work revealed three errors in the bearings as published, probably to be ascribed to copying or printing and not affecting the map. It indicated also that the points of the crest lines determined by intersection are not all accurately placed on the map, the errors amounting usually to a few feet, but not affecting the computed rate of recession.

Each of the crest-line points was originally located, as a rule, by the intersection of two bearings, but there are four points to which three bearings were taken. In the replotting of these points the check afforded by the third bearing was found to give a satisfactory result. The points which have the advantage of this check are all on the east side of the Horseshoe curve, and include the point at the angle of the Horseshoe in the position where the notch subsequently developed (Z in Fig. 6). For the remainder, or western part, of the Horseshoe curve there is no similar check, and the three located points of the crest line are so far apart as to give little mutual support. So far as the published data are concerned, these have no higher intrinsic authority than the two points on the American Fall which have been discredited by independent evidence.

The record of the Horseshoe Fall which stands nearest in time to the map of 1842 is Basil Hall's sketch from the Forsyth Hotel (Fig. 7), the interval being fifteen years. The general form of the crest line is the same in map and sketch, and the tangent based on the sketch is so related to the mapped crest line (Fig. 6) as to indicate some recession between the dates of the sketch and the map, but the amount of recession is less than would be expected.

The factors bearing on the estimate of the rate of recession are not so related that rigid mathematical methods can be applied to their discussion. The conflict of data and the mutual support of data can be weighed only by non-mathematical methods, and the result of their study is an opinion rather than a decision. The general tenor of the evidence, including the five surveys and the Basil Hall sketch, leaves no question that the annual rate of recession has been about 4 or 5 feet. If full authority be ascribed to the map of 1842, the estimated annual rate of recession is 5.3 feet. If full authority be ascribed to the tangent line based on the sketch of 1827, the estimated rate is about 1 foot less. It is my opinion that the map affords the better record. Giving to it the greater weight and to the tangent a smaller weight, I think the best practicable estimate of the rate is between 5.3 and 4.2 feet, but nearer to the former; and I select 5 feet partly because a statement in even feet avoids the implication of high precision which might be suggested by a decimal. As an estimate of the average rate of recession during the period of definite observation, I think this can not be in error more than 1 foot.

SUMMARY AND CONCLUSION.

The data for computing the rate of recession of Niagara Falls include surveys of the crest line made in 1842, 1875, 1886, 1890, and 1905, and camera lucida sketches made in 1827. During the period covered by these data the local conditions affecting the rate of recession have not differed to an important extent from the natural conditions. The present and prospective diversions of water for economic uses interfere with the course of nature and may be expected to modify the rate of recession. The natural rate of recession of the Horseshoe Fall is desired by geologists in connection with estimates of the age of the river. The geologic bearing of a rate modified by human agency is less direct. The rate of recession of the American Fall is of interest to geologists because somewhat representative of the river's activity in gorge making when the volume of water was much less.

The rate of recession of the Horseshoe Fall, or the rate of lengthening of the Niagara gorge, during the sixty-three years from 1842 to 1905 is found to be 5 feet per annum, with an uncertainty of 1 foot. For the thirty-three years from 1842 to 1875 the rate was apparently slower than for the thirty years from 1875 to 1905. The rate of recession of the American Fall during the seventy-eight years from 1827 to 1905 was less than 3 inches per annum.

The time consumed in the recession of the falls from the escarpment at Lewiston to their present position, or the age of the river, is not here estimated. It can not properly be computed without taking account of all conditions, local and temporary, affecting the rate of recession, and some of those conditions have varied greatly from point to point and from time to time.

AGNES MARY CLERKE.*

By E. A. Dent.

In the death of Agnes Mary Clerke, which took place on the 20th of January last, the scientific world lost one of its most useful and distinguished members.

Miss Clerke was one of the four eminent women upon whom, by virtue of scientific attainments, Fellowship in the Royal Astronomical Society has been conferred. The others were Miss Caroline Herschel, Mrs. Somerville, and Lady Huggins.

