DEPARTMENT OF COMMERCE
U. S. COAST AND GEODETIC SURVEY
O. H. TITTMANN
SUPERINTENDENT

GEODESY

PRIMARY TRIANGULATION ON THE ONE HUNDRED AND FOURTH MERIDIAN, AND ON THE THIRTY-NINTH PARALLEL IN COLORADO, UTAH, AND NEVADA

BY

WILLIAM BOWIE
Inspector of Geodetic Work and Chief of the Computing Division
U. S. Coast and Geodetic Survey

SPECIAL PUBLICATION No. 19

WASHINGTON
GOVERNMENT PRINTING OFFICE
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PRIMARY TRIANGULATION ON THE ONE HUNDRED AND FOURTH MERIDIAN, AND ON THE THIRTY-NINTH PARALLEL IN COLORADO, UTAH, AND NEVADA.

By William Bowie,

Inspector of Geodetic Work and Chief of the Computing Division, United States Coast and Geodetic Survey.

GENERAL STATEMENT.

The primary object of this publication is to give the geographic positions, elevations, and descriptions of the main scheme, subsidiary and intersection stations determined by primary triangulation in the State of Colorado and northward, from the line Pikes Peak-Divide of the thirty-ninth parallel triangulation, approximately along the one hundred and fourth meridian to the Canadian border, and also similar data for the various stations of the thirty-ninth parallel triangulation which lie in the States of Colorado, Utah, and Nevada.

The geographic positions are on the North American datum, and, as far as geographic purposes are concerned, they will probably not be changed. The geographic positions of stations of the thirty-ninth parallel within the States mentioned above, as given in Special Publication No. 4 (The Transcontinental Triangulation), are superseded by the positions contained herein. That publication was issued before the adoption of the North American datum.

The author desires to express his appreciation of the valuable services performed in the field and in the office by members of the Survey in connection with the one hundred and fourth meridian triangulation; also in the office work connected with the readjustment of the thirty-ninth parallel triangulation in Colorado, Utah, and Nevada, and the preparation of the results for publication.[1]

Especial mention should be made of E. H. Pagenhart and C. V. Hodgson, who were in charge of the base measurements and triangulation observations; also of J. S. Bilby, who laid out the scheme and selected the stations in the field and then prepared the stations for the observing party. In the office A. L. Baldwin had direct supervision of the computations and adjustments and prepared portions of the text. The heavy adjustments were made by W. F. Reynolds and O. S. Adams under Mr. Baldwin's direction. C. H. Swick prepared the descriptions of stations, assembled the tables, and edited the text. Of the others who assisted in the work, including the preparation of this report, W. D. Lambert, H. R. Tolley, E. F. Church, and E. M. Panopio should be mentioned.

The engineer intent only on securing the necessary information to extend this triangulation or to base other surveys on it will find the information he desires on pages 80 to 148, commencing with the explanation of the table of positions, lengths, and azimuths. The index, printed on pages 155 to 161, used in connection with the sketches at the end of this publication will enable him to find quickly the data for any given locality.

Illustration No. 7, at the back of this volume, shows graphically the area covered by each of the publications of the United States Coast and Geodetic Survey and by one publication of the United States Army Engineers, which give the results of triangulation, which has been rigidly adjusted and computed on the North American datum.

In illustration No. 8 are shown the main scheme of the triangulation covered by this report and the area covered by each of the illustrations Nos. 9 to 17, which give the details of the triangulation nets.

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[1] Acknowledgments are made for the field and office work connected with the transcontinental triangulation in Special Publication No. 4.

There are also given in this publication descriptions of the methods employed in the triangulation and base measurements on the one hundred and fourth meridian arc and data necessary to show the accuracy of the results of that work.

The methods employed on the thirty-ninth parallel triangulation and the accuracy of the results are described in Special Publication No. 4 of the Coast and Geodetic Survey.

RECONNOISSANCE.

The reconnoissance for the triangulation on the one hundred and fourth meridian was done by Signalman J. S. Bilby in 1911. His party consisted of only one man besides himself; his equipment was three mules, one wagon, one riding saddle, necessary tools for repairing the outfit, one tent, cots and bedding for two persons, and a few cooking utensils. The instruments he carried were a 4-inch surveyor's transit, a prismatic azimuth compass, a field telescope, binoculars, and a set of drawing instruments. He also carried copies of all the available maps covering all or parts of the area within which he operated.

The new scheme began with the line Pikes Peak-Divide of the transcontinental triangulation, with station Bison as the third and check point; it was carried northward to the Colorado-Wyoming boundary, thence northeastward just across the Wyoming-South Dakota boundary, thence northward to the international boundary.

Base lines were provided for at Provo, S. Dak. (approximate latitude 43° 12′), and at Ambrose, N. Dak., at the northern end of the scheme.

Provision was made for connecting with a number of triangulation stations of the United States Geological Survey, with monuments of each State boundary crossed, with the triangulation stations of the Missouri River Commission where the scheme crossed that river, with triangulation stations of the international boundary, and with a number of bench marks of various organizations.

The statistics of the reconnoissance are:

Length of scheme along its axis in miles	720
Area of scheme in square miles	17 000
Number of stations in the main scheme	74
Number of subsidiary stations	23
Number of base lines selected	2
Date of beginning field work	May 2, 1911
Date of ending field work	Aug. 10, 1911
Total length of season, months	3.3
Rate of progress per month, miles	218
Average number of stations selected per month:	
Primary	22
Subsidiary	7

GENERAL INSTRUCTIONS FOR RECONNOISSANCE.

1. *Character of figures.*—The chain of triangulation between base nets shall be made up of completed quadrilaterals and of central-point figures, with all stations occupied. It must not be allowed to degenerate even for a single figure to simple triangles. There must be two ways of computing the lengths through each figure. On the other hand there must be no overlapping of figures and no excess of observed lines beyond those necessary to secure a double determination of every length, except that in a four-sided central-point figure one of the diagonals of the figure may be observed.

2. *Strength of figures.*—In the chain of triangulation between base nets the value of the quantity $R=\left(\frac{D-C}{D}\right)\Sigma[\delta^2_A+\delta_A\delta_B+\delta^2_B]$ for any one figure must not in the selected best chain (call it R_1) exceed 25, nor in the second best (call it R_2) exceed 80, in units of the sixth place of logarithms. These are extreme limits never to be exceeded. Keep the quantities R_1 and R_2 down to the limits 15 and 50 for the best and second best chains, respectively, whenever the estimated total cost does not exceed that for a chain barely within the extreme limits by more than 25 per cent. The values of R may be readily obtained by the use of the following "Table for determining relative strength of figures in triangulation."

In the above formula the two terms $\frac{D-C}{D}$ and $\Sigma[\delta^2_A+\delta_A\delta_B+\delta^2_B]$ depend entirely upon the figures chosen and are independent of the accuracy with which the angles are measured. The product of these two terms is therefore a measure of the strength of the figures with respect to length, in so far as the strength depends upon the selection of stations and of lines to be observed over.

In the following table the values tabulated are $\Sigma[\delta^2_A+\delta_A\delta_B+\delta^2_B]$. The unit is one in the sixth place of logarithms. The two arguments of the table are the distance angles in degrees, the smaller distance angle being given at the top of the table. The distance angles are the angles in each triangle opposite the known side and the side required. δ_A and δ_B are the logarithmic differences corresponding to one second for the distance angles A and B of a triangle.

The square of the probable error of the logarithm of a side of a triangle is $\frac{4}{3}(d^2)\frac{D-C}{D}\Sigma[\delta^2_A+\delta_A\delta_B+\delta^2_B]$, in which d is the probable error of an observed direction. D is the number of directions observed in a figure and C is the number of conditions to be satisfied in the figure. The summation indicated by Σ is to be taken for the triangles used in computing the value of the side in question from the side supposed to be absolutely known.

The strength table is to be used in connection with the values of $\frac{D-C}{D}$ to decide during the progress of the reconnoissance which of the two or more possible figures is the strongest and to determine whether a sufficiently strong scheme has been obtained to make it inadvisable to spend more time in reconnoissance.

Table for determining relative strength of figures in triangulation.

°	10°	12°	14°	16°	18°	20°	22°	24°	26°	28°	30°	35°	40°	45°	50°	55°	60°	65°	70°	75°	80°	85°	90°
10	428	359																					
12	359	295	253																				
14	315	253	214	187																			
16	284	225	187	162	143																		
18	262	204	168	143	126	113																	
20	245	189	153	130	113	100	91																
22	232	177	142	119	103	91	81	74															
24	221	167	134	111	95	83	74	67	61														
26	213	160	126	104	89	77	68	61	56	51													
28	206	153	120	99	83	72	63	57	51	47	43												
30	199	148	115	94	79	68	59	53	48	43	40	33											
35	188	137	106	85	71	60	52	46	41	37	33	27	23										
40	179	129	99	79	65	54	47	41	36	32	29	23	19	16									
45	172	124	93	74	60	50	43	37	32	28	25	20	16	13	11								
50	167	119	89	70	57	47	39	34	29	26	23	18	14	11	9	8							
55	162	115	86	67	54	44	37	32	27	24	21	16	12	10	8	7	5						
60	159	112	83	64	51	42	35	30	25	22	19	14	11	9	7	5	4	4					
65	155	109	80	62	49	40	33	28	24	21	18	13	10	7	6	5	4	3	2				
70	152	106	78	60	48	38	32	27	23	19	17	12	9	7	5	4	3	2	2	1			
75	150	104	76	58	46	37	30	25	21	18	16	11	8	6	4	3	2	2	1	1	1		
80	147	102	74	57	45	36	29	24	20	17	15	10	7	5	4	3	2	1	1	1	0	0	
85	145	100	73	55	43	34	28	23	19	16	14	10	7	5	3	2	2	1	1	0	0	0	0
90	143	98	71	54	42	33	27	22	19	16	13	9	6	4	3	2	1	1	1	0	0	0	0
95	140	96	70	53	41	32	26	22	18	15	13	9	6	4	3	2	1	1	0	0	0	0	
100	138	95	68	51	40	31	25	21	17	14	12	8	6	4	3	2	1	1	0	0	0		
105	136	93	67	50	39	30	25	20	17	14	12	8	5	4	2	2	1	1	0	0			
110	134	91	65	49	38	30	24	19	16	13	11	7	5	3	2	2	1	1	1				
115	132	89	64	48	37	29	23	19	15	13	11	7	5	3	2	2	1	1					
120	129	88	62	46	36	28	22	18	15	12	10	7	5	3	2	2	1						
125	127	86	61	45	35	27	22	18	14	12	10	7	5	4	3	2							
130	125	84	59	44	34	26	21	17	14	12	10	7	5	4	3								
135	122	82	58	43	33	26	21	17	14	12	10	7	5	4									
140	119	80	56	42	32	25	20	17	14	12	10	8	6										
145	116	77	55	41	32	25	21	17	15	13	11	9											
150	112	75	54	40	32	26	21	18	16	15	13												
152	111	75	53	40	32	26	22	19	17	16													
154	110	74	53	41	33	27	23	21	19														
156	108	74	54	42	34	28	25	22															
158	107	74	54	43	35	30	27																
160	107	74	56	45	38	33																	
162	107	76	59	48	42																		
164	109	79	63	54																			
166	113	86	71																				
168	122	98																					
170	143																						

Some values[1] *of the quantity* $\frac{D-C}{D}$.—

For a completed quadrilateral, $\frac{10-4}{10}=0.60$.

For a three-sided, central point figure, $\frac{10-4}{10}=0.60$.

For a four-sided, central point figure, $\frac{14-5}{14}=0.64$.

For a five-sided, central point figure, $\frac{18-6}{18}=0.67$.

For a six-sided, central point figure, $\frac{22-7}{22}=0.68$.

For a four-sided, central point figure, with one diagonal also observed, $\frac{16-7}{16}=0.56$.

[1] The starting line is supposed to be completely fixed and is not considered in computing the number of directions.

3. *Lengths of lines.*—No line of the primary triangulation outside of the base nets should be less than 6 kilometers long. There is little if any advantage, in so far as accuracy is concerned, in making the lines much longer than this. Therefore endeavor, in laying out the triangulation scheme, to use the economic length of line; that is, endeavor to use in each region lines of such lengths as to make the total cost of reconnoissance, building, and triangulation a minimum per mile of progress, subject to the limitations stated in these instructions.

4. *Frequency of bases.*—If the character of the country is such that a base site can be found near any desired location ΣR_1 between base lines should be made about 130. This will be found to correspond to a chain of from 15 to 35 triangles, according to the strength of the figures secured. With strong figures but few base lines will be needed and a corresponding saving will be made on this part of the work. If topographic conditions make it difficult to secure a base site at the desired location, ΣR_1 may be allowed to approach but not exceed 200. There will be danger when this is done that an intervening base may be necessary, for if in any case the discrepancy between adjacent bases is found to exceed 1 part in 25 000 an intervening base must be measured.

5. *Base sites and base nets.*—In selecting base sites keep in mind that a base can be measured with the required degree of accuracy on any site where the grade on any 50-meter tape length does not exceed 10 per cent, and that narrow valleys or ravines less than 50 meters wide in the direction of the base are not obstacles to measurement. The length of each base is to be not less than 4 kilometers. In each base net great care should be taken to secure as good geometrical conditions as possible. There should be no hesitancy in placing the base on rough ground, provided the roughness is not greater than that indicated above, if by doing so the geometrical conditions in the base net are improved. Each base net should not be longer than two ordinary figures of the main chain between bases. The base net may also be strengthened by observing over as many lines between stations of the net as can be made intervisible without excessive cost for building or cutting. Caution is necessary in thus strengthening a base net by observing extra lines to avoid making the figure so complicated as to be excessively difficult and costly to adjust.

COST OF RECONNOISSANCE.

The total cost of the field work, including Mr. Bilby's salary and traveling expenses to the field, was $1,995. As most of the equipment of the party had been in use in previous seasons, new articles cost the party only about $75. The cost of this reconnoissance per mile of progress was $2.77, and is the lowest with which the writer is familiar. On page 168 of Appendix 4, Report for 1911, and page 10 of Special Publication No. 11 may be found statements of cost of previous reconnoissances.

As a proof of the accuracy of this reconnoissance, involving the selection of 97 stations (main and subsidiary schemes) in a triangulation 720 miles (1160 kilometers) in length, in only two places was it necessary to alter the proposed scheme, one at the extreme southern end and the other in the vicinity of Cheyenne.

An occasional obstructed line is to be expected, for the officer carrying on the reconnoissance is supposed to adopt such methods and make such selections of stations as to make the total cost, including reconnoissance, erecting signals, and observing, a minimum. It is obvious that the total would be greater if on the reconnoissance the officer spent enough time testing each line to insure against every obstruction than if he took only the time necessary to make it reasonably sure that only an occasional line must be abandoned or an occasional station introduced into the scheme by the observing party. Besides, it is frequently the case that the party building the signals can test any doubtful lines, and thus avoid delays to the observing party.

The reconnoissance party obtained the geographic locations of the stations by any means available, such as estimated distance and compass bearing to a railroad station, topographic maps, General Land Office maps, bearings on mountain peaks whose positions were known, etc. Only such accuracy is required in the geographic positions of reconnoissance stations as to enable the light keeper and observer to signal each other and to permit the computation of the strength of the figures. As the work progressed the chief of party made sketches showing the approximate location of the stations and the lines to be observed.

Descriptions of the stations were written which enabled the building and observing parties and the light keepers to find the stations selected. They also gave information as to the nearest water for drinking and cooking and for stock, nearest post office, railroad station, and place where supplies might be purchased; also as to the best approach to the station, if it were in a rough or rugged country.

MEASUREMENT OF BASES ON THE ONE HUNDRED AND FOURTH MERIDIAN.

General statement.—According to the strength of the separate figures of the scheme of triangulation on the one hundred and fourth meridian only two new base lines were necessary besides the known length, Pikes Peak-Divide, a line of the transcontinental triangulation. These two bases were located by the reconnoissance party at Ambrose, N. Dak., near the Canadian boundary, and at Provo, in the southwestern corner of South Dakota, and were measured by the observing parties with invar tapes in 1912.

After the triangulation had been completed and a preliminary computation had been made, it was found that the length discrepancy between the Provo and the Ambrose bases was only 1 part in 83 000. However, the discrepancy between the line Pikes Peak-Divide and the Provo base was found to be 1 part in 13 500. A revised computation of the Provo base made no change in the length given by the first computation, and a close inspection of the computation of the old El Paso base and of the triangulation from that base to the line Pikes Peak-Divide showed that no error in computation had been made there. After considering all the facts the conclusion reached was that the discrepancy in length was probably due in part to some systematic or constant error in the measurement of the El Paso base with the base bars in 1878,[1] and also to accumulated errors in the triangulation between the Provo base and the line Pikes Peak-Divide.

It was therefore decided to remeasure the El Paso base with the invar tapes, and this was done by Assistant C. V. Hodgson in the summer of 1913. A computation on the field showed a change of 1 part in 59 000 in the old length of the El Paso base, but this change still left a discrepancy in length between the El Paso and Provo bases of 1 part in 24 000. This showed a rather large accumulation of error in the triangulation, and it was decided to introduce an additional base in the scheme in the vicinity of Cheyenne, Wyo. This base also was measured with the invar tapes, by Assistant Hodgson, in 1913. The discrepancies in lengths are now:

Between the El Paso base (new length) and Cheyenne base, 1 part in 31 000.
Between the Cheyenne base and Provo base, 1 part in 40 000.
Between the Provo base and Ambrose base, 1 part in 109 000.

Methods employed.—The following instructions for the measurement of the Ambrose and Provo bases were issued to Assistants E. H. Pagenhart and C. V. Hodgson, the chiefs of the two observing parties engaged on the triangulation on the one hundred and fourth meridian in 1912:

The two bases shown by the reconnoissance scheme, one at Ambroso and ono at Provo, will be measured by the observing parties during the progress of the triangulation.

Very little increase in the average accuracy of the lengths of the triangle sides in the triangulation connected with a base will result from increasing the accuracy of the base measurement beyond that represented by a probable error of 1 part in 500 000 in the length of the base. The following limits of accuracy are selected with a view of attaining a probable error but little, if any, greater than 1 part in 500 000. You will strive to keep as far within these limits as is possible by the use of good judgment and skill, but you will restrict the time and money expended upon each operation substantially to that required to keep barely within them.

Four invar tapes are to be standardized at the Bureau of Standards, both before and after the measurement of the bases. Each base is to be measured with three of these invar tapes used in daylight or at night. A base shall be measured in sections approximately 1 kilometer in length, except that one shorter section may bo used. Each section of a baso shall be measured with at least two different invar tapes. Different pairs of invar tapes shall be used on different sections, so that the three tapes used on the base shall thereby be thoroughly intercompared. Two, and only two, measurements of each section shall be made, unless the discrepancy between these two measurements exceeds 20 millimeters $\sqrt{K}$ (in which K is tho length of the section in kilometers), in which case additional measurements must be made until two are obtained which agree within this limit. The fourth invar tape standardized is to bo retained for use in case of serious damage to any of the three tapes with which the measurements would otherwise be mado.

Such precautions should be taken to secure accurate horizontal and vertical alignment of the tapes and the determination of the tension applied to the tapes as is necessary to insure that the errors arising from these sources on a base shall each be less than 1 part in 1 000 000.

[1] For an account of the measurement of the El Paso base, see pp. 101-107 of the Transcontinental Triangulation, Special Publication No. 4, of the U. S. Coast and Geodetic Survey. A description of the bars used in tho measurements will be found in Appendix 17, Report for 1880, pp. 341-345.

On the Stanton base, in Texas, the wind blowing against the tapes which had only three supports caused some trouble. The wind effect was made negligible on the Deming base measurements by using five tape supports. In the measurements of the Ambrose and Provo bases either three or five supports may be used, but in no case should the effect of wind on the length of a base be more than 1 part in 1 000 000. The wind when at an appreciable angle with the direction of the base tends to draw the ends of the tape closer together, and thus introduces a systematic error which makes the measured length of the base too long.

The remeasurement of the El Paso base and the measurement of the Cheyenne base in 1913 were made under the same instruetions as the bases at Ambrose and Provo.

Standardization of tapes.—The tapes were standardized at the Bureau of Standards, at Washington, D. C., both before and after the measurement of the Ambrose and Provo bases, and again after the remeasurement of the El Paso base and the measurement of the Cheyenne base. The length of the 50-meter comparator was measured with iced bar B_{17} just before and after the comparison of the tapes with the comparator. In the determinations at the Bureau of Standards the tapes were used in practically the same manner as in the field. They were supported at the ends and at the middle point with all three supports in a straight line. Two thermometers were attached to each tape about 1 meter from the graduation mark at each end, and the fixed tension of 15 kilograms was applied. The tapes were suspended under the end microscopes of the comparator, using the cut-off cylinders for the end supports. For a full description of the standardization of base tapes, see pages 115–119 of Appendix 4, Report for 1907.

The same set of tapes has been used for all the primary bases measured since the season of 1906. These tapes have been standardized six times and the results are shown in tables on pages 25 and 26.

AMBROSE BASE.

This base was located by the reconnoissance party in 1911, to the northwest of the town of Ambrose, in northwestern North Dakota. Its connection with the scheme of triangulation is shown on illustration 12 at the end of this volume. Ambrose northeast base is identical with triangulation station School of the International Boundary Survey.

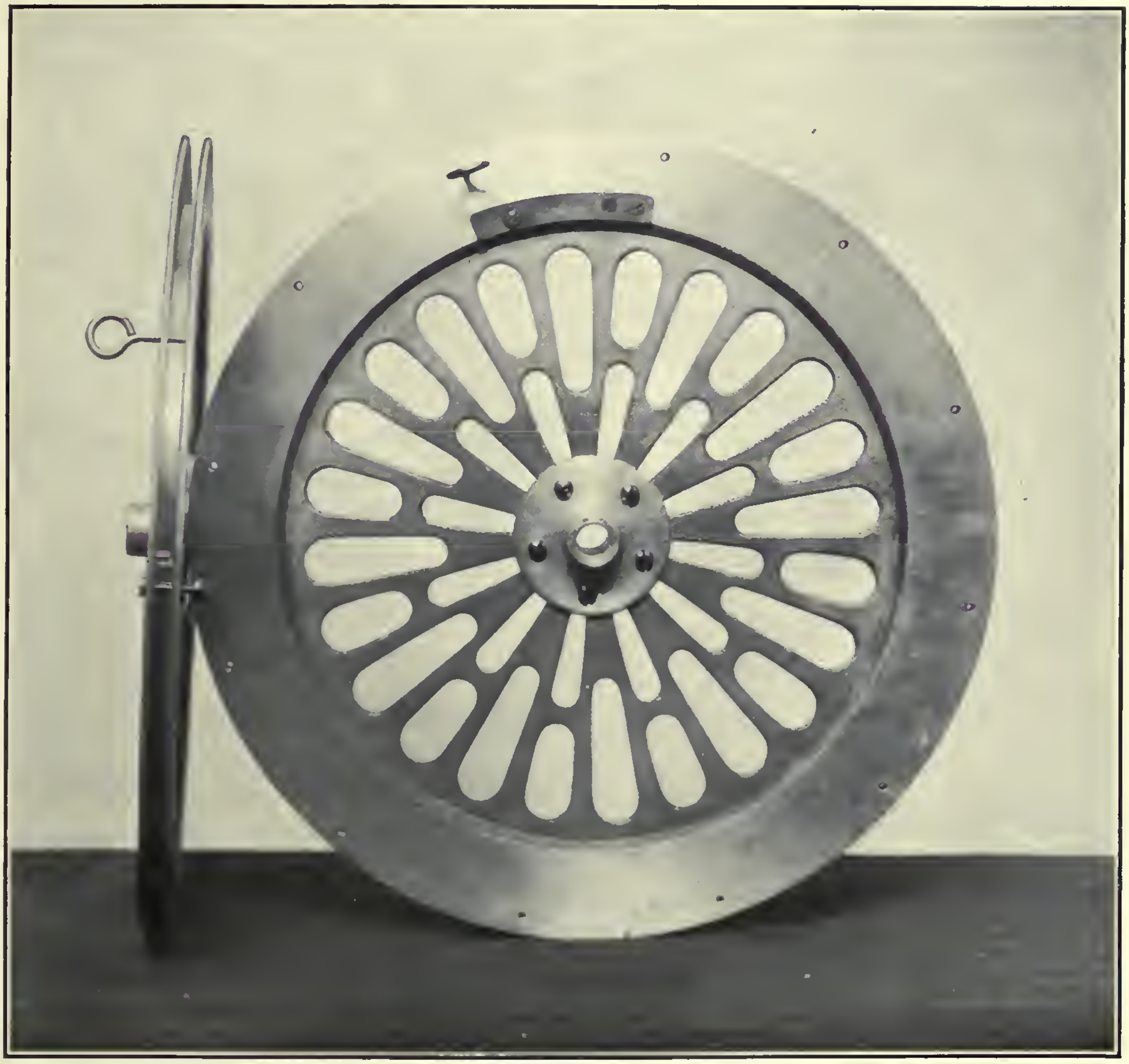
The land is level and comparatively smooth, and at the time of the base measurement all of it was covered with short prairie grass except some sections which had been under cultivation.

