opposite points when extended, which we know to be conditions that must be filled.

The plane table is essentially a direction instrument. Theoretically we can do perfect work without knowing a single distance, and afterwards, by measuring some length between objects marked on the sheet, determine a scale for the whole. This being the case, the angle at the occupied station, between two points marked on the sheet, will be the same wherever the points may happen to be on the paper. It is the practical application of the geometric functions of similar triangles. But the distortion of a sheet destroys these perfect proportions, for we have to preserve directions between fixed objects, and knowingly increase or diminish the angle contained between the directions. As at *X*, we know that it is in its proper position on the line between *ae*, *cg*, etc.; but we know also that the angle *aXh* is smaller than it is in nature, and the angle *aXc* is larger.

This forcing the position does not produce any appreciable error in the work represented, as in short distances, like filling in detail around the station, the distortion cannot be measured, and in long distances it can be eliminated. It is evident that a station made by three points on the lines of contraction will give the table the true orientation, for the effect of the distortion upon three points so situated is only that of a change of scale, and a change of scale does not affect orientation. But the position of the station made in relation to the other points on the table is not true, owing to the change of scale not being the same on both lines of contraction. From the conditions presented, Mr. Ogden deduced the following rules:—

(1) A station made with three points that are on the lines of contraction, the resecting lines forming nearly right angles at their intersection, will give the true position in relation to all points on the sheet (as *h*, *b*, and *d*).

(2) A similar condition of right-angular intersection at the station, but the lines forming diagonals to the lines of contraction, will give the worst possible position for the station (as *a*, *c*, and *e*).

(3) A station made with three points on one of the lines of contraction will give the correct orientation of the table (as *a*, *h*, and *g*).

(4) In estimating errors of the points due to distortion, those situated on the lines of contraction require no allowance, however distant.

Mr. Ogden then explained the treatment in cases where only three points were visible, — first, when all of them are on the lines of contraction; second, when two of them are on the lines of contraction, and one of them not; and, third, when neither of them is on the lines of contraction.

The effects of distortion, as Mr. Ogden explains them, throws some light on the relative accuracy of plane-table triangulation. This class of work is good and reliable if the paper does not change its conditions; but it is evident that a triangulation extended over a sheet that has contracted since the base was plotted on it, and the first few triangles laid down upon it, will be continued on varying scales. We have but to conceive the triangles extended in the form of a parallelogram, working two sides of it from each of the separate bases to a common point, to see the theoretical outcome of such conditions.

Plane-table triangulation is liable to be further complicated by frequent changes of scale or different degrees of contraction as the work progresses, which prevent the possibility of computing the resultant errors. Some check can be obtained by subdividing the sheet into squares of uniform size, which will show, at least, how much the paper has changed when the work is finished. Such squares are an assistance in the information they give while the work is in progress; and by carefully watching the changes in them it would be possible to apply corrections for the points of a plane-table triangulation that would eliminate the worst of the errors incident to such work.

The uniformity in the contraction of a sheet of paper may also be taken advantage of in measuring the length of a diagonal line by drawing lines on the lines of contraction at right angles with each other; and, having obtained the true lengths of the two sides of the triangle, the third may be computed with at least as much accuracy as it could have been measured on the paper if the scale had not become distorted.

ELECTRICAL SCIENCE.

Alternating versus Continuous Current Distribution.

THE subject which most engrosses the attention of electric-lighting people at present, is the question of the relative values of continuous and alternating currents for electrical distribution. In England the matter was brought up by the papers of Messrs. Kapp and Mackenzie on transformers, while in this country a pamphlet issued by the Edison Company, attacking the alternating system, has been followed by two interesting papers read before the Chicago Electric Club, — one by Mr. Leonard in favor of the continuous, the other by Mr. Slatterly favoring the alternating system.

The difficulty in all of this material is that it is distinctly partisan. In spite of this, it is valuable. The trouble, of course, in getting reliable data on the subject, lies in the fact that those who have had most experience of the practical difficulties or advantages of a system are those who are directly interested in its working, and who must have some bias in its favor.