As a clear and forceful writer on astronomical subjects Miss Clerke was almost unrivaled. Her knowledge was deep and thorough; her outlook was broad, and her attitude as a student of the heavens fearless but reverent. Her original investigations covered many subjects, such as studies of star colors, star distribution, the classification of stellar spectra, variable stars, etc., but her great skill in compiling the results of the work of others, and her keen insight in comparing and discriminating as to the bearing and value of different classes of evidence, almost overshadowed her own investigations. The value of her books is enhanced by their charming literary style, fluent yet dignified language, and general grace of expression. They are notable as works of literature as well as of science.

Agnes Mary Clerke, daughter of John William Clerke, was born in the County of Cork, Ireland, on the 10th of February, 1842. Though her astronomical reading began when she was a child of eleven years, her education was not designed to fit her for scientific work. In reply to a question of the writer on the subject she said:

"The truth is bare and bold enough in sound, that in the scientific sense I had no education, but just picked up what came my way. I had a childish passion for natural knowledge and read the books accessible to me in my father's library, taught myself with the minimum of assistance some elementary mathematics, and that was all. I was also very delicate growing up and never went to school, . . . but I had admirable instruction from private professors in languages and music. I had from time to time tried writing stories and poetry, with indifferent success; but in Italy I undertook more serious work and contributed on various topics to the Edinburgh Review from 1877. An article on 'The Chemistry of the Stars' made a turning point. The studies for it revived my astronomical tendencies; Messrs. Black accepted my proposal to write for them a history of recent astronomy, and so I went on."

The publication of "A Popular History of Astronomy in the Nineteenth Century," upon which she spent the work of four years, brought her at once to the attention of the scientific world. The book was at once recognized as a most important contribution to astronomical literature. It reached its fourth edition in 1902, and has been translated into German.

"The System of the Stars," published in 1888, contains the result of several months' work at the Cape Observatory, studying the southern heavens under the guidance of Sir David Gill. The second edition, published in 1905, is largely re-written, in view of the progress which had been made in astronomical research since its first appearance. The same remark may be made of the "History," which was not permitted to become out of date.

"Problems in Astrophysics," published in 1903, deals essentially with twentieth century astronomical science. It embodies not only a history of what has been accomplished in astrophysical research, but it suggests the directions of possible and probable advance and development, stimulating the worker to further investigation. The Fellowship in the Royal Astronomical Society which was conferred upon the appearance of this book was no doubt intended as a public recognition of the value of her services to astronomy.

"The Herschels and Modern Astronomy," published in 1895, is a short history of the celebrated family and its contributions to astronomical science.

Shorter works are "Familiar Studies in Homer," published in 1892; two sections of "Astronomy" in the Concise Knowledge Series; the "Hodgkins Essay" on Temperature Research at the Royal Institution, 1901; about one hundred sketches of the lives of scientific men for the Dictionary of National Biography, and many of the articles in the Encyclopædia Britannica upon the life and work of such men as Galileo, Kepler, Laplace, etc.

The last work, published a year ago, was "Modern Cosmogonies." It is a review of the theories of the universe which have been advanced from time to time, with a discussion as to their merits and defects.

The London Times, commenting on the death of Miss Clerke, (February 22, 1907), said: "No worker in the vast field of modern sidereal astronomy opened by the genius of Herschel and greatly advanced by the application of the spectroscope to the chemical and physical problems of the universe lacked due recognition by Miss Clerke, who performed as it seemed no other writer could have done the work of collation and interpretation of this enormous mass of new material, ever pointing the way to new fields of investigation, often by one pregnant suggestion sweeping aside a whole sheaf of tentative conjectures, and indicating, if not the true line—for in many cases the truth is yet to seek—at least a plausible and scientific line well worth pursuing. She will be missed at the meetings of the Royal Astronomical Society, at which she was a constant visitor, . . . where her clear judgment was at times called upon to determine the value of some new suggestion in the domain of celestial physics."

* Journal of the Royal Astronomical Society of Canada.

FORMS FOR CONCRETE CONSTRUCTION.*

By Sanford E. Thompson, M. Am. Soc. C.E.

Recent failures in reinforced concrete construction cannot be cast aside and forgotten with the passing comment so frequently heard, that the accident was due merely to poor construction or too early removal of forms. The reasons for every failure should be thoroughly investigated by experts to prevent recurrence of similar accidents.