Organization of party.—The Ambrose base was prepared for measurement by Signalman J. S. Bilby, who was assisted by some members of the triangulation observing party of Assistant E. H. Pagenhart. The setting of stakes began on May 11 and was finished on the 15th, the actual measurements with the tapes was done on three days between May 16 and 20, and on May 25 the field computation of the results was completed. Nine persons were engaged for all or part time upon the preparation, leveling, and tape measures. The party lived in tents while engaged on the measurement of this base.

Division of the base.—The base was divided into three main portions, the first extending from Northeast base to the end of the third kilometer, the second from the beginning of the fourth kilometer to the end of the seventh kilometer, and the third from the beginning of the eighth kilometer to Southwest base. The total length of the base is 10 479 meters. Each of the three main divisions was measured at least twice in opposite directions with different tapes, and a different pair was used on each division in order to obtain an intercomparison of the three tapes used in the measurements. Each of the main portions was in turn divided into kilometer sections.

The following table shows the divisions of the base with the tapes used on each and the approximate length of the divisions.

Division.	Tapes used.	Length of divisions.
	Numbers.	*Meters.*
No. 1.....	516 and 517	3000
No. 2.....	517 and 521	4000
No. 3.....	516 and 521	3479



REEL FOR INVAR TAPES (TWO VIEWS).

The descriptions of the location and markings of the base ends are given on page 124.

Apparatus used.—As stated above, the same invar tapes have been used for measuring the primary bases since the compaign of 1906, when six primary bases were measured with both steel and invar tapes. After those measurements it was decided to discard the steel and do all primary measuring with the invar tapes. This decision has been justified by the results obtained.

These invar tapes are 50 meters in length and are similar to those described on pages 111–113 of Appendix 4 of the Report for 1907. The stretcher and other minor parts of the base apparatus were of the same types as those described on pages 149 and 154 of Appendix 4 of the Report for 1910 and are shown in illustrations 4 and 5 of that publication. The reel used for the invar tape is shown in illustration No. 1 of this publication.

Setting stakes and measuring.—The method of setting the stakes on which the tape is supported while making the measurements and the method of carrying on those measurements are rather fully described in the three publications of this Survey giving the results of base measurements in recent years. They are Appendix 1 of the Report for 1901, Appendix 4 of the Report for 1907, and Appendix 4 of the Report for 1910. It is not necessary to go into the details of the methods here. Any one or all of those publications may be obtained free of cost by application to the Superintendent of the United States Coast and Geodetic Survey.

On all of the bases measured on the one hundred and fourth meridian only three supports for a tape were used, as the wind on many days was found to be light and to have a negligible effect. When the wind was strong no measurements were attempted.

Equations of tapes.—The equations of the tapes, furnished by the Bureau of Standards and resulting from the standardization in March, 1912, are:

$$T_{516}=50m+(\ 9.573mm\pm0.029mm)+(0.0178mm\pm0.0007mm)\times(t-26.8^\circ\ C);$$
$$T_{517}=50m+(\ 9.960mm\pm0.022mm)+(0.0160mm\pm0.0007mm)\times(t-26.9^\circ\ C);$$
$$T_{521}=50m+(10.124mm\pm0.021mm)+(0.0205mm\pm0.0008mm)\times(t-26.8^\circ\ C);$$
$$T_{522}=50m+(10.988mm\pm0.017mm)+(0.0614mm\pm0.0011mm)\times(t-26.8^\circ\ C).$$

The equations of the same tapes, furnished by the Bureau of Standards and resulting from the restandardization in January, 1913, are:

$$T_{516}=50m+(\ 9.556mm\pm0.016mm)\text{ at }23.3^\circ\ C;$$
$$T_{517}=50m+(\ 9.953mm\pm0.016mm)\text{ at }23.3^\circ\ C;$$
$$T_{521}=50m+(10.077mm\pm0.016mm)\text{ at }23.3^\circ\ C;$$
$$T_{522}=50m+(10.793mm\pm0.016mm)\text{ at }23.3^\circ\ C.$$

The determination of the coefficient of expansion of each of these tapes was made by the Bureau of Standards in January, 1909. Tape No. 522 was carried to the field, but was not used in the measurements.

The equations resulting from the January, 1913, standardization, reduced to the temperatures of the March, 1912, standardization, are:

$$T_{516}=50m+(\ 9.618mm\pm0.016mm)\text{ at }26.8^\circ\ C;$$
$$T_{517}=50m+(10.011mm\pm0.016mm)\text{ at }26.9^\circ\ C;$$
$$T_{521}=50m+(10.149mm\pm0.016mm)\text{ at }26.8^\circ\ C;$$
$$T_{522}=50m+(11.008mm\pm0.016mm)\text{ at }26.8^\circ\ C.$$

The adopted equations of the tapes used in the final computations of the Ambrose base are:

$$T_{516}=50m+(\ 9.582mm\pm0.012mm)+(0.0178mm\pm0.0007mm)\times(t-26.8^\circ\ C);$$
$$T_{517}=50m+(\ 9.970mm\pm0.014mm)+(0.0160mm\pm0.0007mm)\times(t-26.9^\circ\ C);$$
$$T_{521}=50m+(10.129mm\pm0.007mm)+(0.0205mm\pm0.0008mm)\times(t-26.8^\circ\ C).$$

These values are based upon the assumptions that the difference between the lengths as given by the two standardizations are actual differences in the lengths (that is, that the standardizations were made without error), and also that this change had taken place gradually and at a uniform rate from March, 1912, to January, 1913, the dates of the two standardizations.

In order to compare the lengths of the tapes, the results of the two standardizations are given in the following table:

Mar., 1912, $T_{516}=50m+(\ 9.573mm\pm0.029mm)$ at 26.8° C; $v=+0.023mm$;
Jan., 1913, $T_{516}=50m+(\ 9.618mm\pm0.016mm)$ at 26.8° C; $v=-0.022mm$.

Mean = $9.596mm$

Mar., 1912, $T_{517}=50m+(\ 9.960mm\pm0.022mm)$ at 26.9° C; $v=+0.026mm$;
Jan., 1913, $T_{517}=50m+(10.011mm\pm0.016mm)$ at 26.9° C; $v=-0.025mm$.

Mean = $9.986mm$

Mar., 1912, $T_{521}=50m+(10.124mm\pm0.021mm)$ at 26.8° C; $v=+0.012mm$;
Jan., 1913, $T_{521}=50m+(10.149mm\pm0.016mm)$ at 26.8° C; $v=-0.013mm$.

Mean = $10.136mm$

Mar., 1912, $T_{522}=50m+(10.988mm\pm0.017mm)$ at 26.8° C; $v=+0.010mm$;
Jan., 1913, $T_{522}=50m+(11.008mm\pm0.016mm)$ at 26.8° C; $v=-0.010mm$.

Mean = $10.998mm$

Five of these residuals are smaller than the probable errors of the standardizations, and in no case do they exceed these probable errors by an appreciable amount. Therefore it is reasonable to suppose that between the standardizations the tapes underwent no permanent change in length and that the differences were due to errors in the standardization itself. This shows that a straight mean of the results of the January, 1912, and March, 1913, standardizations could have been used in making the computations of the two bases without introducing any error as great as the probable error of the standardization of a tape, which is on an average less than 1 part in 1 000 000.

Reduction to sea level.—The elevation of Ambrose Northeast base, as given by a connection with the spirit leveling along the international boundary, is 623.521 meters. The mean elevation of each section of the base was obtained from the leveling which was run for the purpose of getting the inclination corrections necessary to reduce the measures to the horizontal.

The formula used in reducing the base to sea level is

$$C=-S\frac{h}{r}+S\frac{h^2}{r^2}-S\frac{h^3}{r^3},\text{ etc.,}$$

in which C is the reduction to sea level for a section of length S and mean elevation h, and r is the radius of the earth's curvature for the section in question. The reduction to sea level for each section of the base is given in the following table in the column headed "Reduction to sea level."

Results of the measurement.—The results of the measurement of the Ambrose base are given in the following table:

The Ambrose base line.

Section.	Date and hour.	Direction of measure.	Tape No.	Weather and wind.[1]	Temperature (centigrade). R, F, or S.[2]	Temperature (centigrade). Mean corrected.	Correction to length for temperature.	Set-up or set-back.	Grade correction.	Tape correction.	Reduction to sea level.	Reduced lengths of sections.	Adopted lengths of sections.	v.	vv.
	May, 1912.					°	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*mm*	*mm*
I, N. E. B.-20	18, 8:10 a. m.	W	517	C, L E	R	7.2	−0.0063	− 0.0395	−0.1592	+0.1994	−0.0969	999.8975	999.9009	+3.4	11.56
	16, 11:10 a. m.	E	516	C, L SW	S	26.7	0.0000	− 0.0312	−0.1592	+0.1916	−0.0969	999.9043		−3.4	11.56
II, 20-40	18, 8:45 a. m.	W	517	C, L E	R	8.9	−0.0058	− 0.0072	−0.2346	+0.1994	−0.0968	999.8550	999.8573	+2.3	5.29
	16, 9:50 a. m.	E	516	C, L SE	R	25.0	−0.0006	0.0000	−0.2346	+0.1916	−0.0968	999.8596		−2.3	5.29
III, 40-60	18, 9:25 a. m.	W	517	Cy, L E	S	10.8	−0.0052	+ 0.0185	−0.1056	+0.1994	−0.0976	1000.0095	1000.0106	+1.1	1.21
	16, 8:50 a. m.	E	516	C, L SE	R	20.1	−0.0024	+ 0.0257	−0.1056	+0.1916	−0.0976	1000.0117		−1.1	1.21

[1] These letters represent the following: C, clear; Cy, cloudy; L, light; M, moderate; NE, northeast; SE, southeast; SW, southwest; E, east; P Cy, partly cloudy.
[2] These letters, R, F, and S, indicate whether the temperature was rising, falling, or stationary.

The Ambrose base line—Continued.

Section.	Date and hour.	Direction of measure.	Tape No.	Weather and wind.	Temperature (centigrade). R, F, or S.	Temperature (centigrade). Mean corrected.	Correction to length for temperature.	Set-up or set-back.	Grade correction.	Tape correction.	Reduction to sea level.	Reduced lengths of sections.	Adopted lengths of sections.	v.	vv.
	May, 1912.					°	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*mm*	*mm*
IV, 60–80	18, 10:20 a.m.	W	517	Cy, L E	F	12.4	−0.0046	0.0000	−0.0748	+0.1994	−0.0982	1000.0218	1000.0222	+0.4	0.16
	20, 3:15 p.m.	E	521	P Cy, L NE.	R	14.0	−0.0052	− 0.0019	−0.0748	+0.2026	−0.0982	1000.0225		−0.3	0.09
V, 80–100	18, 10:55 a.m.	W	517	Cy, L E	R	11.8	−0.0048	+ 0.0480	−0.1073	+0.1994	−0.0986	1000.0367	1000.0374	+0.7	0.49
	20, 2:45 p.m.	E	521	P Cy, L NE.	S	16.4	−0.0043	+ 0.0458	−0.1073	+0.2026	−0.0986	1000.0382		−0.8	0.64
VI, 100–120	18, 11:30 a.m.	W	517	C, L E	R	14.6	−0.0039	+ 0.0917	−0.1061	+0.1994	−0.0990	1000.0821	1000.0826	+0.5	0.25
	20, 2:05 p.m.	E	521	C, L NE	S	14.6	−0.0050	+ 0.0906	−0.1061	+0.2026	−0.0990	1000.0831		−0.5	0.25
VII, 120–140	18, 1:05 p.m.	W	517	H, L SE	S	16.0	−0.0035	+ 0.0760	−0.2600	+0.1994	−0.0992	999.9127	999.9150	+2.3	5.29
	18, 2:05 p.m.	E	521	H, M SE	S	17.4	−0.0038	+ 0.0777	−0.2600	+0.2026	−0.0992	999.9173		−2.3	5.29
VIII, 140–160	20, 5:05 p.m.	W	521	P Cy, L NE.	F	14.2	−0.0052	+35.6425	−0.1364	+0.2026	−0.1032	1035.6003	1035.6008	+0.5	0.25
	20, 8:15 p.m.	E	516	P Cy, L NE.	F	7.8	−0.0068	+35.6560	−0.1364	+0.1916	−0.1032	1035.6012		−0.4	0.16
IX, 160–180	20, 5:40 p.m.	W	521	Cy, L NE	S	13.4	−0.0055	0.0000	−0.1986	+0.2026	−0.1005	999.8980	999.8989	+0.9	0.81
	20, 7:50 p.m.	E	516	Cy, L NE	F	9.7	−0.0061	+ 0.0135	−0.1986	+0.1916	−0.1005	999.8999		−1.0	1.00
X, 180–200	20, 6:15 p.m.	W	521	Cy, L NE	F	13.6	−0.0054	0.0000	−0.3906	+0.2026	−0.1011	999.7055	999.7052	−0.3	0.09
	20, 7:25 p.m.	E	516	Cy, L NE	S	10.6	−0.0058	+ 0.0109	−0.3906	+0.1916	−0.1011	999.7050		+0.2	0.04
XI, 200–S.W.B.	20, 6:45 p.m.	W	521	Cy, L NE	F	12.8	−0.0026	− 5.8370	−0.0602	+0.0912	−0.0451	444.1463	444.1465	+0.2	0.04
	20, 7:15 p.m.	E	516	Cy, L NE	F	11.8	−0.0024	− 5.8318	−0.0602	+0.0862	−0.0451	444.1467		−0.2	0.04

The length of the Ambrose base = 10 479.1774 ± 0.0035 meters.

The logarithm of this length is 4.0203272 ± 1.

This probable error of the length corresponds to 1 part in 3 029 000.

The computation of the probable error was made in a manner similar to that described on pages 160–161 of Appendix 4 of the Report for 1910.

Cost of Ambrose base.—The cost of preparing and measuring the Ambroso base was about $500. This amount includes the salary or pay of each person while engaged on this base, and such other expenses incurred as were not properly chargeable to tho triangulation. It does not includo any traveling expenses of the members of the party to the field, or the costs of any articles of outfit. The length of this base was 10.5 kilometers, hence the cost per kilometer was about $48, or $77 per milo.

If there be included $200 for the cost of one standardization of the four tapes (see p. 15), and also about $40 for the cost of making the final computation at the office, then tho total cost of the base to the Government would be about $740. This is at the rate of about $70 per kilometer, or $113 per mile.

PROVO BASE.

This base line was located in the southwestern portion of the State of South Dakota, near Provo railroad station and village.

Tho ground over which the base passed is gently rolling, with some gulches, none of which wero too wide to be spanned by a 50-meter tape. Except in one case the grade of a singlo tape length was not greater than 5 per cent. The land was free from trees and clear except for sagebrush over about 3 kilometers. This brush was only about 15 inches high and the line through it was easily cleared. Only a small portion of the land along the base had ever been under cultivation.

Organization of party.—As on the Ambrose base, the building party prepared the Provo base for measurement. There were six persons in all engaged on this work, and the total time consumed was seven working days, between August 23 and 30, 1912, inclusive.

Tho observing party of Assistant Hodgson, aided by Mr. Bilby, was engaged on the measurement between October 3 and 8, 1912. Including five hands, the observing party consisted of a total of seven persons.

Division of the base.—As in the case of the Ambrose base (see p. 10) this base was divided into three parts, each of which was measured twice in opposite directions with different tapes. The measurements were so planned that it was possible to obtain an intercomparison between each two tapes used.

The following table shows the divisions of the base, with the tapes used on each and the approximate length of the divisions:

Division.	Tapes used.	Length of division.
	Numbers.	*Meters.*
No. 1	516 and 521	5000
No. 2	517 and 516	5000
No. 3	521 and 517	4550

The descriptions of the location and markings of the base ends are given on page 119.

Apparatus used.—The same tapes and other apparatus which were used on the Ambrose base were used at Provo. (See p. 11.)

Setting stakes and measuring.—Three stakes were used for each tape length, one at each end and one in the center. The measurements were made in the same way as on the Ambrose base. (See p. 11.) The wind effect on the Provo base was negligible.

Equations of tapes.—The equations of the tapes as determined in March, 1912, and January, 1913, are given on page 11, and need not be repeated here.

The adopted equations of the tapes used in the final computation of the Provo base are:

$$T_{516}=50m+(\ 9.605mm\pm0.014mm)+(0.0178mm\pm0.0007mm)\times(t-26.8^\circ\ C);$$
$$T_{517}=50m+(\ 9.996mm\pm0.016mm)+(0.0160mm\pm0.0007mm)\times(t-26.9^\circ\ C);$$
$$T_{521}=50m+(10.142mm\pm0.008mm)+(0.0205mm\pm0.0008mm)\times(t-26.8^\circ\ C).$$

These values were based upon the assumptions that the difference between the lengths, as given by the two standardizations, were actual differences in lengths (that is, that the standardizations were made without error), and also that this change had taken place gradually and at a uniform rate from March, 1912, to January, 1913, the dates of the two standardizations.

Reduction to sea level.—The elevation of Provo west base, as given by a connection with a line of precise leveling running through Provo, is 1177.19 meters. A double line of spirit levels was run over the base for the purpose of getting the grade corrections and the mean elevations above sea level of each section. The correction to reduce to sea level was computed by the formula shown on page 12, and is given for each section in the column headed, "Reduction to sea level" in the following table.

Results of the measurement.—The results of the measurement of the Provo base are given below:

The Provo base line.

Section.	Date and hour.	Direction of measure.	Tape No.	Weather and wind.[1]	Temperature (centigrade). R, F, or S.[2]	Temperature (centigrade). Mean corrected.	Correction to length for temperature.	Set-up or set-back.	Grade correction.	Tape correction.	Reduction to sea level.	Reduced lengths of sections.	Adopted lengths of sections.	v.	vv.
	Oct., 1912.					°	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*mm*	*mm*
I, W. B.-20.....	7, 11:00 a. m..	E	516	C, M W.....	S	17.8	−0.0032	+ 0.1982	−0.2306	+0.1921	−0.1834	999.9731	999.9753	+2.2	4.84
	7, 10:10 a. m..	W	521	C, M W.....	R	16.6	−0.0042	+ 0.1928	−0.2306	+0.2028	−0.1834	999.9774		−2.1	4.41
II, 20-40........	7, 11:35 a. m..	E	516	C, M W.....	S	16.7	−0.0036	+10.9178	−0.1695	+0.1921	−0.1821	1010.7547	1010.7570	+2.3	5.29
	7, 9:25 a. m..	W	521	C, L SE.....	R	13.6	−0.0055	+10.9136	−0.1695	+0.2028	−0.1821	1010.7593		−2.3	5.29
III, 40-60.......	7, 1:20 p. m..	E	516	P Cy, M NW	F	16.3	−0.0037	+ 0.0874	−0.0730	+0.1921	−0.1782	1000.0246	1000.0271	+2.5	6.25
	7, 8:50 a. m..	W	521	C, L SE.....	R	10.0	−0.0069	+ 0.0848	−0.0730	+0.2028	−0.1782	1000.0295		−2.4	5.76
IV, 60-80.......	7, 1:50 p. m..	E	516	P Cy, M NW	S	15.6	−0.0040	+ 0.0745	−0.0604	+0.1921	−0.1768	1000.0254	1000.0272	+1.8	3.24
	7, 8:15 a. m..	W	521	C, L SE.....	R	8.3	−0.0076	+ 0.0710	−0.0604	+0.2028	−0.1768	1000.0290		−1.8	3.24

[1] These letters represent the following: C, clear; Cy, cloudy; P Cy, partly cloudy; O, calm; L, light; M, moderate; W, west; NW, northwest; SE, southeast.

[2] These letters R, F, and S indicate whether the temperature was rising, falling, or stationary.

The Provo base line—Continued.

