search was obtained. The results were classified and an order of standing was determined under the four heads: reliability and simplicity; liability to act when not required; ease of operation; cost of equipment and maintenance.

The most remarkably wide range of prices is reported—$30 to $585, averaging about $200. Eleven of the list tested are authorized for use, and the Board determined that the common form of brake now in use should be replaced by one or another of these, or equally efficient, brakes.

President Vreeland, of the Metropolitan Co., his directors and the executive officers seem to have taken much trouble and to have met most of the expenses of these important pioneer investigations, and his electrical engineer, the master mechanic and the superintendents lent essential aid in the work.

The report can be had by applying to the Board at Albany.

The data may be summarized thus: At 8 miles an hour, a stop was made in from 3 to 8 seconds; at 12 miles in 5 to 9 seconds; at 15 miles, in 6 to 10 seconds; at 16 miles, in 6 to 11 seconds, without sand, and 6½ to 9½ with sand. The distances run ranged from 35 to 66 feet at 8 miles, 58 to 111 at 12 miles, 72 to 203 at 16 miles; averaging for all speeds, from 58 to 133 feet.

A conventional system of checking for 'skidding' wheels was adopted.

All in all, the work must be accepted as an earnest and faithful endeavor to effect, for the first time, a solution of an important problem—one which concerns all railway managements and all travellers on electric street cars very seriously. The report has been criticised as failing to give data relating to dimensions of parts, uncertainty regarding the comparability of brakes differently handled by their exhibitors, and regarding the automatic records. An examination of the apparatus employed, however, shows that the distances traversed were measured by a mechanism positively driven and which, therefore, gave reliable comparison of distances traversed, which measures are the sole basis of all comparisons and are evidently substantially correct. The technical journals generally approve the report as giving valuable and helpful information. Undoubtedly, later investigations will afford opportunities for improvements which this, as all pioneer efforts, indicates to be desirable notwithstanding its evident and admitted defects in time-measurement, the report must be accepted as important. Variations of the time-scale do not affect its conclusions. It is to be hoped that the work will be continued and perfected.

R. H. THURSTON.

Lehrbuch der Photochromie von Wilhelm Zenker; neu herausgegeben. Von PROFESSOR DR. B. SCHWALBE. Braunschweig, Friedrich Vieweg & Sohn.

This is a republication of a work which appeared in 1868, to which has been added a biographical sketch, and a résumé of recent work along similar lines.

It will doubtless surprise the general reader to find that partially successful experiments in photochromy, or the *direct* reproduction of color by photography, were made over a quarter of a century before the announcement of Daguerre's discovery in 1839. As early as 1810 Seebeck obtained colored impressions of the solar spectrum on paper coated with chloride of silver, but the matter attracted but little attention and was soon forgotten.

In 1841 the property which this substance possessed of assuming a color somewhat similar to the hue of the light falling upon it was rediscovered by Herschel, but the possible great importance of the subject does not appear to have been realized until Becquerel, stimulated by Daguerre's discovery, took up the work, and by a laborious series of investigations determined the conditions most suitable for a faithful reproduction of the colors of the original.

Up to the time of the appearance of Zenker's work the almost universal opinion seems to have been that colored compounds of silver (oxidation and reduction products) were formed by the action of the light. Zenker, however, offered a most ingenious physical explanation, as opposed to the chemical theory. He explained the colors as due to the interference of light reflected from thin laminæ of metallic silver, laid down in sheets half a wave length apart, by the action of stationary light waves,

resulting from the interference of the direct wave train with the train reflected from the back surface of the film. In other words, the colors of the photochromes were similar to the colors of the soap-bubble. This is precisely the principle since made use of by Lippman in his beautiful process.

Zenker's book opens with a short elementary account of the nature of light, of no especial interest. Following this comes a very complete account of the work of Seebeck, Becquerel, Poitevin and others. His account of the claims of Hill, the American photographer, are interesting, final judgment of the case being left to the reader.

Full details are given in most cases of the method of preparing the plates, and the reader will find himself strongly tempted to repeat some of these early experiments.

The third portion of the book treats of the theory of photochromy. The colors of the photochromes had been explained in various ways. Some held that colored oxidation and reduction products were formed while others assumed that the chemical action of the light occurring at the surface, formed a film of varying thickness which showed color precisely like the film of a soap bubble. Zenker effectually demolishes this theory by showing that prolonged exposure, by increasing the thickness of the film, should change the color, which is not the case.

He then advances his own beautiful theory, not abandoning the soap film idea, but presenting it in a wholly new light. He conceives the light waves as penetrating the film and suffering reflection at the back surface. The reflected waves interfere with the oncoming waves forming a stationary system, the ether within the film vibrating in nodes, like the string of a musical instrument when sounding a harmonic. He shows us that there will be planes of vibration within the film parallel to the reflecting surface situated half a wave-length apart. In other words the distance between the planes of maximum vibration will depend on the wave-length or color of the light. If the silver is reduced in these planes and not at the nodes (when there is no vibration) we shall have reflecting laminæ formed, which will act like the upper and lower surface of a soap film and show interference colors. The light most copiously reflected under these conditions will be of a color identical with that of the light which formed the laminæ. He describes a number of experiments confirming his theory, but pushes it too far in attempting to explain the color of ordinary objects and the perception of color by the eye in this way.

His book is on the whole a most excellent résumé of the work done up to the time of its publication.

The appendix, in which the further development of the subject is treated by E. Tonn, deals chiefly with matters of theoretical interest. The work of Wiener and Lippmann is discussed in connection with the theory of the reproduction of mixed colors. As a matter of fact there have been very few or no developments since the time of Zenker, except along the lines indicated by Lippmann, and as no details of this process are given, the appendix is likely to be of interest to the physicist rather than to the photographer.

R. W. Wood.

BOOKS RECEIVED.

Grundlinien der anorganischen Chemie. Wilhelm Ostwald. Leipzig, W. Engelmann. 1900. Pp. xix + 795. 18 Marks.

Der Gesang der Vögel. Valentin Häcker. Jena, Gustav Fischer. 1900. Pp. vii + 102. 3 Marks.

Symons's British Rainfall, 1899. Compiled by H. Sowerby Wallis. London, Edward Stanford. 1900. Pp. 251. 10s.

Foundations of Knowledge. Alexander Thomas Ormond. London and New York, The Macmillan Co. 1900. Pp. xxvii + 528.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF GEOLOGY AND MINERALOGY.

At the meeting on May 21st, Dr. A. A. Julien presided and about twenty persons were present. Two papers on the rocks of Mexico were presented. The first was by Mr. G. I. Finlay, entitled 'A New Occurrence of Nephaline Syenite and associated Dikes in the State of Tamaulipas, Mexico, with a review of the distribution of these rocks in North America.' The second paper was a 'Contribution to the