"Poor construction" and "forms," although frequently guilty, are by no means the only culprits. Just so long as men who know nothing of the first principles of mechanics are permitted to design concrete structures, and just so long as irresponsible contractors are engaged to erect them, the list of accidents will increase in startling numbers. It is the men—not the inanimate lumber—who are to blame in every case. However, granting its danger under ignorant hands, reinforced concrete as a whole must not be condemned for failures due to improper conditions any more than brick should be rejected as a building material for apartment houses because of the collapse of several unfinished buildings in New York city two years ago through disregard of frost action upon the mortar.

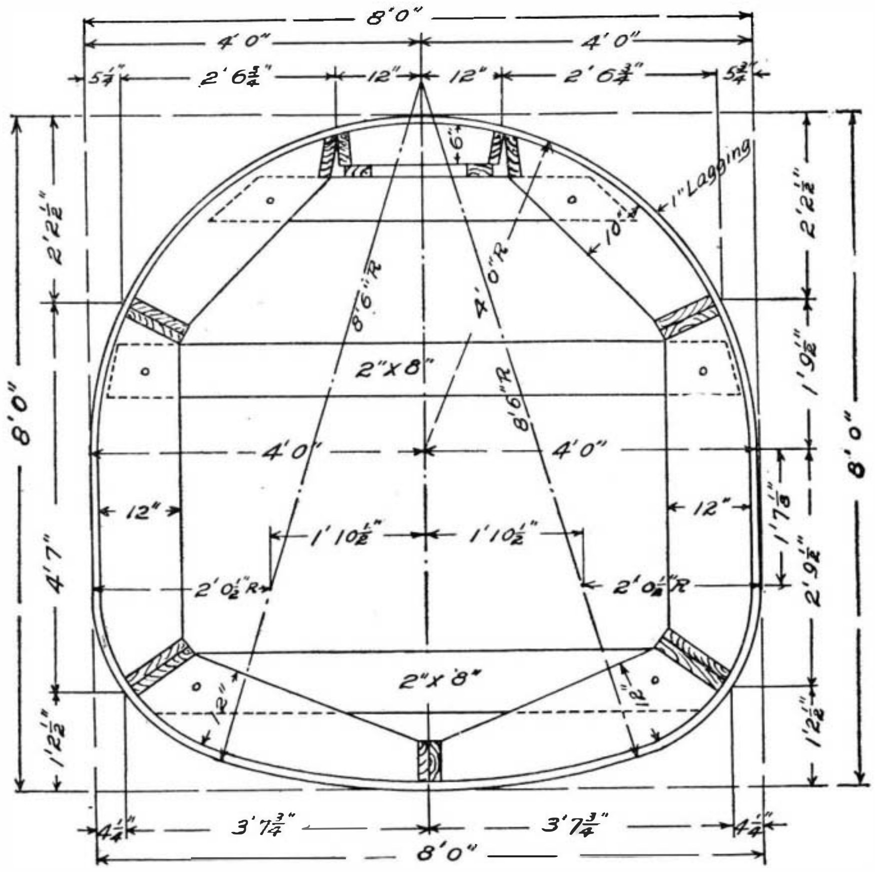

Fig. 1.—CENTER FOR 8 FOOT CONDUIT.

Failures in concrete buildings may be attributed to:

(1) Imperfect design; especially through neglect of essential details in locating the reinforcing metal, and through the adoption of too low a factor of safety.

(2) Poor materials; such as cement which does not properly set up, or sand which is too fine or which has an excess of clay, loam or other impurities.

(3) Faulty construction; from improper proportioning, mixing or placing, or too early removal of forms.

(4) Weak forms.

A disregard of such important principles is frequently criminal negligence, and yet in at least one case under my observation an examination of the structure and the materials after a collapse in which a number of lives were lost showed the design, materials and construction to be all so faulty that it was impossible to decide positively which of the four causes named above was the primary reason for the failure.

In this paper it is proposed to treat only of the design, construction and removal of forms.

GENERAL RULES FOR FORM CONSTRUCTION.

Kind of Lumber.—The selection of the lumber must be governed by the character of the work and the local market. White pine is best for fine facework, and quite essential for ornamental construction cast in wooden forms. For ordinary work, however, even for

* Paper read before the Third Convention of the National Association of Cement Users.