Section.	Date and hour.	Direction of measure.	Tape No.	Weather and wind.	Temperature (centigrade). R, F, or S.	Temperature (centigrade). Mean corrected.	Correction to length for temperature.	Set-up or set-back.	Grade correction.	Tape correction.	Reduction to sea level.	Reduced lengths of sections.	Adopted lengths of sections.	v.	vv.
	Oct., 1912.					°	*m*	*m*	*m*	*m*	*m*	*m*	*m*	*mm*	*mm*
V, 80-100	7, 2:20 p.m.	E	516	Cy, M NW.	S	15.6	−0.0040	+ 0.0408	−0.2234	+0.1921	−0.1769	999.8286	999.8299	+1.3	1.69
	7, 7:45 a.m.	W	521	C, L SE.	R	6.3	−0.0084	+ 0.0371	−0.2234	+0.2028	−0.1769	999.8312		−1.3	1.69
VI, 100-120	3, 12:25 p.m.	E	517	C, L W.	S	24.3	−0.0008	− 0.0099	−0.1170	+0.1999	−0.1766	999.8956	999.8960	+0.4	0.16
	3, 11:00 a.m.	W	516	C, L W.	S	20.8	−0.0021	0.0000	−0.1170	+0.1921	−0.1766	999.8964		−0.4	0.16
VII, 120-140	3, 1:00 p.m.	E	517	C, L W.	S	24.0	−0.0009	− 0.0138	−0.0936	+0.1999	−0.1758	999.9158	999.9180	+2.2	4.84
	3, 10:30 a.m.	W	516	C, L W.	S	19.5	−0.0026	0.0000	−0.0936	+0.1921	−0.1758	999.9201		−2.1	4.41
VIII, 140-160	3, 1:30 p.m.	E	517	C, L W.	F	24.9	−0.0006	− 0.0106	−0.1048	+0.1999	−0.1770	999.9069	999.9069	0.0	0.00
	3, 9:50 a.m.	W	516	C, L W.	R	17.4	−0.0034	0.0000	−0.1048	+0.1921	−0.1770	999.9069		0.0	0.00
IX, 160-180	3, 2:00 p.m.	E	517	C, L W.	S	24.3	−0.0008	+ 0.0384	−0.3527	+0.1999	−0.1754	999.7094	999.7107	+1.3	1.69
	3, 9:10 a.m.	W	516	C, L W.	R	14.9	−0.0042	+ 0.0522	−0.3527	+0.1921	−0.1754	999.7120		−1.3	1.69
X, 180-200	3, 2:30 p.m.	E	517	C, L W.	S	24.4	−0.0008	+ 0.0303	−0.5497	+0.1999	−0.1745	999.5052	999.5050	−0.2	0.04
	3, 8:20 a.m.	W	516	C, L W.	R	12.9	−0.0050	+ 0.0418	−0.5497	+0.1921	−0.1745	999.5047		+0.3	0.09
XI, 200-220	3, 3:15 p.m.	E	521	C, O.	F	23.6	−0.0013	+ 0.0450	−0.1158	+0.2028	−0.1742	999.9565	999.9549	−1.6	2.56
	8, 11:30 a.m.	W	517	C, M W.	S	18.0	−0.0028	+ 0.0461	−0.1158	+0.1999	−0.1742	999.9532		+1.7	2.89
XII, 220-240	3, 3:50 p.m.	E	521	C, O.	S	22.4	−0.0018	+ 0.0273	−0.2201	+0.2028	−0.1747	999.8335	999.8306	−2.9	8.41
	8, 11:00 a.m.	W	517	C, M W.	F	17.7	−0.0029	+ 0.0255	−0.2201	+0.1999	−0.1747	999.8277		+2.9	8.41
XIII, 240-260	8, 8:20 a.m.	E	521	C, L NW.	R	9.7	−0.0070	0.0000	−0.2744	+0.2028	−0.1746	999.7468	999.7447	−2.1	4.41
	8, 10:35 a.m.	W	517	C, M NW.	S	16.8	−0.0032	− 0.0051	−0.2744	+0.1999	−0.1746	999.7426		+2.1	4.41
XIV, 260-280	8, 8:50 a.m.	E	521	C, L NW.	S	10.8	−0.0066	0.0000	−0.0589	+0.2028	−0.1752	999.9621	999.9629	+0.8	0.64
	8, 10:15 a.m.	W	517	C, M NW.	S	16.2	−0.0034	+ 0.0013	−0.0589	+0.1999	−0.1752	999.9637		−0.8	0.64
XV, 280-E. B.	8, 9:20 a.m.	E	521	C, L NW.	R	11.8	−0.0034	+ 0.2109	−0.0164	+0.1116	−0.0966	550.2061	550.2049	−1.2	1.44
	8, 10:00 a.m.	W	517	C, L NW.	S	15.0	−0.0021	+ 0.2088	−0.0164	+0.1100	−0.0966	550.2037		+1.2	1.44

The length of the Provo base is 14 559.2511 ± 0.0046 meters.

The logarithm of this length is 4.1631390 ± 1.

This probable error of the length corresponds to one part in 3 165 000.

The computation of the probable error was made in a manner similar to that described on pages 160–161 of Appendix 4 of the report for 1910.

Cost of the Provo base.—The cost of preparing this base and making the measurements was about $525. This includes all salaries, but there was nothing charged for traveling expenses or outfit.

As the base is 14.5 kilometers in length, the field work cost at the rate of about $36 per kilometer. If to the above amount is added one-half the cost of the two standardizations of the four tapes (the cost is $50 to anyone not connected with the Government for the fundamental standardization of a base tape by the Bureau of Standards), and also about $40 for the cost of making the revised or office computation, the total cost will be $765, a rate of about $53 per kilometer, or $85 per mile. This low cost was due in part to the absence of traveling expenses and any unproductive period before or after the preparation and the measurement of the base.

EL PASO BASE, DISCUSSION OF OLD MEASUREMENT.

This base was located in 1878 by former Assistant O. H. Tittmann (now superintendent) on the eastern slope of the Rocky Mountains, in El Paso County, Colo., about 30 miles (48 kilometers) east-northeast of Pikes Peak. The middle point of the base is in approximate latitude 38° 58′ and longitude 104° 31′. The length is about 11¼ kilometers.

The base was measured by the party of Mr. Tittmann between August 7 and September 4, 1879, once forward and once backward, with the 6-meter contact-slide steel rods Nos. 3 and 4. The methods employed in the measurement of this base and the results obtained are given on pages 101–107 of Special Publication No. 4, The Transcontinental Triangulation.

Length of the contact-slide rods Nos. 3 and 4.—It is stated in the above-mentioned publication that these rods were compared at the survey office with the standard iron 6-meter bar No. 1 just before and just after the measurements in the field. The length of bar No. 1 was obtained from comparisons with six steel meter bars especially constructed for the purpose. The coefficient of expansion of bar No. 1 was determined by extensive observations made in 1860. An account of these observations is given in Appendix 26 of the report for 1862.

The observations in 1877 for the length of the 6-meter standard (No. 1) consisted in the first place of intercomparisons of the six steel meter bars (Nos. 1, 12, 13, 19, 28, 35) and of bar No. 19 with the committee meter; and, secondly, of comparisons of length of the six 1-meter bars (joined together) with the 6-meter bar (No. 1). In these comparisons several thermometers were used and their readings were corrected for index error and defects in graduation. The average temperature during the comparisons was about $7\frac{1}{2}°$ C. The resulting value of the length of 6-meter bar No. 1 was 5.9999547 ± 25 at 0° C.

The value derived from a comparison in 1860 was 5.9999407 ± 8 at 0° C.

An additional value for the length of 6-meter bar No. 1 was obtained from comparisons made in 1882 at the survey office with a 5-meter standard to which was joined a single meter bar, both of known length. This value was 5.9999461 ± 46 at 0° C. For the final value of 6-meter bar No. 1, the weighted mean of the three values of 1860, 1877, and 1882, with their respective weights $\frac{1}{2}$, 1, and $\frac{1}{2}$, were taken. The resulting length of the standard was 5.999949 ± 3 at 0° C.

A comparison in May, 1879, of the 6-meter contact-slide rods Nos. 3 and 4 with standard No. 1 gave the following results:

Length of No. 3 = 6.001076 ± 5 at 17.28° C.

Length of No. 4 = 6.001142 ± 4 at 17.28° C.

A second comparison, made in November, 1879, gave the following lengths:

Length of No. 3 = 6.000514 ± 4 at 7.74° C.

Length of No. 4 = 6.000476 ± 4 at 7.74° C.

Before using the El Paso base length in the computation and adjustment of the transcontinental triangulation it was decided to redetermine the coefficients of expansion of these rods. This was done in 1897, and the resulting coefficients were:

For 6-meter bar No. 3 = 0.00001149.

For 6-meter bar No. 4 = 0.00001141.

The lengths of the bars at the mean temperature of the two standardizations and at 0° C are:

No. 3 at 12.°51 C = 6.000795 m. or at 0° C = 5.999933 m.

No. 4 at 12.°51 C = 6.000809 m. or at 0° C = 5.999953 m.

These are the final lengths used in the computations of the El Paso base.

Since the question of the degree of accuracy of this base measurement is an important one, it is believed to be advisable to reproduce here the table on pages 104–106 of Special Publication No. 4, which gives a summary of the forward and backward measurements of the base.

Section measures of the El Paso base.

Section marks.	Mean temperature F. corrected, forward.	Mean temperature F. corrected, backward.	No. of (average) bars.	Corrected distance, forward.	Corrected distance, backward.	Mean.	Difference from mean.
	°	°		m	m	m	mm
East base to A (day)	57.41	....		240.01450			1.39
East base to A (night)	57.38	....	40	.01309	....	240.01311	0.02
Do.	59.79	....		.01174			1.37
A to B (day)	60.76	....		198.02356			0.26
B to A (day)	....	68.37	33	....	198.02533	198.02382	1.51
A to B (night)	51.11	....		198.02257			1.25
B to C (day)	66.45	....		222.03368			1.60
C to B (day)	....	70.09	37	....	222.03385	222.03208	1.76
B to C (night)	49.29	....		222.02872			3.36
C to D (day)	68.35	....		204.02329			0.32
D to C (day)	....	66.96	34	....	204.02571	204.02361	2.10
C to D (night)	46.39	....		204.02182			1.79

Section measures of the El Paso base—Continued.

Section marks.	Mean temperature F. corrected forward.	Mean temperature F. corrected backward.	No. of (average) bars.	Corrected distance, forward.	Corrected distance, backward.	Mean.	Difference from mean.
	°	°		m	m	m	mm
D to E	64.18	75.61	46	276.03080	276.03100	276.03090	0.10
E to F	54.22	66.71	33	198.00429	198.00368	198.00399	0.30
F to G	63.01	72.44	35	210.01696	210.02012	210.01854	1.58
G to H	71.12	77.59	32	192.02778	192.02788	192.02783	0.05
H to I	80.45	76.84	37	222.04679	222.04399	222.04539	1.40
I to J	88.96	68.72	39	234.06044	234.05621	234.05832	2.11
J to K	82.34	61.63	30	180.02254	180.02129	180.02191	0.62
K to L	63.08	73.68	34	203.98348	203.98378	203.98363	0.15
L to Ridge	74.47	83.44	36	215.97432	215.97716	215.97574	1.42
Ridge to M	60.10	74.74	34	203.98388	203.98487	203.98438	0.50
M to N	64.99	82.80	29	174.02009	174.02008	174.02009	0.01
N to O	71.00	85.27	32	192.00614	192.00253	192.00433	1.81
O to P	62.44	81.02	34	204.00622	204.00438	204.00530	0.92
P to Q	58.20	76.99	34	203.97690	203.97706	203.97698	0.08
Q to R	69.26	82.50	37	222.02792	222.02639	222.02716	0.77
R to S	78.36	84.43	34	204.03384	204.03109	204.03247	1.37
S to Signal	65.71	86.37	40	239.99341	239.99571	239.99456	1.15
Signal to T	76.98	86.34	34	204.02239	204.02165	204.02202	0.37
T to U	84.91	88.65	34	204.04262	204.04120	204.04191	0.71
U to V	94.15	82.22	34	204.04997	204.04668	204.04832	1.65
V to W	67.34	77.59	34	204.03096	204.03242	204.03169	0.73
W to X	66.91	87.06	34	204.02970	204.03318	204.03144	1.74
X to Y	75.15	84.87	34	204.01104	204.01162	204.01133	0.29
Y to Z	82.47	81.43	34	204.04171	204.04092	204.04132	0.40
Z to Gulch	87.16	77.20	31	186.05494	186.05522	186.05508	0.14
Gulch to Range	61.91	69.70	44	264.00555	264.00899	264.00727	1.72
Range to Dot	71.60	60.43	34	204.03409	204.03496	204.03452	0.43
Dot to Spring	79.23	86.42	24	144.00645	144.00729	144.00687	0.42
Spring to Road	89.39	82.30	33	198.01723	198.01803	198.01763	0.40
Road to α	72.89	85.97	49	294.00815	294.00508	294.00662	1.53
α to β	87.74	89.22	32	192.02830	192.02421	192.02625	2.04
β to γ	67.33	80.81	37	222.00464	222.00468	222.00466	0.02
γ to δ	81.18	84.83	32	192.03881	192.03636	192.03758	1.23
δ to ε	88.18	87.22	35	210.02544	210.02297	210.02420	1.23
ε to ζ	87.47	86.59	34	203.99345	203.99205	203.99275	0.70
ζ to η	68.53	83.41	34	203.99583	203.99445	203.99514	0.69
η to θ	76.06	82.01	35	210.02995	210.02866	210.02931	0.64
θ to ι	83.31	78.00	35	210.03734	210.03546	210.03640	0.94
ι to κ	60.29	73.60	34	203.98739	203.98855	203.98797	0.58
κ to λ	66.83	66.87	35	209.97726	209.97842	209.97784	0.58
λ to μ	74.57	56.61	41	246.03364	246.03364	246.03364	0.00
μ to ν	65.18	91.09	28	167.94530	167.94447	167.94488	0.41
ν to ξ	67.83	87.96	24	143.99969	143.99988	143.99979	0.10
ξ to ο	75.54	79.20	40	239.96706	239.96539	239.96623	0.83
ο to π	68.68	69.70	35	210.00583	210.00477	210.00530	0.53
π to ρ	80.51	61.15	36	215.95311	215.95094	215.95202	1.09
ρ to σ	85.41	53.60	34	203.98544	203.98431	203.98488	0.56
σ to τ	85.84	48.28	36	215.97809	215.97683	215.97746	0.63
τ to υ	80.77	78.41	29	173.97449	173.97361	173.97405	0.44
υ to West base	60.95	....		258.20793	....		4.62
Do	61.62	....	43	258.21512	....	258.21255	2.57
West base to υ	....	74.92		....	258.21586		3.31
Do	....	85.08		....	258.21127		1.27

The length of the base as measured with rods is 11 292.8231 meters. The reduction to sea level is 3.6467 meters; therefore the length of the base reduced to sea level is 11 289.1764 ± 0.0150 meters. Since the length, as brought through the triangulation from the Provo base to the El Paso base, differed from the above value by one part in 13 500, it was decided to remeasure the El Paso base, and, if necessary, to insert an additional base in the one hundred and fourth meridian triangulation.

The length of the El Paso base reduced to sea level, as measured in 1913 with three invar tapes, is 11 288.9852 meters. (See p. 22.) There appeared to be no uncertainty whatever in the recovery of the ends of the base, nor was there any uncertainty in the recovery of the marks of the triangulation stations Pikes Peak, Divide, and Bison, the stations in or near the El Paso base net, from which the one hundred and fourth meridian triangulation started. Consequently, the difference between the new and old measures of the El Paso base must be due to systematic or constant errors in one or both measures.

A careful study of the results of various standardizations of the same set of invar tapes (see table on p. 25) makes it seem reasonably certain that there is no constant error in the mean length of any group of three tapes as great as one part in 500 000. The iced bar is used at the Bureau of Standards in determining the length of the 50-meter comparator, and from time to time the iced bar has been compared directly with the prototype meter held at that bureau.

Moreover, the measurements on the field with invar tapes give a very small probable error for the result. There seems to be nothing which could cause a large systematic or constant error in the field measurements. The possibility of a blunder in reading setups and setbacks or in obtaining the grade corrections is almost entirely eliminated by making independent measurements in opposite directions and by leveling in both directions over the tape supports to determine the differences in elevation. Any error which is likely to occur in reading the temperatures of the tapes will have only a very slight effect, owing to the extremely small coefficient of expansion of the metal of which the tapes are made. Therefore it seems probable that the error is in the early measurement of the El Paso base with the bars.

That the error in this measurement is not due to the effect of accidental errors alone is indicated by the small differences of the individual measures from the mean of two or more measures of a section, as shown in the last column of the above table.

The error in the length of the base, by the bar measurement, is probably due to the standardization of the bars or to differences between the true temperature of the bars and that read from the thermometers during the field measurements.

Errors of standardization.—The bars used in the field were compared directly with standard bar No. 1. That bar in turn was compared with six especially constructed meter bars and with a 5-meter and a 1-meter bar, all of which had been compared with the committee meter. The length of the latter standard was obtained from comparisons with the international prototype meter. Each one of the bars mentioned above, except the prototype meter, was an end measure. It is believed that the general experience has been that it is impossible to obtain as great accuracy in comparisons with an end-measure standard as with a line-measure one. No doubt there was an error of appreciable size in the lengths of bars 3 and 4 due to this fact. Again there were doubtless appreciable errors in the values of the lengths of bars 3 and 4 due to errors in the observed temperatures during the various comparisons. The metal was steel and the temperatures of the various bars were obtained by reading thermometers placed near them.

Temperature errors in the field measurements.—Assistant C. A. Schott, on page 106, of Special Publication No. 4, made the following statements:

> The forward and backward measures of the subdivisions were frequently made with greatly different average temperatures, yet when we compare their respective sums we find 11 292.8331[1] meters and 11 292.8157[1] meters, showing the small difference of 17.4 millimeters.
>
> The matter as to whether the thermometers indicate the true temperature of the rods has been inquired into, and it seemed as if the rods were lagging somewhat behind the thermometer indications, but there are so many exceptions to this that no satisfactory result (numerical value) could be deduced.

A comparison between the day and the night measures of the first four sections, as given in the above table, shows that the latter always gave shorter lengths. The average difference between the two is about one part in 75 000. This difference could have been caused by an average temperature 1.2° C. lower than the average recorded temperature. It is probable that the thermometers did not record the temperature of the bar with a high degree of accuracy, even at night, consequently the systematic error due to erroneous observed temperatures in the El Paso base measurements may be somewhat greater or less than one part in 75 000.

Other sources of error.—Errors in the alignment of the bars would affect the results in a systematic manner, making the length too great, but as the alignment was carefully made the total effect could only be very small in amount. The errors made in observing the slope of the bars might be systematic on account of a possible index error in the sector attached to the outside of the rods, but the effect would be of the opposite sign in the second running which was made in the opposite direction. The settling of the bar supports down the grade could not have caused any appreciable error; first, because the slope upward from east to west was only about 16 meters per kilometer on an average; and, second, because any effect of settling while running up a slope would be counteracted by the effect while running down. The effect of the errors made in bringing the rear end of one bar in contact with the forward end of the other is no doubt very small as the errors in making the contact are accidental in character. The errors

[1] Not reduced to sea level.

made in transferring the ends of a bar to the ground mark at the end of a section, or possibly at other points, were very small and should have been accidental in character.

There is a possibility of movements in the upper portion of the earth's crust between the dates of the first and second measurements which might change the distances between any two given points. However, this could probably not happen to any appreciable extent, such as one part in 60 000, on a line of triangulation without serious earthquake shocks, none of which have been noted in recent years in the vicinity of the El Paso base, or the stations Pikes Peak, Bison, and Divide.

After this discussion of the various possible sources of error in the old measurement of the El Paso base, the question at once presents itself: To what degree are other primary bases measured with bars unreliable? This question is a very difficult one to answer.

There was only one other primary base line measured with 6-meter bars Nos. 3 and 4 (those used on the El Paso base) and there are very few bases which were measured with single rod bars. Most of the bar measurements of primary bases were with various kinds of compensating bars. In a number of cases these were used in connection with steel tapes with very accordant results. The bar and tape measurements of the Holton base agreed within one part in about 340 000, as given in Appendix 8 of the Report for 1892. Also in the measurement of the nine bases on the ninety-eighth meridian with steel tapes and the duplex base apparatus, as given in Appendix 3 of the Report for 1901, the measures agreed on an average within one part in about 140 000.

In the writer's opinion, it may safely be assumed that there are very few primary bases in the United States with actual errors in their lengths as great as one part in 59 000, the difference between the bar and invar tape measures of the El Paso base. It is believed that by far the greater number of primary bases measured by bars have a much smaller actual error. The uncertainty of the length of a line in a section of primary triangulation between bases, due entirely to inaccuracies in the angle measures, is that represented by a probable error of about one part in 80 000. Therefore, if the actual error in the length of a base is comparable in size with the probable error of a line of the triangulation due to angle errors, then there is no great decrease in the accuracy of the lengths of the triangulation due to the error in the length of the bases, it being assumed, of course, that the actual errors of the bases would vary in sign.

BASE MEASUREMENTS IN 1913.

EL PASO BASE.

On July 7, 1913, Signalman J. S. Bilby began the preparation of the El Paso base for remeasurement in compliance with instructions from the superintendent, directing him to do all the work on the base except the actual tape measurements and to cooperate with Assistant C. V. Hodgson in that operation. Mr. Hodgson in the meantime was engaged in organizing and outfitting a latitude party for work on the one hundred and fourth meridian.

Mr. Bilby completed the stake-setting and leveling over the base on July 22, 1913, and the tape measurements were made on four days, between July 16 and 20, inclusive. The results of the measurements were obtained and telegraphed to the office on July 23. As the result did not give a satisfactory agreement with the length as brought down from the Provo base through the triangulation, Messrs. Hodgson and Bilby were directed to locate and measure a base in the vicinity of Cheyenne, Wyoming, and to connect it with the main scheme of triangulation.

Methods used.—The instructions issued to Messrs. Hodgson and Bilby were similar to those regarding the Ambrose and Provo bases (see p. 9), and the methods employed in making the measurements were the same as those used in all measurements of primary bases in recent years. (See p. 11.)

Standardization of tapes.—The tapes had been standardized in January, 1913, by the Bureau of Standards, in connection with the Ambrose and Provo bases, and it was decided that no additional determination of the lengths need be made before sending them to the field again in July of the same year. (See also p. 10, under heading "Standardization of tapes.") A restandardization, for the purpose of checking the lengths of the tapes as used, was made at the Bureau of Standards in October, 1913. The results of these standardizations are given under the heading "Equations of tapes," below.

Size of party.—During the preparation of the base, Mr. Bilby had in his party five temporary hands. For the measurement the party consisted of Messrs. Hodgson and Bilby, the recorder of the astronomic party, and the five hands mentioned above, eight persons in all.

The party lived in a camp pitched close to the base line, in order to make a minimum amount of traveling in going to and from the work.

Division of the bases.—There were, as usual, three main divisions in the El Paso base, the approximate length of each being shown in the table which follows. Each division was measured at least twice in opposite directions with different tapes, and a different pair was used on each division in order to obtain an intercomparison of the tapes.

Division.	Tapes used.	Length of division.
	Numbers.	*Meters.*
No. 1	516 and 517	4000
No. 2	516 and 521	3990
No. 3	517 and 521	3300

The descriptions of the ends of the base, with the monuments used to hold the points, are given on page 128 of this publication.

Apparatus used.—The tapes which had been used in measuring the bases at Ambrose and Provo were also used on the El Paso base. The tape stretcher and other apparatus were similar to the ones used on those bases. (See p. 11.)

Stake setting and measuring.—As the wind was found to be light most of the time while preparing the base, it was decided to use only three supports for a tape length, one at each end (the marking tables or stakes) and one at the middle. Very little trouble was encountered on account of the wind. The measuring was done in the usual manner. (See p. 11 of this report and also p. 154 of Appendix 4 of the Report for 1910.)

Equations of tapes.—The equations of the tapes furnished by the Bureau of Standards, resulting from the standardization in January, 1913, are:

$$T_{516}=50m+(\ 9.556mm\pm0.016mm)+(0.0178mm\pm0.0007mm)\times(t-23.3°\ C);$$
$$T_{517}=50m+(\ 9.953mm\pm0.016mm)+(0.0160mm\pm0.0007mm)\times(t-23.3°\ C);$$
$$T_{521}=50m+(10.077mm\pm0.016mm)+(0.0205mm\pm0.0008mm)\times(t-23.3°\ C);$$
$$T_{522}=50m+(10.793mm\pm0.016mm)+(0.0614mm\pm0.0011mm)\times(t-23.3°\ C).$$

The equations of these same tapes, furnished by the Bureau of Standards, resulting from the standardization in October, 1913, are:

$$T_{516}=50m+(\ 9.724mm\pm0.020mm)\text{ at }28.9°\ C;$$
$$T_{517}=50m+(\ 9.978mm\pm0.017mm)\text{ at }29.0°\ C;$$
$$T_{521}=50m+(10.205mm\pm0.018mm)\text{ at }28.9°\ C;$$
$$T_{522}=50m+(11.128mm\pm0.020mm)\text{ at }28.9°\ C.$$

The standardization was made under the same conditions of suspension and tension as during the field measures, that is, three supports and 15-kilogram tension.

