily flashed over land and under sea emphasized the value of Joseph Henry's contribution to modern civilization. Without these things the civilization of the present would become impossible. The value of the purely scientific work of such men was attested by the resulting well-being, comfort, and happiness of mankind.

Mr. H. Carrington Bolton, of University Club, New York, read a paper on Researches on Sonorous Sand in the Peninsula of Sinai, accompanied by magic lantern views illustrative of the subject. It treated of the position of Jabel Nagons, on the Gulf of Suez, its surroundings, the banks of fine brown sand, which were pourtrayed on the canvas by original photographs. The paper also described a new locality in the desert discovered by the author, where the sand is sonorous throughout cliffs a quarter of a mile long. This musical sand is also discovered on the Atlantic coast of the United States and the south coast of England.

A paper was read, Concerning Thermometers, prepared by Prof. Wm. A. Rogers, and R. S. Woodward. The points made were: 1. The movement of a mercurial column was in all cases by pulsation; 2. These pulsations had a regular recurrence; 3. The period of recurrence was constant in the same thermometer, and varied between 0.25° and 11° in different thermometers; 4. Every pulsation had the same harmonic relation whatever the part of the revolving of the call at which it occurs; 5. The amplitude of the curve which represented the harmonic was inconstant, and varied between 0.13° and 0.53° for the thermometers investigated; 6. As the period is constant and the time required for the completion of the cycle was variable, it followed that the danger of error in random readings of the thermometer was greater for slow than for rapid variations of temperature.

Mr. Woodward then followed with a mathematical investigation of the relations pointed out in the foregoing paper.

The Measurement of Magnification in the Microscope was the title of a paper by Prof. W. Leconte Stevens, of Brooklyn, N.Y. His paper was a criticism of the rule commonly employed for estimating magnification in the microscope, that of dividing 100 by the product of the focal length of objective and eye-piece. The deduction of this rule was given, and its roughly approximate character was shown in the assumption it involved. A method was given and a formula was deduced for determining the focal length of the eye-piece, making allowance for the distance of the eye from the glass. The same was done for the determination of the focal length of an objective without implying any knowledge of the position of its optical centre.

Prof. H. T. Eddy, University of Cincinnati, considered a molecule of a perfect gas as a free body which has motions of rotation and translation about each of its three principal axes of inertia. The paper resolved this actual screw motion into two screw motions, both of them about x, and of such pitch that they perfectly replace the actual motion both kinematically and kinetically. It appeared that since during the fortuitous molecular encounters, which control the rotary and translatory motions, the rotary impulse is independent of the translatory impulse, positive and negative notations were therefore associated with positive and with negative translations indifferently. Hence motions on each of the component screws were independent and equally probable. But in each of these component screw motions, into which the actual motion had been resolved, the total energy is half rotary and half translatory. Hence the total kinetic energy of the molecule was half rotary and half translatory.

He also read a paper on Magnetic Rotation of Polarized Light according to the Electro-Magnetic Theory. He said the partial differential equations expressing the propagation of plain polarized light in a magnetic field, published by Professor Rowland, contained terms due to the transverse electro-motive force arising from the Hall effect. The particular solution of these equations which was proposed in that paper, as the one in acceptable accordance with experiment, contained a periodic factor dependent upon the time alone. The author presented a different particular solution containing a periodic factor dependent upon the space which the ray traverses in the magnetic medium, and compared it with the solution already published by Professor Rowland. A comparison of the physical ideas underlying these two forms of solution led the author to think it probable that the transverse electromotive force due to the Hall effect would cause a retardation of the ray.

Prof. Harris J. Ryan, of Ithaca, N.Y., on a Quadrant Electrometers, said the electrometer needle and quadrants were made of the cylindrical form. To the needle was attached a magnetized steel mirror. The needle was hung by a single silk fibre, and metallic contact was made to the same by means of a very fine platinum wire. About the quadrants and needle with its plane in the magnetic meridian and the steel mirror at its centre was arranged a coil of wire as in a tangent galvanometer. The electrometer needle was deflected, and then brought back to its zero position by balancing with a current in the coil surrounding the same, whereby the magnetized mirror was acted upon by a current opposite of sign to that acting on the needle. The current was then a measure of the difference of potential to which the electrometer had been subjected in accordance with the manner in which it might have been arranged.