In the discussion before the Chicago Electric Club, Mr. Leonard, taking the matter up first, considers the following points: first cost, economy, reliability, value of possible sources of revenue, safety, effect on existing property. Under the first head he calculates the cost per lamp of the copper necessary for conductors in the direct system at different distances from the station: for example, with an average loss of eight per cent in the conductors, and a distance of six thousand feet, the cost is $3.87 per lamp. With this he compares the cost of the corresponding investment in the alternating system, — copper and transformers, — and makes it $4. This is on the assumption that copper is sixteen cents per pound. As it is principally in the cost of conductors that the alternating claims advantage over the direct system, Mr. Leonard's figures would go to prove the advantage of the latter for mean distances up to six thousand feet from the station. Passing to depreciation of the distributing plant, Mr. Leonard claims that the conductors in the direct will depreciate in value less than the conductors and converters of the rival system. The reliability of the direct system would seem greater than that of the other; for the apparatus is less complicated, and a breakdown of one engine or dynamo in a station will not affect the lights. The possible sources of revenue seem to Mr. Leonard more numerous in the continuous system. At present the alternating system can supply only light and — if it is ever needed — heat: its rival can be utilized for all the purposes to which electricity can be applied. The danger of high potential alternating currents is dwelt upon, and fatal results were cited.

Mr. Slatterly, in replying to the paper, disputes some of Mr. Leonard's points. The estimates, based on sixteen cents per pound for copper, would hardly apply to copper at nearly twenty-five cents, its present price. The alternating system has the advantage that it can be used at *any* distance from the station, and the latter can be built on inexpensive ground, not in the middle of a crowded district where property is costly. Mr. Slatterly claims for the alternating system that the accidents that have happened are due to inexperience, and their occurrence was not a fault of the system. On the question of danger he states that alternating currents are not so dangerous as continuous currents of the same potential. As regards distribution of power, Mr. Slatterly thinks that an alternating electro-motor will soon be forthcoming.

In considering electrical questions with a view of deciding between two systems, we should consider two things, — economy under present conditions, and the probable progress in the near future. As things stand at present, we may say that the direct system has the disadvantages of a limited area of distribution, and the necessity of locating in a central position, where land is expensive: the alternating system has the disadvantage of a considerably greater loss in distribution, of greater complexity and consequent liability to accident, impossibility of distributing power, and danger. These considerations would point to the direct system being best in the central portions of cities, while the alternating system should be used for towns and for the suburbs of cities; possibly, too, as an auxiliary to arc-lighting stations.

In the future the alternating system can hope for the perfection of a motor and the general improvement of the apparatus: the

direct system can hope, besides the ordinary improvements, for the perfection of some converter for direct currents; above all, for storage-batteries. If storage-batteries are successfully developed, the alternating system has nothing to offer that the direct system does not possess, while the advantages of the latter will be overwhelming. As we have already pointed out, however, a combination of the two systems would undoubtedly be best at the present moment.

ELECTRIC MOTORS FOR MINING-WORK. — Some contracts have just been completed by the Sprague Electric Motor Company that are being watched with interest by mine-owners. The most important order is for motors to be used on a circuit of about eighteen miles in length, for pumping, hoisting, etc. The river whose bed it is desired to work for gold, curves in a horseshoe shape; and a tunnel has been cut across the narrow part of the shoe, diverting the river from its bed. A turbine in the tunnel drives the generating-dynamo, while the motors are distributed along the bed of the river. Some of the other contracts are for running hoisting apparatus by motors, the power being obtained from streams distant two or three miles. There is no application of electricity with a wider field than the distribution of power, and nowhere can power be more successfully distributed by electricity than in mining-work.

FARBARKY AND SCHENCK ACCUMULATORS. — Among the numerous modifications of the Faure-Sellon-Volckmar accumulators, one of the most successful is the battery designed by Farbarky and Schenck. Originally the usual 'grid' form of support plate was used, the improvement consisting in mixing coke or other porous substance with the active material to give a better circulation of the electrolyte in the plate. Recently a change has been made in the shape of the holes in which the active material is contained. With the square hole completely filled with peroxide, there is no allowance made for its slow expansion, and the result is the 'growing' of the positive plate, with, under certain conditions, a falling-out of the plugs. In the new Farbarky-Schenck plate the solid bars are circular in form, intersecting, and leaving between the larger openings smaller, narrow slits, that allow the peroxide in the main openings to expand without causing more than a slight local strain. While it seems possible that this form of plate is an improvement on the ordinary type, yet it is hard to believe that plates made by pasting red lead or litharge into holes in lead frames can form the final type of storage-cell. In England, Germany, Austria, and this country, the Faure plan of using salts of lead mechanically applied to the support is almost universally used. In France, on the other hand, some modification of the Planté plate is usually employed, the endeavor being to form active coatings on the lead supports by the employment of an electric current, either forming the peroxide from the material of the support, or depositing it from the solution employed. At present the Faure plan is most generally used, but it is probable that the final lead storage-cell will be made by some modification of the Planté system.