In order to compare the lengths of the tapes obtained by these two standardizations, one before and one after the measurement of the El Paso and Cheyenne bases, the following tabulation has been prepared, giving the results of the two standardizations all reduced to the temperatures of the first standardization:

Jan. 1913, $T_{516}=50m+9.556mm\pm0.016mm;\ v=+0.034mm$
Oct. 1913, $T_{516}=50m+9.624mm\pm0.020mm;\ v=-0.034mm$

Mean=9.590*mm*

Jan. 1913, $T_{517}=50m+9.953mm\pm0.016mm;\ v=-0.033mm$
Oct. 1913, $T_{517}=50m+9.887mm\pm0.017mm;\ v=+0.033mm$

Mean=9.920*mm*

Jan. 1913, $T_{521}=50m+10.077mm\pm0.016mm;\ v=+0.007mm$
Oct. 1913, $T_{521}=50m+10.090mm\pm0.018mm;\ v=-0.006mm$

Mean=10.084*mm*

The lengths of the tapes as given by the January, 1913, standardization had been used in computing the lengths of the El Paso and Cheyenne bases, and those lengths had been used in the adjustments of the triangulation on the one hundred and fourth meridian before the October, 1913, values of the tapes became available. The mean length of the three tapes used in the measurement of the El Paso and Cheyenne bases as given by the January standardization differed only 0.005 millimeter, or 1 part in 10 000 000, from the mean length as given by the standardization in October, 1913. So it was decided that the results by the first standardization were satisfactory, and the second values were considered only as checks. (See p. 25 for a tabular statement of the values of the tapes resulting from the standardizations for the years 1909 to 1913, inclusive.) If the mean of the values by the two standardizations had been used, the probable error of the base would have been changed slightly, but the length of the base would not have differed by as much as 1 millimeter.

Reduction to sea level.—The elevation of the top of the monument at El Paso west base, as determined by spirit leveling, is 2167 meters. The average elevation of each of the sections of the base was obtained from spirit levels run in both ways over the tape supports to get the grade corrections. The corrections to reduce the various sections to sea level are shown in the table which follows. It is certain that the above elevation is correct within 1 meter, and therefore the reduction to sea level is not subject to any appreciable error.

Corrections to spring balances.—In the table of the results of measurement is a column headed "Correction for erroneous tension," in which is given a correction to the length of each section of the base due to index errors of the spring balances used. Inadvertently, the observer did not have his attention called to the fact that the index errors of the balances sent to the field had not been corrected. He used one balance as a standard when the index read exactly 15 kilograms. It was learned later, when there were sent to the Cheyenne base additional balances which had no index error, that the standard balance at the El Paso base had an index error of 338 grams. This made the actual pull on this balance, while it was being used as a standard, only 14.66 kilograms instead of 15. After the effect of this difference is applied the resulting length is free of error from this source.

Results of remeasurement.—The results of the remeasurement of the El Paso base are given in the following table:

The El Paso base line.

Section.	Date and hour.	Direction of measure.	Tape No.	Weather and wind.[1]	Temperature (centigrade).		Correction to length for temperature.	Set-up or setback.	Grade correction.	Tape correction.	Correction for erroneous tension.	Reduction to sea level.	Reduced lengths of sections.	Adopted lengths of sections.	v.	vv.
					R, F, or S.[2]	Mean corrected.										
	July, 1913.					°	m	m	m	m	m	m	m	m	mm	mm
I, E. B.-20..	20, 9:45 a. m.	W	516	Cy, L SE....	R	18.9	−0.0016	+0.0110	−0.0723	+0.1911	−0.0105	−0.3130	999.8047	999.8047	0.0	0.00
	16, 9:45 a. m.	E	517	Cy, S S......	R	28.8	+0.0019	−0.0097	−0.0723	+0.1991	−0.0013	−0.3130	999.8047		0.0	0.00
II, 20-40....	20, 10:25 a. m.	W	516	Cy, L S......	S	18.9	−0.0016	+0.0953	−0.0916	+0.1911	−0.0105	−0.3141	999.8686	999.8702	+1.6	2.56
	16, 9:00 a. m.	E	517	Cy, S S......	S	27.3	+0.0013	+0.0784	−0.0916	+0.1991	−0.0013	−0.3141	999.8718		−1.6	2.56
III, 40-60...	20, 11:05 a. m.	W	516	Cy, L S......	S	19.1	−0.0015	+0.0836	−0.2359	+0.1911	−0.0105	−0.3158	999.7110	999.7121	+1.1	1.21
	16, 8:20 a. m.	E	517	Cy, L S......	S	26.7	+0.0011	+0.0661	−0.2359	+0.1991	−0.0013	−0.3158	999.7133		−1.2	1.44
IV, 60-80...	20, 12:15 p. m.	W	516	Cy, L S......	S	18.2	−0.0018	+0.1027	−0.1224	+0.1911	−0.0105	−0.3177	999.8414	999.8430	+1.6	2.56
	16, 7:40 a. m.	E	517	Cy, L SW....	R	25.4	+0.0007	+0.0861	−0.1224	+0.1991	−0.0013	−0.3177	999.8445		−1.5	2.25
V, 80-100...	17, 5:40 a. m.	W	521	P Cy, L W...	R	18.2	−0.0021	+0.0488	−0.1356	+0.2015	−0.0012	−0.3196	999.7918	999.7908	−1.0	1.00
	18, 11:20 a. m.	E	516	P Cy, L E...	S	23.3	0.0000	+0.0644	−0.1356	+0.1911	−0.0105	−0.3196	999.7898		+1.0	1.00
VI, 100-120.	17, 6:20 a. m.	W	521	P Cy, L W...	S	19.8	−0.0015	0.0000	−0.0945	+0.2015	−0.0012	−0.3215	999.7828	999.7812	−1.6	2.56
	18, 10:45 a. m.	E	516	Cy, L SE....	S	24.2	+0.0003	+0.0148	−0.0945	+0.1911	−0.0105	−0.3215	999.7797		+1.5	2.25
VII, 120-140.	17, 7:10 a. m.	W	521	P Cy, L W...	R	20.8	−0.0010	−9.6844	−0.1562	+0.2015	−0.0012	−0.3205	990.0382	990.0382	0.0	0.00
	18, 10:05 a. m.	E	516	Cy, O........	S	22.2	−0.0004	−9.6654	−0.1562	+0.1911	−0.0105	−0.3205	990.0381		+0.1	0.01

[1] These letters represent the following: C, clear; Cy, cloudy; P Cy, partly cloudy; O, calm; L, light; M, moderate; S, south; W, west; E, east; SW, southwest; SE, southeast.

[2] These letters R, F, and S indicate whether the temperature was rising, falling, or stationary.

The El Paso base line—Continued.

Station.	Date and hour.	Direction of measure.	Tape No.	Weather and wind.	Temperature (centigrade). R, F, or S.	Temperature (centigrade). Mean corrected.	Correction to length for temperature.	Set-up or setback.	Grade correction.	Tape correction.	Correction for erroneous tension.	Reduction to sea level.	Reduced lengths of sections.	Adopted lengths of sections.	v.	vv.
	July, 1913.					°	m	m	m	m	m	m	m	m	mm	mm
VIII, 140–160	17, 7:45 a. m.	W	521	P Cy, L SW..	S	21.8	−0.0006	+0.0486	−0.1815	+0.2015	−0.0012	−0.3261	999.7407	999.7391	−1.6	2.56
	18, 8:55 a. m.	E	516	Cy, O........	F	17.7	−0.0019	+0.0664	−0.1815	+0.1911	−0.0105	−0.3261	999.7375		+1.6	2.56
IX, 160–180.	17, 8:45 a. m.	W	517	P Cy, L SW..	S	23.1	−0.0001	+0.0975	−0.2237	+0.1991	−0.0013	−0.3288	999.7427	999.7444	+1.7	2.89
	17, 2:40 p. m.	E	521	Cy, L W.....	S	25.8	+0.0010	+0.0973	−0.2237	+0.2015	−0.0012	−0.3288	999.7461		−1.7	2.89
X, 180–200..	17, 9:25 a. m.	W	517	P Cy, L SW..	S	24.0	+0.0002	−2.8474	−0.3426	+0.1991	−0.0013	−0.3307	996.6773	996.6790	+1.7	2.89
	17, 2:10 p. m.	E	521	Cy, M S......	S	25.1	+0.0007	−2.8471	−0.3426	+0.2015	−0.0012	−0.3307	996.6806		−1.6	2.56
XI, 200–220.	17, 10:20 a. m.	W	517	C, L SW.....	S	25.5	+0.0007	+0.0323	−0.3459	+0.1991	−0.0013	−0.3351	999.5498	999.5512	+1.4	1.96
	17, 11:35 a. m.	E	521	C, L SE.....	R	27.6	+0.0018	+0.0315	−0.3459	+0.2015	−0.0012	−0.3351	999.5526		−1.4	1.96
XII, 220–W. B.	17, 11:15 a. m.	W	517	C, O..........	F	26.4	+0.0003	+4.8315	−0.3566	+0.0597	−0.0003	−0.1030	304.4316	304.4313	−0.3	0.09
	17, 11:25 a. m.	E	521	C, O..........	S	26.7	+0.0004	+4.8300	−0.3566	+0.0605	−0.0003	−0.1030	304.4310		+0.3	0.09

The length of the El Paso base is 11 288.9852 ± 0.0031 meters.

The logarithm of this length is 4.0526549 ± 1.

This probable error of the length corresponds to one part in 3 642 000.

The probable error was computed in a manner similar to that described on pages 160–161 of Appendix No. 4 of the Report for 1910.

CHEYENNE BASE.

When it was found that the new length of the El Paso base did not agree closely with the computed length as carried through the triangulation from the Provo base, it was decided to introduce a new base in the one hundred and fourth meridian triangulation. (See p. 9.) After making a reconnaissance, Mr. Bilby located this base in the vicinity of Cheyenne, Wyo. He also selected several triangulation stations at which horizontal directions were later observed for the purpose of connecting the base with the main scheme of triangulation. See illustrations at the end of this volume.

Organization of party.—The preparation of the base for measurement was made by Mr. Bilby with the assistance of five temporary hands employed in the vicinity of the work. The preparation and leveling over the base occupied the time between July 28 and August 6, 1913.

Upon the completion of the above work, Mr. Hodgson, who had been engaged upon latitude observations since the completion of the measurements of the El Paso base, moved to the Cheyenne base and carried on the actual tape measurements with the cooperation of Mr. Bilby. The measuring party consisted of Messrs. Hodgson and Bilby and six hands. The actual tape measurements were made on two days only, August 8 and 10.

Divisions of the base.—Like the other bases on the one hundred and fourth meridian, this one had three main divisions, each of which was measured twice in opposite directions with different tapes. Each division was measured with a different pair of tapes in order that an intercomparison of the three tapes used might be made.

The following table shows the divisions of the base, the tapes used, and the approximate length of each division:

Division.	Tapes used.	Length of division.
	Numbers.	*Meters.*
No. 1	516 and 517	2000
No. 2	517 and 521	2000
No. 3	516 and 521	2652

The descriptions of the locations and permanent monuments at the base ends are shown on page 117.

Apparatus used.—The same tapes were used on the Cheyenne base that had been used on the Ambrose, Provo, and El Paso bases. (See p. 11.) The other articles of apparatus were similar in character to those used on those three bases.

Methods employed.—The base was measured in the same manner as the others on this arc. Since the wind was not found to be troublesome, only three supports were used for each tape length, oné at each end and one at the center point. (See p. 11)

Standardization and equations of tapes.—On page 20, under the same heading, are given the equations of the tapes used on the Cheyenne base as furnished by the Bureau of Standards. As on the El Paso base, the equations of the tapes resulting from the standardization in January, 1913, were used in the final computations of the base. The results of the second standardization were not available when the computation and adjustment of the one hundred and fourth meridian triangulation was begun. After the results of the second standardization were received it was found that the average difference between the two standardizations was only 1 part in 10 000 000 which was negligible.

Reduction to sea level.—The elevation above sea level of Cheyenne west base as determined by trigonometric leveling is 2074.20 meters. The average elevation of the various sections of the base was determined by a line of levels run over the base in opposite directions for the purpose of obtaining the grade corrections. The correction to sea level for each section is shown in the following table. Since the uncertainty in the adopted elevation of West base is less than one meter, the corrections shown in the table for reducing the measured lengths to sea level are free from any appreciable error from this source.

Corrections to spring balances.—Like the table of results of the remeasurement of the El Paso base, the table for the Cheyenne base also contains a column of corrections for erroneous tension. The discussion on page 21 states that there were sent to the Cheyenne base spring balances which had no index error. These did not arrive, however, until after the measurement had been completed. Therefore, corrections similar to those explained for the El Paso base, must be applied to the results for the Cheyenne base.

Results of measurement.—The results of the measurement of the Cheyenne base are shown in the following table:

The Cheyenne base line.

Section.	Date and hour.	Direction of measure.	Tape No.	Weather and wind.[1]	Temperature (centigrade). R, F, or S.[2]	Temperature (centigrade). Mean corrected.	Correction to length for temperature.	Set-up or setback.	Grade correction.	Tape correction.	Correction for erroneous tension.	Reduction to sea level.	Reduced lengths of sections.	Adopted lengths of sections.	v.	vv.
	Aug., 1913.					°	m	m	m	m	m	m	m	m	mm	mm
I, W. B.-20.	10, 4:15 a. m.	E	517	C, O	S	19.0	−0.0014	+0.0776	−0.3750	+0.1991	−0.0111	−0.3234	999.5658	999.5638	−2.0	4.00
	8, 9:25 a. m.	W	516	C, S SW	R	25.4	+0.0008	+0.0788	−0.3750	+0.1911	−0.0105	−0.3234	999.5618		+2.0	4.00
II, 20-40	10, 4:35 a. m.	E	517	C, O	S	18.6	−0.0015	+0.0917	−0.4632	+0.1991	−0.0111	−0.3205	999.4945	999.4933	−1.2	1.44
	8, 8:55 a. m.	W	516	C, M SW	S	24.2	+0.0003	+0.0949	−0.4632	+0.1911	−0.0105	−0.3205	999.4921		+1.2	1.44
III, 40-60	10, 5:15 a. m.	E	521	C, O	R	19.2	−0.0017	+0.0575	−0.2186	+0.2015	−0.0101	−0.3185	999.7101	999.7089	−1.2	1.44
	8, 8:05 a. m.	W	517	C, L SW	R	23.2	0.0000	+0.0569	−0.2186	+0.1991	−0.0111	−0.3185	999.7078		+1.1	1.21
IV, 60-80	10, 5:40 a. m.	E	521	C, L NW	S	19.1	−0.0017	+0.0609	−0.4054	+0.2015	−0.0101	−0.3175	999.5277	999.5267	−1.0	1.00
	8, 7:35 a. m.	W	517	C, L SW	R	22.9	−0.0001	+0.0607	−0.4054	+0.1991	−0.0111	−0.3175	999.5257		+1.0	1.00
V, 80-100	10, 8:10 a. m.	E	516	C, L NW	S	20.0	−0.0012	+0.0506	−0.3876	+0.1911	−0.0105	−0.3168	999.5256	999.5276	+2.0	4.00
	10, 10:50 a. m.	W	521	C, S NE	R	23.8	+0.0002	+0.0424	−0.3876	+0.2015	−0.0101	−0.3168	999.5296		−2.0	4.00
VI, 100-120.	10, 8:40 a. m.	E	516	C, L NW	R	20.8	−0.0000	+0.0894	−0.1769	+0.1911	−0.0105	−0.3160	999.7762	999.7784	+2.2	4.84
	10, 10:20 a. m.	W	521	C, M NE	F	23.8	+0.0002	+0.0819	−0.1769	+0.2015	−0.0101	−0.3160	999.7806		−2.2	4.84
VII, 120-E. B.	10, 9:35 a. m.	E	516	C, L N	R	21.8	−0.0003	+3.0353	−0.1086	+0.1242	−0.0068	−0.2059	652.8379	652.8380	+0.1	0.01
	10, 10:00 a. m.	W	521	C, L NE	F	22.8	−0.0001	+3.0286	−0.1086	+0.1310	−0.0066	−0.2059	652.8382		−0.2	0.04

[1] These letters are used to represent the following: C, clear; O, calm; L, light; M, moderate; S, strong; N, north; NE, northeast; NW, northwest; SW, southwest.

[2] These letters, R, F, and S, indicate whether the temperature was rising, falling, or stationary.

The length of the Cheyenne base is 6650.4367 ± 0.0028 meters.

The logarithm of this length is 3.8228501 ± 2.

The probable error of the length corresponds to 1 part in 2 367 000.

The computation of the probable error was made in a manner similar to that described on pages 160–161 of Appendix 4 of the Report for 1910.

The length of the El Paso base, as computed through the triangulation from this measured length of the Cheyenne base, is now shorter than the measured length of the El Paso base by 1 part in 30 800. Since the adjustment of the triangulation between these bases gives small corrections to directions, the accidental errors therein are not sufficient to account for this discrepancy in length. The difference, therefore, must be due to some systematic errors in the triangulation.

One of the causes of the discrepancy between these bases may be the elevation of the surface of the geoid above that of the ellipsoid, although the effect of this is not large enough to cause the total difference stated above.

An attempt to show the geoid contours in the United States was made on illustration No. 17 of the United States Coast and Geodetic Survey publication entitled "The Figure of the Earth and Isostasy from Measurements in the United States," but the area within which these contours were drawn is very limited in extent. In the vicinity of the El Paso base the geoid contour is marked 32 meters. It is impossible, of course, to tell what will be the number for the geoid contour at the Cheyenne base which is in southeastern Wyoming, but as the geoid contours seem to conform somewhat to the topographic contours, it may be expected that the number at the Cheyenne base will be between 24 and 30 meters. These contours of the geoid should not be considered as giving anything more than relative elevations above the ellipsoid, for the initial point used in constructing the geoid contours was given a value of 10 meters, in order that negative values might be avoided.

If the difference between the geoid elevation at the Cheyenne and El Paso bases is 8 meters, a relative error of 1 part in about 800 000 would result. If the reduction to sea level at Cheyenne were considered correct then the reduction at El Paso would be in error by 0.014 meter. This error would make the El Paso base as measured too long. This agrees in sign with what is shown by the comparison of that length with the one brought through the triangulation from the Cheyenne base. However, there must be some other cause for the difference of 0.367 meter between those two bases.

The average elevation of the geoid above the spheroid along the transcontinental triangulation, as indicated by the illustration in The Figure of the Earth and Isostasy from Measurements in the United States, is about 12 meters (after subtracting 10 meters, the assumed elevation of the starting point). Therefore, the average error in the measured lengths of the base lines along that arc caused by the elevation of the geoid surface is 1 part in about 500 000. Although this error is constant in its effect, it is practically impossible to apply a correction for it, owing to the fact that available data showing relative geoid elevations are very limited, and that no data whatever as to the absolute elevation of the geoid above or below the surface of the ellipsoid are available.

Cost of the El Paso and Cheyenne bases.—The total cost of the measurement of these two bases was $980. In addition to the cost of labor, materials, etc., this included the salary of Mr. Bilby from the time he reached Colorado until he left for work on reconnoissance, one-half of his traveling expenses and those of Mr. Hodgson from Washington to Littleton, Colo., and the salary of Mr. Hodgson while not on his latitude work. The cost per base was $490 and the cost per kilometer was $55, both bases being considered. The office computation of the two bases took the equivalent of 22 days of one computer, with a cost of $105. The Bureau of Standards makes a charge of $50 for a fundamental standardization of a base tape; therefore to get the total cost of the bases to the Government the cost of two standardizations of four tapes, $400, should be added to the field expenses and the cost of computation.[1]

[1] The cost of one of these standardizations was charged to the Provo and Ambrose bases but is included here also to make the total cost comparable with that of the other bases.

The total cost of the bases was \$980+\$105+\$400=\$1485; this is \$742 for each base, and at the rate of \$83 per kilometer.

While the measurements were being made at the Cheyenne base, the party also observed horizontal directions at the base ends and at the two stations Waddill and Whitaker for the purpose of connecting the base with the main scheme of triangulation. The work on the base was only slightly interrupted by these operations. The stands used at Waddill and at Whitaker in 1912 were still in place, so it was only necessary to place stands at the base ends, which required very little lumber. As nearly as the writer could determine, the cost of the additional work of connecting the base with the main triangulation scheme was only about \$130. The observing was done at night on signal lamps.

Summary of tape values.—The following table shows for each of the four tapes the length as determined by six different standardizations, the probable error of each determination, the mean of the results from the six standardizations, and the residuals. The values given are for the lengths of the tapes when resting upon three points of support and subjected to a fixed tension of 15 kilograms. In order to make the values comparable, they have all been reduced to the same temperature, namely, 21.2° C.

Values of tapes with three supports at temperature of 21.2° C.

Date of standardization.	T_{516}=		T_{517}=	
	50m+	v	50m+	v
	mm mm	mm	mm mm	mm
January, 1909	9.542±0.017	−0.044	9.735±0.018	+0.081
May, 1909	9.454±0.028	+0.044	9.782±0.025	+0.034
March, 1910	9.415±0.017	+0.083	9.738±0.015	+0.078
March, 1912	9.473±0.029	+0.025	9.869±0.022	−0.053
January, 1913	9.519±0.016	−0.021	9.919±0.016	−0.103
October, 1913	9.587±0.020	−0.089	9.853±0.017	−0.037
	9.498		9.816	

Date of standardization.	T_{521}=		T_{522}=	
	50m+	v	50m+	v
	mm mm	mm	mm mm	mm
January, 1909	9.750±0.018	+0.175	10.543±0.019	+0.068
May, 1909	9.835±0.021	+0.090	10.566±0.024	+0.045
March, 1910	9.878±0.015	+0.047	10.593±0.018	+0.018
March, 1912	10.009±0.021	−0.084	10.644±0.017	−0.033
January, 1913	10.034±0.016	−0.109	10.664±0.016	−0.053
October, 1913	10.047±0.018	−0.122	10.655±0.020	−0.044
	9.925		10.611	

The above table gives very valuable data as to the constancy of the lengths of the invar tapes. The total ranges for four years in the values of the various tapes are:

Tape No.	Total range.	Proportion.
	mm	
T_{516}	=0.172	1 part in 290 000
T_{517}	=0.184	1 part in 270 000
T_{521}	=0.297	1 part in 170 000
T_{522}	=0.121	1 part in 410 000

The differences in length between the values resulting from the first and last standardizations are:

Tape No.	Range.	Proportion.
	mm	
T_{516}	=0.045	1 part in 1 110 000
T_{517}	=0.118	1 part in 420 000
T_{521}	=0.297	1 part in 170 000
T_{522}	=0.112	1 part in 450 000

Each of the tapes was longer at the time of the last standardization than at the first one, the average increase being 0.143 millimeter, or 1 part in 350 000. These changes are within the possible effect of the accidental and constant errors of standardization, except in the case of T_{521}. That tape shows a continuous increase from January, 1909, to October, 1913, but the maximum change in the length of this tape between any two consecutive standardizations is only 0.131 millimeter (March, 1910, to March, 1912), or 1 part in 380 000. The maximum change between two consecutive standardizations for T_{516} is 0.088 millimeter, or 1 part in 570 000; for T_{517} it is 0.131 millimeter, or 1 part in 380 000 (the same as for T_{521}); and for T_{522} it is only 0.051 millimeter, or 1 part in 980 000.