Prof. Thomas Gray, of Terre Haute, Indiana, read a paper on the Relative Merits of Dynamometric and Magnetic Methods of obtaining absolute measurement of Electric Currents. The paper discussed the methods commonly adopted for the measurement of electric currents by the electro-dynamo and the magnetic methods. The methods of determining the value of the horizontal intensity of the terrestrial magnetic field by using it in the current measurement were examined, and some modifications were suggested both in the ordinary Gauss and in the suspended coil Kohlrausch methods. The measurement of the dimensions of standard galvanometer coil was also examined in connection with this method, and a means of obtaining high accuracy described. The degree of accuracy attainable from the instrumental point of view was found to be within one-twentieth per cent. of absolute. In the dynamometric method a general agreement was expressed with the position taken up by Lord Raleigh, and the opinion given that this method could be made to give an accuracy within 100 per cent. of absolute.

A paper on Globular Lightning, by Prof. T. C. Mendenhall, briefly reviewed the evidence for the existence of globular lightning, as presented by Arago and others, with additional information and quotations drawn from earlier literature. The testimony of recent observers was related, and the conclusion reached that in view of the mass of evidence, and notwithstanding the conflicting character of much of it, the reality of the phenomenon must be admitted.

Prof. H. S. Carhart, of Ann Arbor, Michigan, read a paper on Magnetic Leakage in Dynamos, showing the manner and extent to which leakage occurs in dynamos.

Prof. H. S. Carhart also read a paper called an Improved Clark Standard Cell with Low Temperative Co-efficient, descriptive of certain improvements desirable in a standard cell, and giving some directions respecting the preparation of materials for such a standard.

A paper prepared by Messrs. Edward L. Nicholls and Benj. W. Snow was read on The Influence of Temperature upon the Colour of Pigments. The paper stated that the general law commonly supposed to hold that the change of colour in pigments with rise of temperature was always toward the red was not substantiated. It was found, however, without exception, that the substances experimented with suffered decrease of reflecting power when heated, and all wave lengths of the visible spectrum were subjected to greater absorption by the hot than by the cold pigment. In some cases this increased absorption occurred in nearly like proportions throughout the spectrum, in other cases it was selective.

MECHANICAL SCIENCE.

At the meetings of Section B, Mechanical Science and Engineering, the following papers were read:

Prof. O. Chanute read an interesting paper on Resistance of Air to Inclined Planes in Motion. On this subject the author advanced a new theory based on the generally accepted law that fluid pressures are in direct proportion to the number of molecules affected by the motion. The author suggested that there was no warrant for assuming that the geometrical figure enclosing the molecules is that of a column, but that it might be a prismoid with only the height due to the velocity, and still enclose double the number of molecules of parallelopipiden of equal altitude.

Prof. O. Chanute read a paper on preserving wood against decay. He said the growing scarcity of wood in this country was fixing attention upon economical means of lengthening its resistance to decay. The Europeans had been compelled by the same reason to experiment largely with the various chemicals, and during the last forty years had achieved much success. The following methods had proved a success:

1st. Kyanizing, or preserving with corrosive sublimate. 2nd. Copperizing, or preserving with sulphate of copper. 3rd. Burnettizing, or preserving with chloride of zinc. 4th. Creosoting, or preserving with oil of coal tar.

Prof. J. E. Denton followed with a paper on the Relative Performance of Modern Air-Compressors.

Ernest B. Perry read a paper on Steam Injectors. In view of the great scarcity of literature on this subject, especially the experimental part, the aim of the paper was to put in shape for reference such results as were carefully obtained from a series of tests of three well-known machines; also a comparison under actual working conditions of the injector and a Gordon duplex pump.

Mr. M. E. Cooley, of Ann Arbor, Mich., read a paper, The Performance of a Vibrating Piston Engine, showing the friction of an engine under various loads and the efficiency under a constant load, determined and compared with similar results on reciprocating piston engines.

Mr. W. R. Warner, Cleveland, Ohio, read notes on Anti-Friction Construction for Revolving Mechanism for Observatory Domes. According to the method he recommended, the lower trunk or wall-plate was turned to its proper cone, so that the conical wheel would run round freely when in position and both theoretically return to the starting point.

Mr. M. E. Cooley read a paper on The Performance of the Pumping Engine, showing the duty carefully determined in the water cylinders to show the loss by friction