THE SCHANSCHEIFF PRIMARY BATTERY. — This battery has zinc and carbon electrodes in a solution of basic sulphate of mercury and bisulphate of mercury in water. The cell has been tested by Sir W. Thomson, Mr. Preece, and others, and has been highly commended by them. The liquid can be quickly renewed when exhausted; the expense is not great; and for certain classes of work, such as mine-lamps, the lighting of trains, etc., it is said to possess advantages in weight and economy over secondary batteries.

BOOK-REVIEWS.

The Long White Mountain; or, A Journey in Manchuria. By H. E. M. JAMES. London and New York, Longmans, Green, & Co. 8°. $6.

WE have reported several times on the interesting journey of Messrs. James, Younghusband, and Fulford in the south-eastern portions of Manchuria. A full account of this journey has now been published. The special value of the book lies in the full and concise description of the history, the inhabitants, and the religion of the province, and particularly its administration, produce, and trade. In the southern provinces the Chinese form of administration has now almost entirely superseded the Manchu, while in the province of Kirin both Chinese civil officials and Manchu military commandants are found. In the northern provinces, where Chinese immigrants are not so numerous as in southern Manchuria, the Manchu military officers still bear sway. In the region of the Long White Mountain no officials of any kind are found, but the inhabitants have formed themselves into guilds, — a very effective means of keeping their district free from brigands, which infest almost the whole province of Manchuria. The towns and villages are protected from their ravages by walls. In discussing the taxation, the author mentions the general corruption of the authorities, and gives his opinion on the opium trade. He shows that opium is grown in many parts of Manchuria, even close by the highways, although its cultivation is prohibited by law. Therefore he thinks that the raid upon the Indian opium trade is out of place, as China can supply her want of opium herself. This chapter of the book is one of the best, as the author, who is a member of the Civil Service of India, has evidently a thorough knowledge of the trade and commerce and of the production of eastern Asia. In the description of his travels, which occupies the second half of the book, particular attention is paid to the produce of each part of the province, to the methods and facilities of trade, and to the dues collected from it. He describes the roads, which are for the most part practicable only in winter, when the swamps and bogs are frozen. Even the military roads are in a poor condition. The most interesting part of the journey was that in the Ch'ang-pai-shan, the Long White Mountain, which was known from descriptions of Chinese travellers and the Jesuits, who visited it in the beginning of last century. The mountains were said to attain a height of twelve thousand feet or more, but the measurements of Younghusband show that it is only eight thousand feet high. The sources of all important rivers of Manchuria are situated in these mountains; and it must be regretted that the travellers, on account of a scarcity of supplies, were unable to make a more accurate survey of this region. The description of the inhabitants, who have formed a small republic of their own, is very interesting. We described some of the observations made by the travellers in this region in No. 245 of *Science*, according to a lecture delivered by James before the Royal Geographical Society. In the present volume he details his experiences more fully, and his report is full of interesting facts. After leaving the Long White Mountain, the travellers turned northward, and visited Tsitsihar and many other places, their travels practically covering the whole region east of the line from the Gulf of Liao-Tung to Tsitsihar. The book, which is accompanied by a good map and numerous illustrations, forms a very valuable contribution to our knowledge of the present state of affairs in Manchuria, the author giving a vivid picture of all he has seen and heard during his interesting journey.

A Manual of Analytical Chemistry, Qualitative and Quantitative, Inorganic and Organic. By JOHN MUTER. 3d ed. Philadelphia, Blakiston. $2.

THE object of this work has been to produce a manual, short and easily understood, taking the student from the simplest to the most complex matters of qualitative analysis, and also dealing with quantitative work sufficiently to give him a fair insight into all branches of this department. It is adapted for students who desire to prepare for pharmaceutical, medical, or general university examinations in practical chemistry. The present edition has been considerably condensed in bulk, though a large amount of additional matter has been introduced. Muter's analytical chemistry has always been a popular manual with teachers and students, and the improvements in this edition will make it still more acceptable.

The Urine. Memoranda, Chemical and Microscopical, for Laboratory Use. By J. W. HOLLAND. Philadelphia, Blakiston. 12°. 50 cents.

THIS manual deserves to be generally adopted in medical schools and by physicians. It contains the latest and best tests, and is well illustrated. In addition to the tests recommended, which are both chemical and microscopical, Dr. Holland gives, under the heading 'Import,' the bearing which the result of these tests has upon the diagnosis and treatment of the patient. For instance, after describing the various tests which may be employed for the detec-