The following table is similar to the preceding one, except that the values given are for the lengths of the tapes when resting upon five points of support. The common temperature to which these values are reduced is 26.8° C.

Values of tapes with five supports at temperature of 26.8° C.

Date of standardization.	T_{516}=		T_{517}=	
	50m+	v	50m+	v
	mm mm	mm	mm mm	mm
May, 1909	12.446±0.026	+0.002	12.817±0.026	+0.031
March, 1910	12.370±0.017	+0.078	12.768±0.015	+0.080
March, 1912	12.399±0.014	+0.049	12.857±0.017	−0.009
January, 1913	12.482±0.021	−0.034	12.938±0.017	−0.090
October, 1913	12.543±0.019	−0.095	12.862±0.016	−0.014
	12.448		12.848	

Date of standardization.	T_{521}=		T_{522}=	
	50m+	v	50m+	v
	mm mm	mm	mm mm	mm
May, 1909	13.055±0.021	+0.106	14.051±0.029	+0.018
March, 1910	13.066±0.015	+0.095	14.029±0.017	+0.040
March, 1912	13.195±0.019	−0.034	14.059±0.017	+0.010
January, 1913	13.234±0.017	−0.073	14.115±0.021	−0.046
October, 1913	13.257±0.016	−0.096	14.089±0.017	−0.020
	13.161		14.069	

The above table is shown in order that the values obtained in the past for the lengths of the tapes with five supports may be available for purposes of comparison with the values which may be determined in the future under similar conditions. It is probable that the invar tapes will be supported at five points whenever a base is measured in a locality subject to strong and constant winds.

The values in this table result from the same standardizations as those shown in the table on page 25. The changes in the lengths of the tapes between the standardization in May, 1909, and October, 1913, while on five supports, are in each case smaller than when supported at three points.

Tape T_{522} was carried to the field by each party measuring the bases on the Texas-California arc and on the one hundred and fourth meridian, but in no case was it used in the measurements. In fact, it was never unreeled in the field. Therefore any change in length of that tape has been due to other causes than those incident to the use of tapes in the field during measurements.

The data in the above tables indicate a remarkable constancy in the values of the lengths of the tapes, considering the fact that three of them were used in the field in the measurement of six bases, totaling about 156 kilometers of single measures (including remeasuring of certain sections), about 52 kilometers for each tape. It may be stated also that the invar tapes are not so susceptible to injury during field work as was supposed to be the case soon after their introduction. Each of the base parties which used the tapes under discussion, with the exception of two members, consisted entirely of men unskilled in the use and treatment of tapes.

The members of each party were cautioned to use every care in handling the tapes, but even so it seems remarkable that none of the tapes have been injured.

Rapidity of base measurements.—The following table shows the speed attained in the measurements of the four bases. The times given are the hours of actual work, including the time spent in changing tapes and in placing the copper strips on the end stakes, but not long delays such as the stops for luncheon:

Ambrose base.				Provo base.			
Date.	Time.	Distance.	Kilometers per hour.	Date.	Time.	Distance.	Kilometers per hour.
1912.	h m	km		1912.	h m	km	
May 16	2 55	3.00	1.03	Oct. 3	7 15	12.00	1.66
18	5 40	8.00	1.41	7	6 00	10.00	1.67
20	5 15	9.90	1.89	8	3 35	7.10	1.98
El Paso base.				Cheyenne base.			
1913.	h m	km		1913.	h m	km	
July 16	3 00	4.00	1.33	July 8	2 30	4.00	1.60
17	7 35	10.60	1.40	10	5 00	9.30	1.86
18	3 05	4.00	1.30				
20	2 55	4.00	1.37				

The average speed for each of the four bases is:

	Kilometers per hour.
Ambrose base	1.51
Provo base	1.73
El Paso base	1.36
Cheyenne base	1.77

The speed attained on other bases measured with invar tapes is given on page 151 of Appendix 4, Report for 1907, and on page 170 of Appendix 4, Report for 1910.

Tapes v. *Wires.*—It is only necessary to touch briefly on the use in some other countries of steel or invar wires in the measurement of bases. Excellent results have been obtained with them, but in the opinion of the writer the tapes are more easily handled than the wires. It is always possible to detect a twist in the tape, but the wire may have a twist without detection during the field measures. Also the wires may be injured during reeling, while there is only a remote possibility that an injury while reeling might occur to a tape. The tape is probably affected by strong wind more than is a wire, but the experience in the United States has been that no material delay has been caused by the wind. At the Stanton base only was the wind troublesome. (See Appendix 4, 1910.) At the Deming base the wind effect was made negligible by the use of five supports instead of three for the 50-meter tape.

Stakes v. *Movable supports.*—When measurements of primary bases were made with steel tapes, it was necessary to work at night in order to take advantage of the more constant temperature; and in order that night work might be done it was necessary to have the supports for the tape set during the daylight. In general stakes 4 inches in cross section were used as the end supports, and very much lighter material for the intermediate supports. This method of supporting the steel tape has been continued with the invar tapes.

Where stakes are used, all the members of the party may be inexperienced except one observer; and no preliminary training is required, as the first measurements by the new party will nearly always be found satisfactory. The stake setting and the leveling over the base may go on simultaneously and then the combined force may do the actual measurements with the tapes. For measuring with the movable supports the party must be larger and must include several especially trained men. With the stakes the setting and leveling can be done in windy weather while with the movable supports no measuring can be done at such times. In the plains region of the United States where frequently the wind is strong in the day but light at night, the stake supports would be preferable. Either method will enable the party to secure results far more accurate than are really required for the highest grade of triangulation.

CONCLUSIONS FROM BASE MEASUREMENTS.

Some of the conclusions which may be drawn from the measurements of the four base lines discussed in this publication are:

(*a*) The plan adopted on the Texas-California arc of having the observing party on triangulation measure the bases as they are reached, is an efficient one, and should be continued. This method insures that the lengths of the bases may be known in time for use in an adjustment of the arc of triangulation as soon as the last field work of the triangulation has been done.

(*b*) Tapes of the invar metal make an entirely satisfactory apparatus for base measurements.

(*c*) There is no evidence that a different length than 50 meters should be used for the base tape.

(*d*) The 50-meter invar tape is affected by wind of even moderate strength, when supported at only three points. But ordinarily, during the progress of the various operations at a base, sufficiently long periods of favorable wind conditions may be found for making the measurements. All four of the bases on the one hundred and fourth meridian had only three supports for each tape length, one at each end and one in the center. No serious trouble with the wind was encountered. An efficient remedy for the wind effect, if troublesome, is to use five supports for each tape length, as on the Deming base in 1910. (See pp. 154–155 of Appendix 4, Report for 1910.)

(*e*) Owing to the small time and cost needed to measure a base, it is believed that the ummation of R_1 (see p. 8) between bases should be between 90 and 140, instead of between 130 and 200. With the higher values there is the possibility of having to introduce other bases after the completion of the triangulation and the measurement of the bases provided for by the reconnaissance.

(*f*) While the index error in the spring balance did not introduce an error into the El Paso and Cheyenne base lengths, at the same time it was a cause of annoyance. The index of the balance should be rigidly fastened to its stem to prevent a change in the index error if the balance were roughly handled.

(*g*) After the use of the same tapes on six bases in four different seasons between 1909 and 1913, inclusive, the lengths of one tape show a maximum range of only 0.297 millimeters, or 1 part in 170 000, while the average maximum variation of all the tapes is only 0.193 millimeters, or 1 part in 260 000. If the actual uncertainty in the length of each tape should be as much as the total range in values as shown in the table on page 25, even then the uncertainty of a base measured with three or more tapes would be less than the uncertainty in the length of any one tape. Such accuracy is far greater than that of the triangulation, and hence the invar metal must be considered as a most satisfactory material from which to make a base measuring apparatus.

BUILDING SIGNALS AND MARKING STATIONS.

The erection of the signals or instrument stands and the marking of stations were done by a party under the direction of Signalman J. S. Bilby. He arrived on the working ground April 12, 1912. Actual field operations of the building party began on April 24 and ended August 28, 1912, a total time of four months and five days.

The building party consisted of Mr. Bilby and two men, with occasional temporary employees who assisted in cutting lines or erecting signals. One of the regular men began work at Cheyenne, Wyo., worked southward to the end of the scheme and then northward from Cheyenne to meet the other man who had started at the Canadian border and worked southward. Mr. Bilby was with the one or the other of these men, depending upon where his assistance and guidance were most needed.

TWELVE-INCH THEODOLITE.

The building party erected stands or signals for mounting the theodolite at 102 stations, prepared the base lines at Ambrose and Provo, and gave some assistance to the observing parties in the measurement of the bases. The stations were also marked in a permanent manner by the building party. The character of the marks is described in notes 1 to 8 on page 115, and the metal tablet placed in the concrete or cemented to solid rock is shown in illustration No. 4.

Signals.—The type of signal is that shown by illustrations and described in Appendix 4, Report of the United States Coast and Geodetic Survey for 1903. In that publication are also given detailed directions for its erection. The signal is a double structure consisting of an inner tower, called the tripod, on which the instrument rests, and the outer tower, called the scaffold, near the top of which there is a platform for supporting the observer. The two structures do not touch each other at any point and consequently the observer may move about on the platform without disturbing the level or azimuth of the theodolite. The heliotrope and lamp are sometimes posted on the tripod and at other times on the scaffold.

The signals shown in the illustrations in Appendix 4 of the Report for 1903 were designed for use by a double observing party, and the upper platform enabled the light keeper to post his heliotrope or lamp centrally over the station even when one of the observers was at his station. When there is only one observing party the scaffold does not extend above the tripod, as the top platform is not needed.

It has been found that it is more economical to build the tripod to only a moderate height, say less than 70 feet, and then extend the scaffold to a sufficient height to make clear the line from its top to the tripod head at a second station and likewise to extend the scaffold at the second station to such a height that the line between its top and the tripod head at the first station will also be clear, rather than to attempt to build the double structures to such heights that the line between the tripod heads at the two stations will be clear of obstructions.

Illustration No. 10 of Appendix 4, Report for 1903, shows a signal which has the tripod about 66 feet high and the light stand at the top of the superstructure on the scaffold 137 feet above the ground.

The one hundred and fourth meridian arc is rather remarkable for the low average elevation of the instrument above the ground. The tables on pages 43 to 47 give the elevation of the telescope of the theodolite above the station mark. There were only eight stations at which the height of the instrument was greater than that necessary to bring the telescope to the eye of the observer as he stood upon the ground. The height of the simple stand for mounting the theodolite was about 3½ feet. The average height of the tripods of the eight signals was 28.15 feet. Inasmuch as the country traversed was at most points distant from lumber yards, the reconnaissance party made such selections of stations as to make the amount of building a minimum.

On the Texas-California arc of primary triangulation (reported in Special Publication No. 11, United States Coast and Geodetic Survey) the plan previously employed of always having the telescope of the theodolite at least 10 feet above the ground except on sharp peaks, was abandoned. Where the line was clear of obstructions only stands for the instruments were used even though the country was flat for some distance in all directions from the station.

The accuracy of the Texas-California triangulation was better, on an average, than that of the other great arcs in the United States. The writer, who observed part of one season on the Texas-California arc, noticed that the lights and heliotropes observed from a station where the theodolite was only a few feet from the ground were more unsteady than when the lines were high, and especially when high near the station occupied by the observer.

The plan used on the Texas-California arc was adopted on the one hundred and fourth meridian arc of primary triangulation, and the instrument was never mounted at a greater height than was barely necessary to clear the line. The accuracy of the work on the one hundred and fourth meridian is discussed later in this report.

Cost of building signals and marking the stations.—The total cost of the work of the building party was about $4200. This includes the salaries and traveling expenses for the chief and all the members of the party, also the cost of lumber and cement delivered to the stations, and various small expenditures. This is at the rate of $5.83 per mile of progress, a remarkably low amount.

The use of instrument stands instead of signals, even of low height, decreased greatly the expenses of preparing the stations for the observing parties. The lumber necessary for signals would have been expensive and hauling it to the stations would also have been costly.

INSTRUMENTS USED ON TRIANGULATION.

Theodolites.—The type of instrument used for the horizontal measures is described in detail in Appendix 8 of the Report for 1894. It is believed that the portion of that description shown below will be of interest and value to the reader. These theodolites have been used on all of the primary triangulation done by the United States Coast and Geodetic Survey since they were made in the early nineties. One of them is shown in illustration No. 2.

The base is of cast iron, into the socket of which is fitted another cast-iron socket, to which is rigidly attached the brass circle and into which is fitted the center which carries the alidade. Under the circle is a device for firmly clamping this socket to the base in any position of the circle. The center is 22.2 centimeters (8 inches) long, its two bearing surfaces being cones of different angles. It is made of the best quality of tool steel, and the cones are made glass hard. No pains were spared in the construction of these centers and sockets, and it is believed they are the most perfect ever made for theodolites, and are probably the first theodolite centers with glass-hard bearing surfaces.

In the alidade the cover of the circle, the supports for the micrometer microscopes, the wye supports, axis, and setting circle of telescope are made of aluminum. The bearing surfaces of the wyes are of brass, and the pivots of telescope axis are of bell metal. The draw tube of telescope, micrometer microscopes, clamps, and other small parts are of brass.

The use of aluminum in the construction of these instruments was not with the special purpose of reducing the total weight of the instrument, but to reduce the weight supported upon the centers. The cast-iron bases of these instruments, in proportion to the whole mass of the instruments, are much heavier than is usual in other theodolites of the same size. These heavy bases and long centers give great stability to the instruments. The weight of the whole alidade is 7.5 kilograms (17 pounds), whereas in other instruments of the same size that have been used in the Survey the weight of similar parts is 18 kilograms (40 pounds). The centers of the old instruments are of various forms, and the friction is so great that it has to be relieved by some device at lower end of centers. No such device is necessary with the new instruments. The total weight of one of the new instruments is 18.5 kilograms (41 pounds).

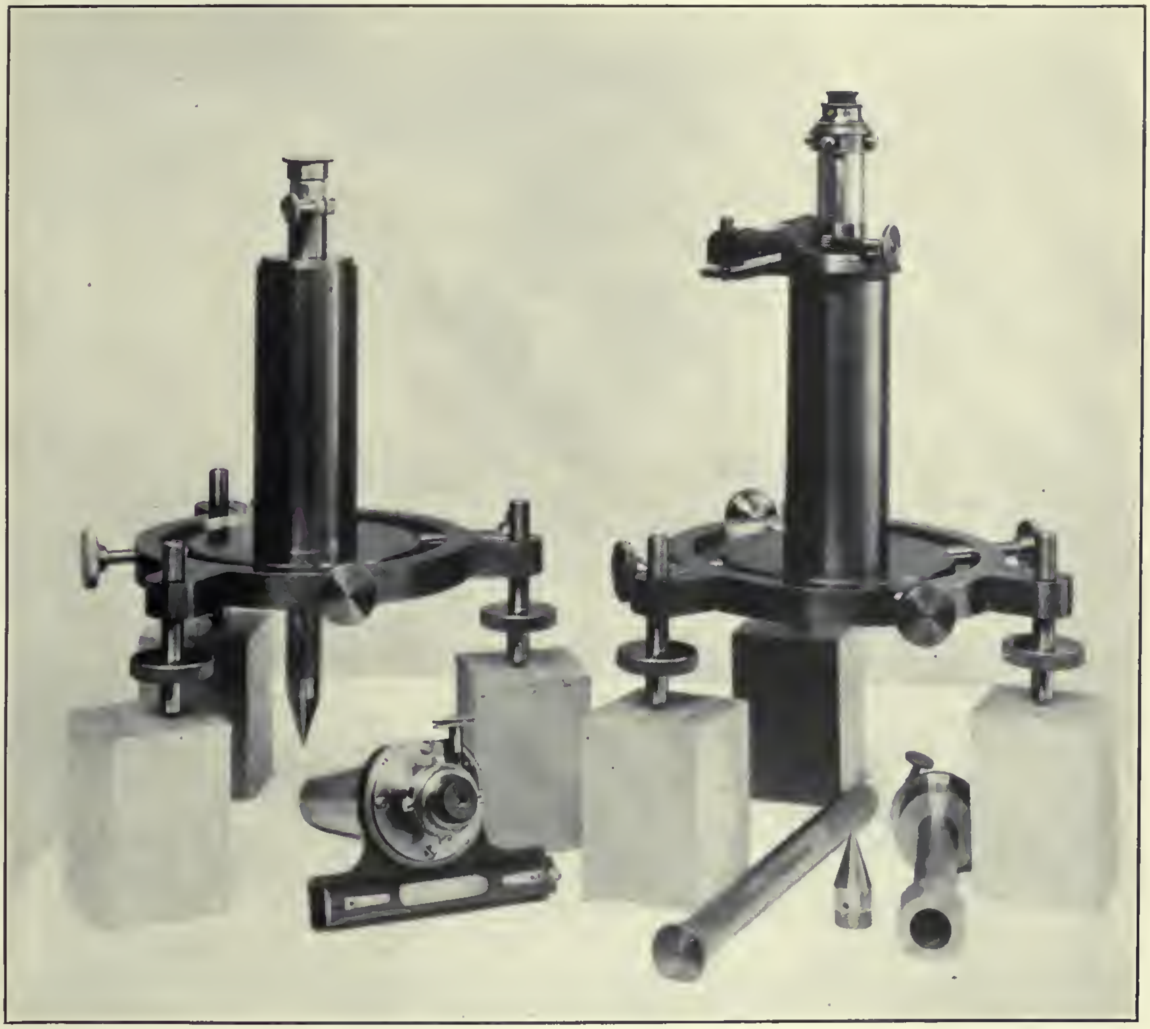
The telescope objective was made by J. Brashear, and is 6.1 centimeters (2.4 inches) aperture, and 73.7 centimeters (29 inches) focus. The telescope has an ocular micrometer, with three Ramsden eyepieces, giving powers of 30, 45, and 60. Several levels, all made by A. Pesseler, of Germany, are attached to the alidade for convenience. The stride level has divisions of 2 millimeters, with arc value of 4 seconds.

The graduation of the circle is on coin silver and is 30.5 centimeters (12 inches) in diameter. It is divided to 5 minutes and reads to seconds by three equidistant micrometer microscopes. Each degree of the graduation is numbered. The degrees and nearest 5 minutes are read by a low power index microscope 50 degrees to the right of micrometer microscope A. Attached to the cover of the circle is a small camel's-hair brush which sweeps over the graduation.

The circles were graduated on the United States Coast and Geodetic Survey engine. This graduating engine was originally made by Troughton & Simms, of London, and bears the date of 1841. In the hands of the Survey it has received various improvements, the chief of which are a new tracing apparatus and new support for the same. The engine is driven by a small turbine wheel upon which a constant water pressure is maintained. To graduate a circle to 5 minutes takes about 3 hours and 35 minutes. The graduations are made at a temperature of 36°.66 C. (98° F.), that temperature being most easily maintained at any season of the year and least affected by the occasional presence of the operator. For the last nine years this engine has been manipulated exclusively by the present chief instrument maker of the Survey and in his hands has produced some very fine graduations, as the results with the two new theodolites, Nos. 145 and 146, show.

Vertical collimator.—In centering a signal over the mark of a previously established station, when placing a mark under a new signal, and for centering the theodolite over the station mark, there was used a vertical collimator which is shown in illustration No. 3a. In order that this instrument may be used there must be an opening in the center of the cap block of the tripod head of the signal. Into the vertical socket of the base of the instrument fits a telescope carrying a fixed level and having adjustable cross wires in its reticule. The axis of the level is at right angles to the line of sight of the telescope. The base rests on three leveling screws.

The adjustments of the instrument are extremely simple. After having focussed the eyepiece on the cross wires, the cross of the wires is adjusted to make it remain on a point as the telescope is revolved about its axis. Then the level is adjusted to make the bubble remain in



VERTICAL COLLIMATOR (TWO VIEWS).

the center as the telescope is revolved. With the instrument in perfect adjustment and the bubble brought to the center in two positions at right angles, the line through the cross of the wires will be vertical. In actual use it is not essential that the instrument be in perfect adjustment, for if the bubble is brought to the center in each of four positions of the telescope, about 90 degrees between each two positions, four points may be determined and the mean position of them will be in the vertical line through the center of the telescope.

After the instrument has been placed directly over some mark the telescope is withdrawn and there is inserted a plunger, the lower end of which is a point. The center of the instrument may be marked by the intersection of two strings at right angles drawn across the tripod head with their intersection at the point of the plunger; or small nails may be used to mark two lines approximately at right angles whose intersection is at the point of the plunger. These are only two of various methods which may be used to indicate on the tripod head the center of the vertical collimator.

When only a stand is used for mounting the theodolite, heliotrope, and lamp, the centering is done by means of a plummet.

Heliotropes and lamps.—The observations for the horizontal directions in the main scheme were made entirely on heliotropes and acetylene signal lamps. The heliotrope is of the box type and is shown in illustration No. 3b. The diameter of the fixed mirror is 2¾ inches (70 millimeters). The lamp is shown in illustration No. 3c. It is an ordinary automobile acetylene headlight fitted with a base which may be easily set up centrally over a triangulation station. One charge of calcium carbide will give a satisfactory light for about four hours.

LIGHT KEEPERS.

The plan of having the same men throughout all or a large part of a season and the method of directing them by heliographing with the Morse alphabet were first used on triangulation in the United States on the ninety-eighth meridian in 1902. (See pp. 826–829 of Appendix 4 of the Report for 1903.) Previous to that time it had been the custom to employ some one near a triangulation station to show the heliotrope and to attend to the signal lamp. A simple code of signals was sometimes used to indicate to the man that the work had been completed, but no systematic and elaborate method of signaling had been used, and serious delays were inevitable, as an officer would have to visit and post men at the new stations before the observations could proceed. The method of signaling by means of the Morse alphabet was used in guiding and directing a heliotroper by Prof. J. F. Hayford when he was the astronomer on the United States-Mexican Boundary Commission, and it was he who proposed its use in the 1902 work.

There are a number of causes which have contributed to the rapid progress made by the observing parties of the United States Coast and Geodetic Survey engaged on primary triangulation in recent years, but one of the most important is the trained corps of light keepers and the ease with which their movements can be directed and controlled by the observer with the aid of the signaling.

Six regular heliotropers (or light keepers) were used by each observing party on the one hundred and fourth meridian triangulation. Sometimes, in order to avoid delays, an additional light keeper was engaged for work at a single station, and in a few cases the driver of the observing party showed the heliotrope and lamp at a station. It was only occasionally that one of the stations to be observed on did not have a light keeper when the observer was ready to begin work.

Each light keeper's outfit consisted of a tent, bedding, a small number of cooking utensils, binoculars, signal lamp, heliotrope, prismatic compass, sketch of the triangulation, a few tools, and such other small articles of camp equipage as were deemed necessary. At some of the stations the light keepers were able to get their meals with a farmer or ranchman, but nearly always they prepared their own food. They made their moves between stations in farm wagons hired especially for the trip.

The light keepers posted their own lights and heliotropes during the entire season. At all stations occupied by the observer lines were accurately drawn on the light stand to each signal observed upon, and a light keeper following had simply to use these lines. The stations ahead of the observer had no lines laid out; consequently the light keepers had to use their ingenuity in finding the direction to the observer. This, however, did not prove very difficult, as each man was given a sketch of the reconnaissance, and by placing the sketch on the light stand and orienting it approximately by the magnetic meridian line as gotten by his compass he was enabled to locate at least one of the stations. He would then orient the sketch accurately over this direction and lightly mark on the stand the directions to all of the stations as given by the sketch. He would then begin showing to the observer. If he did not get lights from him in reply, he would swing his heliotrope or lamp through a small angle to each side of the approximate direction. (The term "light" will be used hereafter to indicate either the heliotrope or lamp.) As soon as the observer saw a light from one of the stations ahead he showed a steady light to enable the light keeper to get a correct line. Most of the forward lines were found at night, as the lamps would show over a wider angle than the heliotropes and were not affected by clouds.

A light keeper was usually able to find some object in the line to a station, such as a lone or high tree or a rock, by which he could post his heliotrope and also the lamp if put up before dark. This method was preferable to simply using the lines drawn on the light stand.

A man to be a good light keeper must have education enough to keep his accounts, but, what is more essential, he should have a practical turn of mind which will enable him to overcome difficulties and get his lights posted in spite of floods, breakdowns, etc.; of course it goes without saying that he must be conscientious and faithful. Unless a man shows the above qualities, it is not advisable to keep him in the party a longer time than is required to get another man.

SIGNAL CODE AND INSTRUCTIONS TO LIGHT KEEPERS.

In order to facilitate the work, written directions were given the light keepers, which included the Continental Morse alphabet, the code signals, and such other information as the light keepers might need in conducting their work. The signal code and instructions, as issued to the light keepers for the one hundred and fourth meridian triangulation, are as follows:

Continental Morse alphabet.—

A .—	J .———	S ...
B —...	K —.—	T —
C —.—.	L .—..	U ..—
D —..	M ——	V ...—
E .	N —.	W .——
F ..—.	O ———	X —..—
G ——.	P .——.	Y —.——
H	Q ——.—	Z ——..
I ..	R .—.	

The notations for numerals will be dispensed with and the numbers spelled out when required.

The Continental Morse differs from the American Morse in that there are no "spaces" between the elements of the letters.

Signaling.—Dots should be short, just long enough to permit the lights to be seen clearly.

Light should shine for dash about two seconds. Duration of darkness between elements of letters, one second.

Duration of darkness between letters, three seconds; duration of darkness between words, five seconds. If the lights are dim these periods may be somewhat louger. It is not important that these periods should be absolutely observed, but the relative proportion should be maintained.

The alphabet must be committed to memory; also, what is more difficult, all letters must be easily recognized by seeing or hearing their elements. Perfection in this matter will eliminate much trouble, as most of the difficulty is due to the receiver not being able to recognize a letter before the next one has begun.

Maintain a uniform speed in sending, for varying speeds make the receiviug of the message difficult.

Be careful that all light is cut off between elements of letters.

Do not use hand in signaling.

Cut the light off and on by quick movements.

BOX HELIOTROPE USED ON TRIANGULATION.

LARGE ACETYLENE SIGNAL LAMP USED ON TRIANGULATION.

An observer calls a light keeper by showing a steady light to him until answered.

A light keeper calls the observer by sending his own letter until answered.

Answer a call by a series of slow dots (not more than seven), then watch for the signal by aid of the binoculars. Repeat every few minutes until answered by observer.

Darken light before beginning message for a period of about 15 seconds.

All messages are to be repeated by the receiver, except in case of messages from light keeper to observer. Here the observer will answer by sending slow dots. Never repeat a word unless you are sure it is right. This is a decided annoyance to the observer and a source of a great deal of trouble. If an observer knows that a messago has not been received, he is at least in a position to know what to do to remedy matters.

Code signals.—A series of quick dots means, "I have made a mistake and will begin again."

An *A* means, "Wait a while."

A *G*, followed by the name of a station, means, "Get person at that station by calling him, and tell him where observer is."

An *N:* "Your light is too faint."

An *R:* "Repeat message; I could not get it."

A series of slow dots: "I understand your message."

An *M:* "Moderate your light; it is too strong."

Signals to be used by the observer when communicating with a light keeper.—*S T*, followed by name of station and date, means: "Stop showing light to this station; show to the station indicated on datc named, and look for observer's call."

S T, with no name of station, means: "Stop showing light to this station, and show light to the station to which observer goes, which is indicated in the written schedule of observer's moves, a copy of which has been furnished to you. If no date is given, show to new station at next observing period."

T H D: "Have finished on you for this afternoon (or night)."

D G, followed by name of station and date, means: "Done where you are; go to the station named, show light, and look for observer's call on date given."

D G, with no name, means: "Done where you are; go to the next station mentioned in your written schedule of moves, and show light to the observer at his old or new station, according to the schedule. If no date is given, begin showing light at first observing period after station is reached."

If the observer sends an "*A*" after 10.00 p. m., it means that the light keeper is to stay on the tower and keep a sharp lookout until called again. Should this be followed by an "*L*," it signifies that the light keeper is to recharge the lamp and leave the station for the night.

FINI: "Have finished on you; obey written instructions."

"Money," "Mail," etc., followed by name of place, means: "The article is at the place named."

Signals to be used by light keepers to observer.—"Money," "Carbide," etc., means: "I am in need of same."

Other necessary messages will be spelled out in full.

Keep a sharp lookout for signals for 10 minutes after each recharging of lamp and for 10 minutes after each hour and half hour.

N's may be sent any time if your light is poor.

Signals to be used by a light keeper to another light keeper.—*O*, followed by the name of a station, means: "Observer is at that station; show to him at once."

General considerations.—Before starting out alone be sure that some one of the party has taught you how to use the signal lamp and how to test and adjust a heliotrope and to put on the cut-off rings on the heliotrope and lamp.

Test your heliotrope and lamp so that the light goes to the observer, for the line through the sights may point to tho observer but the light may not be centered on him.

Every day, if necessary, see that your lamp drops water fast enough to give a strong light.

Keep your heliotrope and lamp in good condition. When the air is clear, a poor light possibly may be seen, but if it is hazy only a clean lamp and reflector will give good results. The carbide chamber should be cleaned as soon as possible after getting through using the lamp, as the metal is corroded if carbide is allowed to stand in it.

At every opportunity get the correct standard time and keep your watch within a few minutes of it.

The first thing to do when reaching a station is to try to locate all of the stations to which you will show. By doing this at the first opportunity, and not waiting for the exact moment that you expect your light to be used on a line, you will avoid causing delays to the observing party.

Whero smoke, clouds, and fog are encountered, the value of getting your pointings on the clear days is evident. After finding a station you should hold the direction to it by lines marked on the stand or by any other means practicable. When you are on a wooded peak and there has been a delay in seeing the observer's light, watch carefully for him, for the light might be obstructed close to your station and you might be able to see the call from the top of a tree or from some other point on the mountain. In other words, do not be absolutely sure that tho line is open unless you have seen a light from the other station, and unless you are sure keep trying to get tho observer's call by watching very closely.

When the observer's light is once seen, set your telescope on it and fasten or mark it so that you will know you havo the direction of the line even if the weather should become cloudy or smoky. Then point your heliotrope, using thin wedges if necessary to get the proper elevation, and mark the place on the stand where each wedge belongs and also mark the wedge to show how far it is to be pushed under the heliotrope; also mark along the side of the heliotrope box for the direction. Then you can replace your heliotrope exactly after it has been disturbed. The lamp may be set and pointed by the lines made for the heliotrope. When in trouble about the direction of the lines, always keep watching for calls from stations other than the observer's, for the observer may be sending a message to you through one of the other light keepers.

Your work on the tower begins at 1 p. m. From then until 4.30, unless instructed otherwise by the observer, you should show your heliotrope all the time if there is sun enough to make a shadow. If your heliotrope is pointed with care, a faint sun is just as good to show the observer as a bright sun on comparatively short lines; also, if you get only a faint sun every 10 minutes or so, which lasts for a short time, it may be used by the observer. It is not for you to decide whether you think it worth while, or whether the observer can use it or not. An effort will be made to send you *THD* as often as practicable.

At night go on the tower each hour and each half hour and look for signals from the observer, remaining 10 minutes each time. Begin doing this as soon as you have finished your evening meal.

At 11 p. m. begin sending slow dots (about 20 at a time) and remain on the lookout for signals for 15 minutes (until 11.15). If no signals are received, see that the light is burning well (recharging if desirable) and then you can leave the tower for the night.

Keep a lookout for the observer's call from his next station, as he may have moved without notifying you.

The lamp should be set up and lighted a half hour before sundown.

Be careful to sight your lamp and heliotrope accurately; if in doubt, send your initial, then the observer will show you a light.

Be extremely careful not to have lanterns or other extra lights about the tower. They are often mistaken for the signal lights by the observer. Frequently they can be seen at the foot of the tower as well as on the top.

When your line is 10 miles long, or less, watch for an *M*, meaning that your light is too strong and should be reduced by means of the concentric rings provided, or by paper rings cut out true.

Keep your tents, mess outfits, instruments, and other articles of equipment clean and in order.

It should be remembered that the towers are built with the least material required for safety; that the signal notices apply to light keepers as well as to other people, and therefore you should in no way weaken the scaffold by removing any of its parts.

An extra effort should be made to move between stations as rapidly as possible to prevent holding back the observing party longer than is necessary.

So much depends upon the efficiency and faithfulness of the light keeper that an indifferent one must be disposed of as soon as convenient.

Light keepers' accounts.—Each light keeper was given in writing detailed directions for making out his accounts, for shipping by freight or express, and he was also given copies of the various kinds of bills, receipted, of which he might have need in his accounting.

In addition to the sketches showing the scheme of triangulation as located by the reconnoissance party, the light keepers were given descriptions of the stations which enabled them to move from one station to another. They were given lists of the triangulation stations in the order in which they would be occupied by the observer and each light keeper was also given a statement of his own moves and for each of his stations the line or lines over which he was to show a light. This information was tabulated in the following form:

Schedule of moves for observer and light keepers.

Observer.	Light keeper "B."	Light keeper "D."	Light keeper "H."	Light keeper "K."	Light keeper "P."	Light keeper "V."	Light keeper (extra).
Haystack	Rawhide	Hobbs	Willow	Coleman	Notch	Chugwater	
Coleman	Haystack	do	do	do	do	do	
Notch	do	Whitaker	Ragged	do	do	do	
Chugwater	do	do	do	do	do	do	
Whitaker	Wadill	do	do	Greentop	do	do	
Ragged	do	do	do	do	do	do	

Each light keeper was assigned a letter so chosen as not to be identical with or similar to any of the code letters. The stations which each light keeper was to occupy in succession were shown in the vertical column under his letter, while the location of the observer and the various light keepers at any time were shown in the horizontal lines. Thus, when the observing party was at Haystack, light keeper "B" was at Rawhide, "D" at Hobbs, etc., and when the observer moved to Coleman, "B" moved to Haystack, and the other light keepers kept their stations.

By arranging the schedule carefully with regard to the time required for the various moves it was nearly always possible to adhere closely to the prearranged plan of operation.

OBSERVATIONS FOR HORIZONTAL DIRECTIONS.

Two observing parties, under Assistants E. H. Pagenhart and C. V. Hodgson, completed all of the observations for horizontal directions in one season, extending from the spring to the autumn of 1912. The actual days on which observations for horizontal directions were made are shown in the tables on pages 38 and 39.

Each party was organized practically in the same manner as the observing party of the season of 1908–9 on the Texas-California arc of primary triangulation except that each had a second officer. Assistant C. M. Cade was with Mr. Hodgson during the whole season and for a part of the time conducted a second observing party under his direction. Assistant T. L. Warner was in the party of Mr. Pagenhart from the beginning of the season until September 28, 1912. Besides the chief of party and his assistant, there were in each observing party a teamster and a recorder. They lived in tents and carried a small mess outfit, cooking their food over an open fire.

Each party had a freight wagon and a light spring wagon, each drawn by two horses or mules, for transporting the instruments and camp equipage from station to station.

A number of the stations occupied by Mr. Hodgson were on mountain peaks to which the instruments and observing tent were carried by pack animals. This was the case also for several of the stations occupied by Mr. Pagenhart.

GENERAL INSTRUCTIONS TO OBSERVERS ON PRIMARY TRIANGULATION.

There are given below the general instructions to chiefs of the observing parties on primary triangulation, under which practically all of the primary triangulation in the United States has been done in recent years. They were approved by the Superintendent of the United States Coast and Geodetic Survey in 1905, upon the recommendation of Prof. John F. Hayford, at that time inspector of geodetic work in the survey. The general instructions were first printed on pages 170–174 of Appendix 4 of the report for 1911. The observers on the one hundred and fourth meridian triangulation worked under these instructions.

1. *Instruments.*—In general, direction instruments of the highest grade should be used in triangulation of this class. Repeating theodolites are to be used only when the station to be occupied is in such a position as to be difficult of occupation with a direction instrument or when there is doubt of the instrument support being of such a character as to insure that the movement of the observer about the instrument does not disturb it in azimuth. Such stations usually occur on lighthouses and buildings.

2. *Number of observations—Main scheme—Direction instrument.*—In making the measurements of horizontal directions measure each direction in the primary scheme 16 times, a direct and reverse reading being considered one measurement, and 16 positions of the circle arc to be used, corresponding approximately to the following readings upon the initial signal:

Number.	Reading.	Number.	Reading.
	° ′ ″		° ′ ″
1	0 00 40	9	128 00 40
2	15 01 50	10	143 01 50
3	30 03 10	11	158 03 10
4	45 04 20	12	173 04 20
5	64 00 40	13	192 00 40
6	79 01 50	14	207 01 50
7	94 03 10	15	222 03 10
8	109 04 20	16	237 04 20

3. When a broken series is observed, the missing signals are to be observed later in connection with the chosen initial or with some other one, and only one, of the stations already observed in that series. With this system of observing no local adjustment is necessary. Little time should be spent in waiting for the doubtful signal to show. If it is not showing within, say, one minute of when wanted, pass to the next. A saving of time results from observing many or all of the signals in each series, provided there are no long waits for signals to show, but not otherwise.

4. *Standard of accuracy.*—In selecting the conditions under which to observe primary directions, proceed upon the assumption that the maximum speed consistent with the requirement that the closing error of a single triangle in the primary scheme shall seldom exceed three seconds, and that the average closing error shall be but little greater than one second, is what is desired rather than a greater accuracy than that indicated with slower progress. This standard of accuracy used in connection with other portions of these instructions defining the necessary strength of figures and frequency of bases will in general insure that the probable error of any base line, as computed from an

adjacent base, is about 1 part in 88 000, and that the actual discrepancy between bases is always less than 1 part in 25 000.

5. *Rejections—Direction observations.*—The limit for rejection of observations upon directions in the main scheme shall be 5 seconds from the mean. No observation agreeing with the mean within this limit is to be rejected unless the rejection is made at the time of taking the observation and for some other reason than simply that the residual is large. A new observation is to be substituted for the rejected one before leaving the station, if possible without much delay.

6. *Number of observations—Supplementary stations—Direction instrument.*—In observing upon supplementary stations and in observing from supplementary stations upon stations in the main scheme, four measures of the character outlined above shall be made of each direction, using the circle in the first four positions stated in that paragraph. A supplementary station is one which is not in the main scheme, but which is observed upon or from which observations are taken for the purpose of connecting with stations which can not be effectively reached from the stations in the main scheme and with which a connection is required by specific instructions.

7. *Number of observations—Intersection stations—Direction instrument.*—An intersection station is a station of which the position is determined by intersections from stations of the main scheme or supplementary stations and which is not occupied. One such measure as is outlined on page 35 shall be made of each direction to each intersection station. A second such measure shall be made if it can be secured under conditions nearly as favorable to accuracy as were the conditions when the first measure was made and without much delay to observations in the main scheme. Each series of observations on intersection stations is to contain some one, and only one, of the main scheme or supplementary stations. It is important to have at least three lines to each intersection station in order to secure a check, but a possible intersection station should not be neglected simply because only two lines to it can be secured.

8. *Observing—Supplementary and intersection stations.*—Observations upon and from supplementary stations and observations upon intersection stations may be taken under any atmospheric conditions whenever the object to be pointed upon is visible and no delay is likely to be made to secure good seeing before observing.

9. *Land section corners and other survey marks.*—Whenever it is feasible to do so without incurring undue expense and delay, the section corners established by the United States Land Survey, and survey marks of any kind found upon the ground, shall be connected with the triangulation either by direct measurement of a distance and direction from a station or by using them as intersection stations.

10. *Value of intersection stations.*—In selecting intersection stations it should be kept in mind that the geographic value of a piece of triangulation depends upon the number of points determined, the size of the area over which they are distributed, and the permanence with which they are marked. The geographic value of the triangulation is lost for a given area when points can not be recovered within that area. The chance of permanency is increased by increasing the number of points as well as by thorough marking. These considerations should lead to the determination as intersection stations of many artificial objects of a permanent character, such as lighthouses, church spires, cupolas, towers, and large chimneys; should lead occasionally to the determination of specially marked stations established for this particular purpose; and should frequently lead to the permanent marking upon the ground of topographic or hydrographic stations and their determination as intersection stations. The practice of permanently marking such hydrographic points as are in commanding positions—on promontories, for example—and which are so situated that the station is not likely to disappear if permanently marked (on firm ground not likely to be washed away or on rocks), and determining their positions as intersection stations will frequently obviate the necessity which would otherwise exist for new triangulation when a later hydrographic survey is made. It is especially desirable to increase the area effectively covered for geographic purposes by selecting intersection stations which are outside the area covered by the main scheme.

11. *Vertical measures in main scheme.*—At each station in the main scheme vertical measures are to be made over all lines in the main scheme radiating from it. These vertical measures should be made on as many days as possible during the occupation of the station, but in no case should the occupation of the station be prolonged in order to secure such measures. Three measures, each with the telescope in both the direct and the reversed positions, on each day, are all that are required. These measures may be made at any time between 11.00 a. m. and 4.30 p. m., except that in no case should primary vertical measures be made within one hour of sunset. It is desirable, however, with a view of avoiding errors due to diurnal variation of refraction, to have a fixed habit of observing the verticals in the main scheme at a certain hour, as, for example, between 2 and 3 p. m. If the vertical measures at a station are made by the micrometric method, double zenith distance measures shall be made on at least two of the lines radiating from that station.

12. *Vertical measures—Supplementary and intersection stations.*—In addition to the vertical measures required in the main scheme, vertical measures must be made at each station, whether in the main scheme or supplementary, over every line of which the horizontal direction is measured. Three measures each with the telescope in both the direct and reverse positions are all that are required on all lines to or from supplementary or intersection stations, except when the observations upon such stations are made for the purpose of connecting with bench marks of which the elevations are fixed by precise leveling or tidal observations. In the latter case observations should be made on as many days as possible during the occupation of the station, but in no case should the occupation of a station be prolonged in order to obtain measures. Also, in the latter case, the vertical observations are to be made in both directions over every line more than 5 kilometers long, even though horizontal measures may be necessary in but one direction over the line.

13. *Marking of stations.*—Every station, whether it is in the main scheme or is a supplementary or intersection station, which is not in itself a permanent mark, as are lighthouses, church spires, cupolas, towers, large chimneys, sharp peaks, etc., shall be marked in a permanent manner. At least one reference mark of a permanent character shall be established not less than 10 meters from each station of the main scheme and accurately referred to it by a distance and direction. Such reference marks shall preferably be established on fence or property lines, and always in a locality chosen to avoid disturbance by cultivation, erosion, or building. It is desirable to establish such reference marks at all marked stations. At all stations where digging is feasible both underground and surface marks which are not in contact with each other shall be established. Wood is not to be used in permanent marks.

14. *Descriptions of stations.*—Descriptions shall be furnished of all marked stations. For each station which is in itself a mark, as are lighthouses, church spires, cupolas, towers, large chimneys, sharp peaks, etc., either a description must be furnished, or the records, lists of directions, and lists of positions must be made to show clearly in connection with each point by special words or phrases if necessary the exact point of the structure or object to which the horizontal and vertical measures refer. Every land section corner connected with the triangulation must be fully described. The purpose of the description is to enable one who is unfamiliar with the locality to find the exact point determined as the station and to know positively that he has found it. Nothing should be put into the description that does not serve this purpose. A sketch accompanying the description should not be used as a substitute for words. All essential facts which can be stated in words should be so stated, even though they are also shown in the sketch.

15. *Abstracts and duplicates.*—The field abstracts of horizontal directions and vertical measures are to be kept up and checked as the work progresses, and all notes as to eccentricities of signals or instrument, of height of point observed above ground, etc., which are necessary to enable the computation to be made, are to be incorporated in the abstracts. As soon as each volume of the original record has been fully abstracted and the abstracts checked, it is to be sent to the Office, the corresponding abstracts being retained by the observer. A duplicate of the description of stations is to be made. If the original descriptions of stations are written in the record books, a copy of these descriptions compiled in a separate book may be considered the duplicate and should then be marked as such. A duplicate of the miscellaneous notes mentioned above may also be made if considered desirable. No other duplicates of the original records are to be made. Pencil originals should not be inked over.

16. *Number of observations—Main scheme—Repeating theodolite.*—If a repeating theodolite is used for observations in the main scheme, corresponding to those indicated in paragraph 2, make the observations in sets of six repetitions each. For each angle measured follow each set of six repetitions upon an angle with the telescope in the direct position immediately by a similar set of six on the explement of the angle with the telescope in the reversed position. It is not necessary to reverse the telescope during any set of six. Make the total number of sets of six repetitions on each angle ten—five directly on the angle and five on its explement. Measure only the single angles between adjacent lines of the primary scheme and the angle necessary to close the horizon. With this scheme of observing no local adjustment is necessary, except to distribute the horizon closure uniformly among the angles measured. The limit of rejection corresponding to that stated in paragraph 5 shall be for a set of six repetitions 4″ from the mean.

17. *Number of observations—Supplementary stations—Repeating theodolite.*—If the observations at a supplementary station or upon a supplementary station, corresponding to those indicated in paragraph 6, are made with a repeater, our sets of six repetitions each should be made, two directly upon each angle with the telescope in the direct position and two upon its explement with the telescope in the reversed position. No measures introducing station conditions other than closure of horizon are to be made upon or at supplementary stations.

18. *Number of observations on intersection stations—Repeating theodolite.*—If the observations upon intersection stations, corresponding to those indicated in paragraph 7, are made with a repeater, two sets of three repetitions each should be made, one directly upon an angle with the telescope in the direct position and one upon its explement with the telescope in the reversed position. Fix the direction to each intersection station by measuring the angle between it and some line in the main scheme or to a supplementary station. No measurements introducing conditions are to be made.

19. *Field computations.*—The field computations are to be carried to hundredths of seconds in the angles, azimuths, latitudes, and longitudes, and to seven places in the logarithms. The field computation may be stopped with the completion of the lists of directions for all stations and objects, and the triangle side computation for the main scheme and supplementary stations, unless there are special reasons for carrying it further. The computation to this point should be kept up as closely as possible as the work progresses to enable the observer to know that the observations are of the required degree of accuracy. No least square adjustments are to be made in the field. All of the computation, taking of means, etc., which is done in the record books and the lists of directions should be so thoroughly checked by some person other than the one who originally did it as to make it unnecessary to examine it in the Office. The initials of the person making and checking the computations in the record books and the lists of directions should be signed to the record as the computation and checking progress.

METHODS OF OBSERVING EMPLOYED.

All the angle measures were made by the direction method, using the 12-inch (30-centimeter) theodolites which had been made in the Instrument Division of the Survey and which are described on page 30.

The telescope of the theodolite has two parallel vertical wires, about 20 seconds apart, for making the pointings for horizontal angles. The results from a number of seasons' work indicate that this arrangement of the wires in the telescope is more satisfactory than either the single vertical wire or the oblique cross. The double wire is especially effective when the image of the light or heliotrope is large and unsteady.

The theodolites used on the one hundred and fourth meridian primary triangulation had two pairs of lines, about four minutes apart, in the micrometer microscope. This arrangement saved much time, for, when a reading backward or forward was made by placing one pair of lines on a five-minute graduation of the circle, then the other pair of lines would have to be moved through the space of only one minute to bring it in contact with a second graduation to make the forward or backward reading.

The readings upon the initial signal were so selected that the mean value of any angle is practically free from errors due to periodic errors of graduation and is almost entirely free from the effects of the run of the micrometers. However, the micrometer microscopes were adjusted whenever tests showed that the mean run of the three was more than one second for a five-minute space or when any one micrometer microscope had a run greater than three seconds.

PROGRAM OF OCCUPATION OF STATIONS, ONE HUNDRED AND FOURTH MERIDIAN.

In the following tables the stations occupied during 1912 by each of the observers are arranged in the chronological order in which the observations were made. The second column indicates the days on which observations on the primary stations were taken, and the third column gives the number of dates at each station on which primary horizontal directions were observed.

In the party of Mr. Hodgson there was a second observing party in charge of Assistant C. M. Cade, from September 4 to November 24, 1912. During part of this period the first observing party (Mr. Hodgson, observer) was engaged in revising the reconnoissance at the southern end of the scheme and in measuring the Provo base line.

Several stations were reoccupied in order to strengthen the angles of some of the triangles. The reoccupied stations are shown by a reference to a footnote in the tables below.

Mr. Pagenhart's party, working south from the Canadian boundary, suffered no interruptions, as the Ambrose base was measured before observing began. He had only one observing party under him.

Stations occupied.

Assistant E. H. PAGENHART, Chief of Party and Observer; Season of 1912.

Station.	Days on which observations of primary horizontal directions were made.	Total days.	Station.	Days on which observations of primary horizontal directions were made.	Total days.
Ambrose northeast base	May 28, 29	2	Bonetraill	June 27	1
Ambrose southwest base	May 29, 31; June 1, 3	4	Marmon	June 28	1
Bowie [1]	June 4, 5, 17	3	Williston	July 6, 8, 9	3
Norge	June 10, 11	2	Bull	July 10, 11	2
Ambrose	June 12	1	Snake	July 12	1
Crosby	June 13, 15	2	Bainville	July 13	1
Stady	June 18	1	Lanark	July 15	1
Muddy [1]	June 19, 29	2	Buford	July 17, 18, 19	3
Howard [1]	June 20, 21; July 1, 2	4	Montana	July 20, 22, 23	3
Gladys	June 24	1	Mondak	July 24, 25, 27	3

Assistant E. H. PAGENHART, Chief of Party; Assistant T. L. WARNER, Observer; Season of 1912.

Ferry	July 30	1	Cook	Aug. 23, 24	2
Cut-off	July 31; Aug. 1	2	Hump	Aug. 26	1
Jackson	Aug. 2, 3, 5	3	Sentinel	Aug. 29, 30	2
Lovering	Aug. 6, 8, 9	3	Saddle	Sept. 2, 3, 4	3
Sheep	Aug. 10, 12	2	Badland	Sept. 6	1
Flat	Aug. 13	1	Rainy	Sept. 9, 10	2
Trotter	Aug. 15	1	Black	Sept. 12	1
Blue	Aug. 17, 20, 21	3	Butte	Sept. 16, 17	2

[1] This station was reoccupied.

Stations occupied—Continued.

Assistant E. H. PAGENHART, Chief of Party and Observer; Season of 1912.

Station.	Days on which observations of primary horizontal directions were made.	Total days.	Station.	Days on which observations of primary horizontal directions were made.	Total days.
Whetstone[1]	Sept. 24, 25, 26	3	Wymonkota	Oct. 20, 21, 22	3
Lodge	Sept. 29, 30	2	Terry	Oct. 26, 29	2
Table	Oct. 2	1	Sundance	Nov. 4, 5	2
Reva	Oct. 7, 8	2	Inyankara	Nov. 8	1
Harding	Oct. 10, 11	2	Laird	Nov. 12, 13	2
Moreau	Oct. 12	1	Alkali[2]	Nov. 21	1
Castle	Oct. 14, 15, 16	3			

Assistant C. V. HODGSON, Chief of Party and Observer; Season of 1912.

Station.	Days on which observations of primary horizontal directions were made.	Total days.	Station.	Days on which observations of primary horizontal directions were made.	Total days.
Haystack[3]	May 14, 15, 16, 17	4	Brighton[3]	Aug. 5, 6, 8[5]	3
Coleman	May 21, 22	2	Watkins astronomic	Aug. 10	1
Notch[3]	May 25, 28	2	Indian[5]	Aug. 15, 16, 17, 18; Sept. 20	5
Chugwater[3]	May 31; June 1	2	Morrison[3]	Aug. 19, 20, 21, 22, 23; Sept. 23, 25, 26, 27, 30.[4]	10
Ragged[3]	June 4, 5, 7	3			
Whitaker[3]	June 10, 11, 12; Nov. 21[4]	4	Hilltop	Sept. 6, 7, 8, 10, 12, 16[5]	6
Wadill[3]	June 11, 15, 17; July 2, 7[4]	5	Douglas	Sept. 17, 18	2
Russell[5]	June 21	1	Willow	Oct. 15, 16, 18	3
Twin[3]	June 24, 25, 26	3	Manville	Oct. 19, 20, 21	3
Warren[3]	June 28, 29; July 1	3	Cottonwood	Oct. 27, 29	2
Dewey	July 9, 11, 13, 16, 19	5	Sullivan	Nov. 1	1
Horsetooth	July 22, 23	2	Elk	Nov. 4, 5, 8	3
Boulder[3]	July 27, 29; Aug. 2	3	Cambria	Nov. 10, 11, 12, 14	4

Assistant C. V. HODGSON, Chief of Party; Assistant C. M. CADE, Observer; Season of 1912.

Station.	Days on which observations of primary horizontal directions were made.	Total days.	Station.	Days on which observations of primary horizontal directions were made.	Total days.
Greentop[4]	June 19, 20; Nov. 22	3	Kirtley	Oct. 19, 20	2
Brighton[3]	Aug. 28	1	Provo east base	Oct. 24	1
Indian[6]	Aug. 29, 31	2	Provo astronomic	Oct. 25	1
Pikes Peak	Sept. 16, 17, 18	3	Provo west base	Oct. 26	1
Divide[4]	Sept. 22, 23, 24, 25; Oct. 4, 5	6	Parker	Oct. 28, 29, 31; Nov. 1, 2	5
Elbert	Sept. 26, 27, 30	3	Alkali	Nov. 5, 6	2
Hilltop[3]	Oct. 1, 2, 3	3	Crow	Nov. 13, 14	2
Hobbs	Oct. 14, 15	2	Russell[6]	Nov. 21	1
Rawhide	Oct. 16	1			

[1] At this station some of the observations were made by Assistant T. L. Warner.
[2] This is a reoccupation of station Alkali. The first occupation was by Assistant C. M. Cade.
[3] At this station some of the observations were made by Assistant C. M. Cade while with Mr. Hodgson's observing party.
[4] This station was reoccupied.
[5] This station was also occupied by Assistant C. M. Cade while in charge of a second observing party.
[6] This station was also occupied by Mr. Hodgson.

CONNECTIONS MADE BETWEEN THE ONE HUNDRED AND FOURTH MERIDIAN TRIANGULATION AND STATIONS AND MONUMENTS OF OTHER SURVEYS.

The one hundred and fourth meridian are started from Pikes Peak and Divide, two stations of the thirty-ninth parallel primary triangulation.

Stations or monuments of the following organizations were connected with the triangulation stations on the one hundred and fourth meridian are:

- The United States Geological Survey;
- The Missouri River Commission;
- The General Land Office;
- The United States and Canada Boundary Commission.

Connections were also made with monuments of the following boundaries between States:

- Colorado and Wyoming boundary;
- Wyoming and Nebraska boundary;
- South Dakota and Nebraska boundary;
- South Dakota and Wyoming boundary;
- North Dakota and South Dakota boundary;
- North Dakota and Montana boundary;
- Northeast corner of Wyoming;
- Southeast corner of Montana.

The connections were made by having the stations identical, by connections by subsidiary stations or by an observed direction and a direct measurement.

The data in regard to these connections may be found by consulting the index and illustrations at the end of the report, and the table of geographic positions and the descriptions which begin on pages 88 and 115, respectively.

The bench marks connected with the one hundred and fourth meridian triangulation for the purpose of controlling the elevations determined by trigonometric leveling are referred to on page 141 and 145, under the heading, "Computation, adjustment, and accuracy of the elevations."

CONNECTIONS MADE BETWEEN THE THIRTY-NINTH PARALLEL TRIANGULATION AND STATIONS AND MONUMENTS OF OTHER SURVEYS.

The United States Geological Survey, and no doubt other organizations which have carried on surveys in Colorado, Utah, and Nevada, have connected their work with the stations of the thirty-ninth parallel triangulation. At the time the triangulation of the Coast and Geodetic Survey was done in those States, the other organizations of the Government had not carried on very extensive operations in them. Several connections were made, however, between the stations of the thirty-ninth parallel triangulation, at the time they were established, and stations of the United States Geological Survey and the General Land Office. Monuments of the Colorado-Utah and the Utah-Nevada boundaries were also connected with the triangulation. The geographic positions of the stations of other organizations and of the state boundary monuments are given in the table beginning on page 88. The index of stations and the sketches should also be consulted.

The bench marks connected with the thirty-ninth parallel triangulation for the purpose of controlling the elevations determined by trigonometric leveling are referred to on page 145, under the heading "Computation, adjustment, and accuracy of the elevations."

STATEMENT OF COSTS.

The following table gives a statement of the cost of the triangulation along the one hundred and fourth meridian for each of the two observing parties, and also the cost of the entire work. For comparison and for use in estimating the cost of future work, there are given similar data for the primary triangulation on the ninety-eighth meridian, done later than 1901, and on the Texas-California arc.

Name of observer or arc.	Months of observations.	Primary stations occupied.	Stations occupied per month.	Total field expenses.	Cost per station occupied.	Total points determined.	Cost per point determined.	Miles of progress.	Cost per mile of progress.	Area in main scheme in square miles.	Cost per square mile.
E. H. Pagenhart	5.5	49	8.9	[1] $13 550	$277	87	$156	330	$41	7800	$1.74
C. V. Hodgson	8.2	33	4.0	[1] 15 300	464	80	191	390	39	9200	1.66
Total arc, one hundred and fourth meridian	13.7	.82	6.0	[1] 28 850	352	167	173	720	40	17 000	1.70
Ninety-eighth meridian triangulation after 1901	30.5	265	8.6	78 187	293	849	109	1329	63	21 655	5.19
Texas-California arc	16.7	94	5.6	38 384	408	262	147	1207	32	49 220	0.78

[1] These amounts include the costs of measuring the Provo and Ambroso bases. (See pp. 13 and 15.)

During about two and one-half months there were two observers in Mr. Hodgson's party. The number of months of observations given in the table for that party is the sum of the times of the two observers. The observations were made by that party between May 14 and November 23, 1912. The time this party was engaged on revision of reconnoissance and the measurement of the Provo base line is not included in the number of months of observing.

There was no interruption to the work of Assistant Pagenhart's single observing party, as he had measured the Ambrose base line before observations were begun on the triangulation.

To make the ninety-eighth meridian triangulation comparable with the work of the other two arcs, 9.3 months should be added to the number of months of observation, for during that time there were two observers at work under one chief of party. Then the total observing period would be 39.8 months, and the stations occupied per month would be 6.7.

The total expenses include the cost of preparing and marking the stations and all salaries, but not the cost of the reconnoissance.

The cost per mile of progress, which the writer believes is the fairest unit for comparison, is practically the same for the two parties—$41 for Mr. Pagenhart and $39 for Mr. Hodgson. In Mr. Pagenhart's party there was only one observer, while in that of Mr. Hodgson's there was one observer for about half the season and two observers for the other half.

The cost per mile of progress is only about 60 per cent of that of the ninety-eighth meridian triangulation after 1901, but it is 25 per cent greater than the cost per mile of the Texas-California arc. The cost of the building on the one hundred and fourth meridian triangulation was much less than that on the ninety-eighth meridian triangulation and only slightly less than the building on the Texas-California arc. The weather conditions on the one hundred and fourth meridian were not so favorable on an average as those on the Texas-California arc. Considering the fact that no one of the observers on the one hundred and fourth meridian triangulation had ever done primary triangulation previously, it must be concluded that the work was done in a remarkably rapid and efficient manner. The completion of a continuous arc of primary triangulation 720 miles (1159 kilometers) in length during one summer is an exceptional and noteworthy performance.

There were 8 subsidiary stations occupied by Mr. Pagenhart and 12 such stations occupied by Mr. Hodgson which have not been classed as occupied stations in the above table. At each of these stations the amount of observing was much less than at a primary station, and as a rule the additional time required in traveling for a subsidiary station was not so much as for a primary station. It would seem to be advisable, therefore, to give a weight of one-half to the subsidiary stations and then obtain the rates of progress and the costs per stations occupied, which are given below.

Name of observer.	Months of observations.	Primary stations occupied.	Stations occupied per month.	Total field expenses.	Cost per station occupied.
E. H. Pagenhart	5.5	53	9.6	$13 550	$256
C. V. Hodgson	8.2	39	4.8	15 300	392

The following is a summary of the costs of the primary triangulation and other geodetic work on the one hundred and fourth meridian:

Reconnoissance	$2000
Observing, building signals, marking stations, observing azimuths, and measuring the Ambrose and Provo bases	28 850
Base measurements at El Paso and Cheyenne in 1913	980
Determinations of 5 astronomic longitudes	2100
Determinations of 25 astronomic latitudes	4970
Computation and adjustment of triangulation and astronomic observations at the office	3200
Total	42 100

Included in the above are all traveling expenses and salaries connected with the field and office work, except the salary of the Inspector of Geodetic Work. There is also included the entire cost ($2935) of the automobile truck, although that truck was in good condition at the end of the season and will be used for future geodetic work.

STATEMENT OF ADJUSTMENTS.

No local adjustments were made, these having become unnecessary since the adoption of the present method of supplying missing observations in broken series.[1]

The remeasurement of the El Paso base and the adoption of a new value for its length (differing one part in 59 000) made the problem of adjustment a difficult one. The one hundred

[1] See U. S. Coast and Geodetic Survey Report for 1911, Appendix 4, p. 171.

and fourth meridian triangulation starts from the line Pikes Peak-Divide adjoining the El Paso base net which had been fully adjusted as reported in Special Publication No. 4, pages 101–114.

The length discrepancies developed in the triangulation along the thirty-ninth parallel assembled on page 614 of Special Publication No. 4 disclosed the fact that the lengths in the El Paso base net were too long by 85 in the seventh decimal place of logarithms (one part in 51 000) when compared with the Salt Lake base and also too long by 92 in the seventh decimal place of logarithms (one part in 47 000) when compared with the Salina base to the eastward. This not only strengthened the decision to adopt the new measured length for the El Paso base but also made necessary a readjustment of the triangles in and adjoining the El Paso base net to distribute this length change without changing the standard positions along the parallel to the east and west for any very great distance.

It was determined to readjust the triangulation of the thirty-ninth parallel from the line Arapahoe-Monotony near the Colorado-Kansas boundary to the line Tushar-Mount Nebo of the Nevada-California series, adjoining the Salt Lake base net. The geodetic positions already adopted for these two lines were held fixed and by means of one adjustment the 191 conditional or observation equations relating to the one hundred and fourth meridian were combined with the 14 equations of the El Paso base net,[1] the 28 observation equations of the Rocky Mountain series,[2] 27 of the observation equations of the Kansas-Colorado series,[3] 2 azimuth equations, 1 latitude equation and 1 longitude equation. The last-mentioned two and one of the azimuth equations were necessary to hold fixed the standard positions at the east and west ends of this section of the thirty-ninth parallel. The extra azimuth equation was necessitated by the introduction of the Laplace azimuth as the true geodetic azimuth at station Watkins. The total number of normal equations solved was 264.

Three Laplace azimuths were computed and adopted at stations Watkins astronomic, Provo astronomic, and Mondak. The introduction of these into the adjustment made two other azimuth equations necessary.

The fixed lengths in the adjustment were six, viz., the line Arapahoe-Monotony, with its length as adjusted in the thirty-ninth parallel;[4] the El Paso base; the line Tushar-Mount Nebo, with its length as ajusted in the Nevada series of the thirty-ninth parallel;[5] the Cheyenne base; the Provo base; and the Ambrose base.

ABSTRACT OF HORIZONTAL DIRECTIONS AND ELEVATION OF TELESCOPE ABOVE THE STATION MARK.

All observed directions in the one hundred and fourth meridian triangulation have been given equal or unit weight. Those directions were reduced to center where either the instrument or the object observed was not coincident with the center of the station mark.

The horizontal directions are all reduced to sea level. The correction expressed in seconds is given by

$$\frac{e^2 h \sin 2\alpha \cos^2\phi}{2\,\rho \sin 1''}$$

where $e^2 = \frac{(a^2-b^2)}{a^2}$, h = height of station sighted, ρ = the radius of curvature in a plane normal to the meridian, ϕ = the latitude, and α = the azimuth counted from the south westward.

In the following table are also given the elevations of the telescope of the theodolite above the station mark at each of the primary stations of the one hundred and fourth meridian and at those primary stations of the thirty-ninth parallel where the data were available. These elevations enable the reader to judge of the amount of building done and they permit the engineer or surveyor who uses the stations to form an estimate of the probable amount of building required to make any particular line clear.

The abstracts of horizontal directions and the condition equations in the thirty-ninth parallel triangulation are reprinted, but the numbers assigned to the directions were preserved. The table of corrections to the observed directions enables the reader to compare directly with the corresponding corrections in the original adjustment.

[1] See Special Publication No. 4, pp. 110–111.
[2] Ibid., pp. 560–563.
[3] Ibid., pp. 527–539.
[4] Ibid., p. 548.
[5] Ibid., p. 591.

Station occupied and elevation of instrument above station mark.	Number of direction.	Object observed.	Observed direction reduced to sea level.	Final seconds after figure adjustment.
			° ′ ″	″
Arapahoe, 12.68 meters.	154	First View	0 00 59.98	59.80
	155	Cheyenne Wells	33 03 37.83	37.56
	......	Monotony	60 41 14.87	14.70
	......	McLane	106 32 46.02	46.33
	......	Curlew	158 31 39.74	40.21
Monotony, 12.68 meters.	......	McLane	0 00 00.00	59.71
	......	Curlew	27 57 07.25	06.76
	......	Arapahoe	66 02 45.24	45.29
	162	First View	135 50 58.10	58.84
	163	Cheyenne Wells	147 15 48.65	48.08
	164	Landsman	163 46 19.23	19.41
Cheyenne Wells	165	Monotony	0 00 00.08	00.11
	166	Arapahoe	71 09 20.69	21.44
	167	First View	160 18 22.37	22.46
	168	Landsman	212 27 29.72	28.83
First View, 9.62 meters.	169	Kit Carson	0 00 00.06	59.97
	170	Eureka	57 33 37.39	37.40
	171	Landsman	99 35 36.20	36.84
	172	Cheyenne Wells	147 25 30.46	29.94
	173	Monotony	155 42 18.79	18.64
	174	Arapahoe	205 12 52.89	52.99
Landsman	175	Monotony	0 00 00.05	59.79
	176	Cheyenne Wells	15 56 56.61	57.53
	177	First View	95 57 59.24	58.76
	178	Kit Carson	148 12 39.99	39.74
	179	Eureka	205 13 38.86	38.92
Kit Carson, 2.11 meters.	180	Aroya	0 00 59.93	59.38
	181	Overland	32 24 48.48	48.96
	182	Eureka	67 39 53.21	53.05
	183	Landsman	108 58 51.12	51.09
	184	First View	137 08 34.21	34.49
Eureka, 1.90 meters.	185	Landsman	0 00 59.97	00.26
	186	First View	28 42 22.12	21.66
	187	Kit Carson	81 40 04.71	04.89
	188	Aroya	137 13 18.52	18.82
	189	Overland	186 32 02.17	01.87
Aroya, 1.90 meters.	190	Adobe	0 00 00.08	00.51
	191	Hugo	69 40 19.90	18.93
	192	Overland	115 08 24.66	24.74
	193	Eureka	167 53 52.18	52.15
	194	Kit Carson	224 40 46.23	46.72
Overland, 1.75 meters.	......	Azimuth mark	0 00 00.00	....
	195	Eureka	104 10 37.47	37.68
	196	Kit Carson	144 03 38.94	38.68
	197	Aroya	182 06 29.09	29.01
	198	Adobe	219 50 30.24	30.23
	199	Hugo	277 58 13.86	14.00
Hugo, 1.91 meters.	200	Overland	0 00 59.97	59.88
	201	Aroya	38 40 10.21	11.06
	202	Adobe	86 51 30.29	30.08
	203	Square Bluffs	130 05 35.37	34.96
	204	Holt	166 31 20.55	20.43
Adobe, 5.61 meters.	......	Mark	0 00 00.00	....
	207	Hugo	4 35 07.30	06.97
	208	Overland	39 35 56.52	56.36
	209	Aroya	66 43 33.19	33.03
	205	Cramer Gulch	254 09 13.06	12.44
	206	Square Bluffs	309 09 14.59	15.87
Square Bluffs, 1.88 meters.	210	Holt	0 00 59.89	59.55
	211	Hugo	78 24 58.62	59.92
	212	Adobe	159 45 07.59	06.78
	213	Cramer Gulch	228 06 18.44	18.60
	214	Big Springs	284 02 36.32	36.42
	215	Holcolm Hills	322 24 10.03	09.63
Holt, 1.83 meters.	216	Hugo	0 00 00.02	59.45
	217	Square Bluffs	65 09 15.48	15.83
	218	Holcolm Hills	178 19 13.47	13.68
Cramer Gulch, 6.22 meters.	219	Big Springs	0 00 59.89	59.52
	220	Square Bluffs	74 58 25.93	25.97
	221	Adobe	131 37 12.56	12.90
	......	Dry Camp	319 47 03.96	....
Holcolm Hills	......	Holt	0 00 00.03	59.29
	223	Square Bluffs	29 14 12.29	13.21
	20	Big Springs	86 36 27.83	27.47
	21	Corral Bluffs	156 28 01.86	05.37
	22	El Paso east base	165 48 35.91	35.83
	23	El Paso west base	181 38 58.18	58.37
	24	Divide	212 10 36.73	36.31
Big Springs	25	Corral Bluffs	0 00 59.90	00.03
	26	El Paso east base	27 23 27.38	26.88
	27	Divide	33 35 42.043	41.31
	28	Holcolm Hills	54 42 04.94	05.17
	224	Square Bluffs	138 58 19.89	20.46
	225	Cramer Gulch	188 03 38.51	38.64
	......	Dry Camp	235 37 57.079	....
	66	Plateau	279 28 24.430	25.01
	67	Pikes Peak	344 22 41.480	41.04
Divide, 1.45 meters.	15	Holcolm Hills	0 00 59.89	00.11
	16	Big Springs	33 19 29.08	28.50
	17	El Paso east base	46 47 59.79	60.56
	18	Corral Bluffs	83 14 11.32	11.21
	19	El Paso west base	98 42 24.44	25.00
	5	Pikes Peak	126 59 20.22	20.33
	65	Bison	168 29 32.54	33.38
	6	Elbert	229 01 44.02	43.54
	7	Hilltop	230 46 25.14	23.81
Pikes Peak, 1.33 meters.	......	Azimuth mark, Mount Rosa.	0 00 00.00	....
	55	Plateau	0 24 12.57	12.52
	50	Mount Ouray	107 11 36.82	36.74
	51	Mount Elbert	145 46 20.91	21.86
	52	Bison	179 36 26.33	26.20
	4	Divide	281 54 23.84	23.58
	54	Big Springs	319 01 36.65	37.08
	1	Morrison	211 48 45.82	45.85
	2	Hilltop	247 43 11.09	10.38
	3	Elbert	263 47 48.56	48.40
El Paso east base	......	Azimuth mark	0 00 00.00	....
	1	Holcolm Hills	67 48 34.55	33.93
	2	Big Springs	141 17 47.24	48.24
	3	Corral Bluffs	229 57 10.61	10.28
	4	El Paso west base	282 48 01.53	01.48
	5	Divide	340 58 34.40	34.41
El Paso west base	6	Divide	0 00 00.14	59.44
	7	Holcolm Hills	50 45 56.49	57.17
	8	El Paso east base	69 55 02.78	02.40
	9	Corral Bluffs	148 54 53.35	53.76
	......	Bear Creek	202 33 37.97	....
	......	Glen Eyrie	219 44 24.05	....
Corral Bluffs	10	El Paso west base	0 00 00.01	00.09
	11	Divide	15 36 52.53	52.17
	12	El Paso east base	48 09 18.10	17.87
	13	Holcolm Hills	56 40 11.19	11.22
	14	Big Springs	112 06 29.59	30.08
	......	Bear Creek	255 15 13.89	....
	......	Glen Eyrie	275 18 41.66	....
Bison	......	Reference mark	0 00 00.000	....
	57	Pikes Peak	8 05 07.647	07.21
	58	Mount Ouray	84 58 58.452	58.78
	59	Mount Elbert	130 53 06.876	07.02
	56	Divide	331 53 09.941	09.92
Plateau	61	Pikes Peak	0 00 59.714	59.91
	62	Corral Bluffs	36 49 56.694	56.62
	63	Big Springs	73 43 16.683	16.07
	......	Dry Camp	98 12 57.315	....
	60	Mount Ouray	312 14 50.449	50.93
Mount Ouray	......	Reference mark	0 00 00.000	....
	......	Azimuth signal	4 43 02.772	....
	39	Uncompahgre	73 31 43.901	44.54
	40	Treasury Mountain.	134 01 13.790	14.16
	41	Mount Elbert	169 02 58.555	48.15
	42	Bison	217 35 12.159	12.56
	43	Pikes Peak	248 16 47.931	47.65
	44	Plateau	273 44 33.126	32.40
Uncompahgre	......	Azimuth mark	0 00 00.000	....
	28	Mount Ellen	17 57 20.789	21.30
	29	Mount Waas	34 57 59.822	59.81
	30	Tavaputs	66 53 01.218	01.38
	31	Treasury Mountain.	122 33 55.882	56.00
	32	Mount Elbert	142 52 07.746	07.52
	33	Mount Ouray	175 40 48.333	47.77
Tushar	......	Beaver	0 00 00.000	....
	......	Pioche	27 52 18.310	18.40
	......	Wheeler Peak	67 17 11.920	12.29
	......	Ibepah	96 32 39.837	39.44
	......	Mount Nebo	155 33 43.204	43.20
	1	Wasatch	182 45 10.509	10.56
	2	Mount Ellen	238 41 36.230	37.26

Station occupied and elevation of instrument above station mark.	Number of direction.	Object observed.	Observed direction reduced to sea level.	Final seconds after figure adjustment.
			° ′ ″	″
Mount Nebo	......	Azimuth mark	0 00 00.000	....
	3	Patmos Head	99 26 42.181	41.97
	4	Wasatch	155 13 16.371	16.61
	......	Tushar	194 36 40.201	40.43
	......	Wheeler Peak	242 40 45.872	45.93
	......	Ibepah	265 48 49.516	49.37
	......	Pilot Peak	299 41 12.903	12.85
	......	Deseret	309 18 29.602	29.47
	......	Ogden Peak	350 55 13.503	13.83
Patmos Head	......	Azimuth mark	0 00 00.000	....
	0	Tavaputs	98 42 01.717	01.25
	10	Mount Waas	149 29 04.862	05.08
	11	Mount Ellen	207 09 05.278	05.40
	12	Wasatch	257 55 46.513	46.98
	13	Mount Nebo	297 05 30.568	30.22
Wasatch	......	Azimuth mark	0 00 00.000	....
	6	Mount Nebo	56 15 21.300	20.99
	7	Patmos Head	141 19 25.472	25.26
	8	Mount Ellen	228 22 19.500	19.79
	5	Tushar	302 49 50.306	50.53
Mount Waas	......	Azimuth mark	0 00 00.000	....
	19	Mount Ellen	57 49 34.078	34.25
	20	Patmos Head	124 44 59.353	58.92
	21	Tavaputs	175 33 49.680	49.70
	22	Treasury Mountain	239 14 21.688	22.02
	23	Uncompahgre	273 50 30.935	30.86
Mount Ellen	......	Azimuth mark	0 00 00.000	....
	14	Tushar	121 30 16.781	16.90
	15	Wasatch	171 06 54.365	53.79
	16	Patmos Head	213 17 51.574	51.24
	17	Mount Waas	268 43 14.464	14.96
	18	Uncompahgre	287 44 08.352	08.65
Treasury Mountain	......	Azimuth mark	0 00 00.000	....
	34	Mount Elbert	137 13 55.336	55.70
	35	Mount Ouray	189 27 23.228	22.77
	36	Uncompahgre	255 51 27.047	26.93
	37	Mount Waas	313 40 06.691	07.08
	38	Tavaputs	349 02 27.958	27.78
Tavaputs	......	Azimuth mark	0 00 00.000	....
	24	Treasury Mountain	87 15 56.924	56.98
	25	Uncompahgre	118 24 50.337	49.89
	26	Mount Waas	168 13 53.180	53.31
	27	Patmos Head	246 38 30.060	30.32
Mount Elbert	......	Reference mark	0 00 00.000	....
	45	Bison	176 00 16.476	16.24
	46	Pikes Peak	199 22 22.679	22.54
	47	Mount Ouray	261 34 00.140	00.28
	48	Uncompahgre	313 14 39.165	39.55
	49	Treasury Mountain	354 19 11.010	10.86
Hilltop, 1.34 meters.	17	Indian	0 00 00.05	58.96
	12	Divide	151 32 27.41	28.22
	13	Elbert	152 50 49.22	50.36
	14	Pikes Peak	193 34 17.30	17.27
	15	Morrison	282 38 49.46	48.84
	16	Douglas	333 14 26.84	26.62
Indian, 1.10 meters.	25	Brighton	0 00 59.94	59.45
	24a	Watkins astronomic.	9 42 19.17	18.27
	21	Hilltop	212 53 14.81	15.41
	22	Douglas	224 51 19.30	19.68
	23	Morrison	291 24 37.08	37.37
	24	Boulder	318 55 25.92	26.03
Morrison, 1.42 meters.	26	Boulder	0 00 59.94	59.55
	27	Brighton	56 00 44.81	45.16
	27a	Watkins astronomic.	91 57 34.27	32.50
	28	Indian	102 43 32.17	32.12
	29	Douglas	120 10 20.17	20.96
	30	Hilltop	126 51 02.77	03.12
	31	Elbert	142 10 48.31	47.98
	32	Pikes Peak	181 52 16.56	17.63
Elbert, 1.36 meters.	11	Hilltop	0 00 59.94	59.18
	8	Divide	176 56 56.26	56.82
	9	Pikes Peak	236 48 00.36	00.91
	10	Morrison	325 07 40.15	39.82
Brighton, 1.36 meters.	38	Indian	0 00 59.92	59.49
	39	Morrison	64 41 55.29	56.09
	40	Boulder	100 39 56.02	55.82
	41	Horsetooth	166 31 25.21	25.10
	42	Dewey	217 30 16.45	16.37

Station occupied and elevation of instrument above station mark.	Number of direction.	Object observed.	Observed direction reduced to sea level.	Final seconds after figure adjustment.
			° ′ ″	″
Watkins astronomic, 3.23 meters.	24b	Indian	0 00 59.96	58.89
	24c	Morrison	90 56 19.09	19.74
	24d	Boulder	122 06 14.94	15.37
Warren, 1.27 meters.	61	Twin	0 00 59.97	59.69
	62	Russell	27 11 38.16	37.05
	63	Wadill	68 54 53.96	53.71
	59	Dewey	239 23 26.51	27.35
	60	Horsetooth	291 59 14.69	14.57
Dewey, 0.96 meter.	45	Horsetooth	0 00 59.98	00.79
	46	Twin	41 11 10.44	10.32
	47	Warren	61 06 10.73	09.72
	43	Brighton	283 57 46.45	45.99
	44	Boulder	312 17 14.36	15.15
Horsetooth, 1.36 meters.	50	Dewey	0 00 59.99	59.59
	51	Brighton	52 59 00.94	01.04
	52	Boulder	93 51 37.90	38.12
	48	Twin	260 21 54.73	55.31
	49	Warren	293 41 48.62	48.13
Boulder, 1.26 meters	33	Horsetooth	0 00 00.04	00.30
	34	Dewey	38 25 45.65	45.08
	35	Brighton	73 16 02.22	01.27
	35a	Watkins astronomic.	104 24 42.78	43.94
	36	Indian	111 31 36.80	36.61
	37	Morrison	161 17 19.55	19.82
Douglas, 1.40 meters	20	Indian	0 00 00.09	59.96
	18	Hilltop	141 16 23.19	23.54
	19	Morrison	264 00 04.64	04.41
Ragged, 1.40 meters.	86	Whitaker	0 00 59.96	59.82
	87	Wadill	23 39 47.74	47.98
	88	Greentop	74 41 54.68	55.11
	84	Notch	262 30 14.41	14.31
	85	Chugwater	294 23 52.26	51.82
Wadill, 1.38 meters.	67	Greentop	0 00 59.91	59.61
	68	Ragged	13 26 37.85	38.30
	69	Whitaker	59 34 20.03	19.78
	64	Warren	235 21 02.62	02.35
	65	Twin	300 05 14.17	14.23
	66	Russell	337 35 33.48	33.51
	69a	Cheyenne west base.	17 02 52.14	52.65
	69b	Cheyenne east base.	59 03 18.14	17.90
Greentop, 1.28 meters.	76	Wadill	0 00 59.92	59.07
	77	Twin	62 16 07.41	08.66
	78	Russell	66 31 40.16	40.01
	74	Ragged	244 28 44.59	44.13
	75	Whitaker	330 14 25.44	25.67
Russell, 1.30 meters.	70	Greentop	0 00 59.98	59.05
	71	Wadill	91 03 54.17	53.89
	72	Warren	127 00 08.19	09.00
	73	Twin	173 13 00.65	00.18
Twin, 1.42 meters.	58	Horsetooth	0 00 59.97	00.35
	53	Russell	174 39 01.24	01.22
	54	Greentop	177 10 29.96	29.72
	55	Wadill	234 59 37.06	37.28
	56	Warren	281 20 33.34	33.53
	57	Dewey	320 49 06.91	06.41
Cheyenne west base, 1.44 meters.	430	Whitaker	0 00 00.04	00.21
	431	Cheyenne east base.	89 53 02.02	02.14
	432	Wadill	107 42 25.25	24.96
Cheyenne east base, 1.44 meters.	435	Wadill	0 00 00.20	00.26
	433	Cheyenne west base.	120 10 12.51	12.23
	434	Whitaker	180 38 03.19	03.42
Haystack, 1.22 meters.	101	Coleman	0 00 59.98	00.09
	102	Willow	82 07 07.21	07.33
	103	Hobbs	94 24 04.24	03.93
	104	Rawhide	108 58 16.84	16.36
	99	Chugwater	294 26 05.31	05.77
	100	Notch	325 36 07.76	07.85
Coleman, 1.31 meters.	107	Haystack	0 00 59.99	59.40
	108	Chugwater	79 11 15.86	15.92
	109	Notch	111 25 05.23	05.29
	105	Willow	312 31 28.00	27.55
	106	Hobbs	327 34 21.20	22.18
Notch, 1.42 meters.	96	Chugwater	0 00 59.88	59.51
	97	Whitaker	21 50 37.18	37.01
	98	Ragged	44 26 21.55	22.03
	94	Coleman	248 38 31.04	31.02
	95	Haystack	282 49 36.62	36.72

Station occupied and elevation of instrument above station mark.	Number of direction.	Object observed.	Observed direction reduced to sea level.	Final seconds after figure adjustment.
			° ′ ″	″
Chugwater, 1.41 meters.	91	Notch	0 00 59.85	00.12
	92	Coleman	36 24 45.62	45.72
	93	Haystack	71 39 42.03	41.21
	89	Whitaker	219 21 18.01	18.11
	90	Ragged	256 19 55.49	55.86
Whitaker, 1.38 meters.	80	Greentop	0 00 00.06	00.70
	81	Ragged	19 32 24.87	24.59
	82	Notch	79 26 58.96	59.02
	83	Chugwater	96 57 42.36	42.13
	79	Wadill	269 19 52.31	53.07
	79a	Cheyenne east base.	269 26 54.72	54.35
	79b	Cheyenne west base.	299 06 01.98	01.43
Hobbs, 1.32 meters.	110	Haystack	0 00 00.03	00.38
	111	Coleman	53 10 21.77	22.05
	112	Willow	142 26 35.12	35.08
	113	Rawhide	256 16 37.78	37.18
Rawhide, 1.46 meters.	116	Willow	0 00 59.89	59.80
	117	Manville	38 08 35.61	35.40
	118	Kirtley	98 00 51.88	51.72
	114	Haystack	255 11 35.13	34.79
	115	Hobbs	316 53 58.85	59.67
Willow, 1.42 meters.	119	Manville	0 00 00.07	00.17
	120	Kirtley	45 50 57.05	56.39
	121	Rawhide	107 04 41.10	40.94
	122	Hobbs	130 08 38.74	38.95
	123	Haystack	155 25 07.50	08.21
	124	Coleman	205 49 33.21	32.99
Manville, 1.37 meters.	126	Kirtley	0 00 00.01	00.66
	127	Rawhide	78 31 22.84	22.53
	128	Willow	113 18 06.68	07.00
	129	Alkali	277 07 28.80	28.47
	125	Parker	321 46 21.80	21.46
Kirtley, 1.28 meters.	134	Rawhide	0 00 00.11	00.44
	130	Willow	20 45 26.12	25.97
	131	Manville	41 36 25.18	25.18
	132	Alkali	113 38 26.69	26.50
	133	Parker	162 36 37.49	37.50
Cottonwood, 1.33 meters.	153	Sullivan	0 00 00.04	59.72
	154	Parker	52 03 21.60	21.84
	155	Provo east base	88 42 55.29	55.47
	156	Provo astronomic	94 16 19.06	19.25
	157	Provo west base	108 56 44.65	43.93
	152	Alkali	311 53 38.06	38.48
Sullivan, 1.37 meters.	172	Alkali	0 00 59.98	59.60
	173	Elk	68 27 42.52	42.58
	170	Parker	213 03 56.23	56.18
	171	Cottonwood	274 41 18.98	19.35
Provo east base, 9.70 meters.	169	Parker	0 00 00.03	00.30
	166	Provo west base	245 27 12.79	11.86
	167	Provo astronomic	251 21 54.32	54.88
	168	Cottonwood	269 55 51.79	51.91
Provo astronomic, 1.35 meters.	164	Parker	0 00 00.07	00.18
	165	Provo east base	56 03 54.33	54.33
	162	Provo west base	224 42 18.72	18.25
	163	Cottonwood	260 11 14.61	14.98
Provo west base, 4 14 meters.	160	Provo astronomic	0 00 00.04	00.27
	161	Provo east base	5 26 53.74	53.36
	158	Cottonwood	230 09 21.21	21.42
	159	Parker	325 13 07.02	06.95
Parker, 1.33 meters.	140	Cottonwood	0 00 00.06	59.40
	141	Alkali	48 18 44.86	45.15
	142	Sullivan	66 19 17.29	16.96
	143	Elk	77 26 37.90	38.63
	135	Provo east base	306 43 40.20	39.76
	136	Provo astronomic	322 01 40.61	40.56
	137	Kirtley	325 03 35.88	36.18
	138	Provo west base	331 57 05.13	05.65
	139	Manville	345 49 50.78	50.47
Alkali, 1.41 meters.	144	Inyankara	0 00 00.04	00.03
	145	Cambria	17 37 42.20	41.98
	146	Elk	64 05 41.19	40.86
	147	Sullivan	87 18 25.96	26.04
	148	Parker	102 21 52.04	52.62
	149	Cottonwood	133 53 28.96	28.38
	150	Kirtley	150 08 45.09	44.62
	151	Manville	175 14 18.77	19.76

Station occupied and elevation of instrument above station mark.	Number of direction.	Object observed.	Observed direction reduced to sea level.	Final seconds after figure adjustment.
			° ′ ″	″
Elk, 1.40 meters.	176	Alkali	0 00 00.04	00.45
	177	Cambria	87 45 17.78	17.79
	178	Crow	116 49 38.08	38.31
	174	Parker	247 24 02.20	01.68
	175	Sullivan	271 40 27.31	27.17
Cambria, 1.24 meters	182	Inyankara	0 00 59.90	00.26
	183	Laird	72 54 00.28	59.69
	184	Crow	120 20 22.73	22.90
	185	Elk	195 31 11.22	11.15
	186	Alkali	241 17 58.26	58.38
Crow, 19.28 meters.	180	Cambria	0 00 00.01	59.83
	181	Laird	81 10 47.84	48.25
	179	Elk	284 15 07.14	06.91
Laird, 1.19 meters.	188	Cambria	0 00 00.00	00.54
	189	Inyankara	51 41 47.47	47.75
	190	Sundance	91 10 54.64	54.82
	191	Terry	187 07 35.74	35.13
	187	Crow	308 37 11.74	11.35
Inyankara, 1.42 meters.	192	Sundance	0 00 59.94	59.96
	193	Terry	87 51 00.08	00.68
	194	Laird	105 57 00.82	00.39
	195	Cambria	161 21 15.42	15.03
	196	Alkali	205 01 33.54	33.75
Terry, 1.52 meters.	197	Laird	0 00 00.12	00.61
	198	Inyankara	26 28 14.73	14.44
	199	Sundance	62 38 02.19	02.02
	200	Wymonkota	118 54 04.12	04.11
	201	Castle	155 05 17.13	17.12
Sundance, 1.37 meters.	206	Inyankara	0 00 59.94	59.90
	202	Wymonkota	221 18 22.86	22.99
	203	Castle	248 10 28.02	27.81
	204	Terry	304 00 44.73	44.86
	205	Laird	325 26 05.38	05.36
Castle, 1.32 meters.	210	Harding	0 00 59.93	00.00
	211	Moreau	11 24 39.43	39.28
	212	Reva	56 41 33.52	33.35
	207	Terry	241 59 15.90	16.12
	208	Sundance	273 41 55.01	54.70
	209	Wymonkota	310 18 33.07	33.43
Table, 1.31 meters.	233	Butte	0 00 00.05	59.72
	234	Whetstone	24 55 31.84	31.60
	235	Lodge	64 48 04.49	04.53
	236	Reva	104 14 39.12	39.75
	237	Harding	165 58 52.50	52.41
Reva, 1.27 meters.	232	Lodge	0 00 00.03	00.70
	228	Castle	177 38 48.71	48.83
	229	Moreau	217 22 55.84	55.82
	230	Harding	227 14 20.30	19.95
	231	Table	296 30 26.21	25.80
Harding, 1.38 meters.	218	Table	0 00 00.03	00.01
	219	Lodge	32 26 17.99	18.11
	220	Reva	48 59 48.17	48.24
	221	Moreau	85 01 09.45	09.20
	222	Castle	122 42 50.92	51.13
	223	Wymonkota	184 34 52.02	51.88
Moreau, 1.30 meters.	227	Reva	0 00 00.06	00.05
	224	Castle	94 59 04.10	04.05
	225	Wymonkota	162 04 59.95	59.84
	226	Harding	225 52 43.78	43.96
Wymonkota, 1.44 meters.	213	Harding	0 00 00.04	00.11
	214	Moreau	16 38 34.51	34.79
	215	Castle	68 26 38.10	37.84
	216	Terry	143 56 17.40	17.10
	217	Sundance	184 58 01.48	01.71
Lodge, 1.28 meters.	238	Reva	0 00 00.04	59.16
	239	Harding	30 40 51.22	51.73
	240	Table	77 03 52.92	52.65
	241	Butte	129 20 40.16	40.61
	242	Whetstone	173 26 34.75	34.94
Whetstone, 1.05 meters.	248	Lodge	0 00 00.02	59.72
	249	Table	43 44 48.93	49.30
	250	Butte	74 24 24.44	24.68
	251	Black	104 44 11.74	11.84
	252	Rainy	156 09 28.72	28.30

Station occupied and elevation of instrument above station mark.	Number of direction.	Object observed.	Observed direction reduced to sea level. ° ′ ″	Final seconds after figure adjustment. ″
Butte, 1.19 meters	243	Black	0 00 59.98	00.09
	244	Rainy	52 25 12.90	12.46
	245	Whetstone	98 56 10.07	10.45
	246	Lodge	160 25 54.94	54.57
	247	Table	223 21 05.67	05.99
Black, 1.15 meters	257	Butte	0 00 59.98	00.29
	253	Sentinel	162 54 13.57	13.37
	254	Badland	206 49 32.60	33.30
	255	Rainy	263 20 52.96	53.29
	256	Whetstone	309 15 57.14	56.00
Rainy, 1.08 meters	258	Whetstone	0 00 59.98	00.73
	259	Butte	51 44 02.26	01.69
	260	Black	82 39 44.04	44.15
	261	Sentinel	135 50 52.53	52.77
	262	Badland	146 15 40.61	40.92
	263	Saddle	176 00 05.90	05.04
Badland, 1.22 meters.	264	Rainy	0 00 59.95	59.81
	265	Black	59 52 45.90	45.50
	266	Sentinel	161 44 44.10	44.04
	267	Saddle	239 21 03.45	04.05
Sentinel, 1.20 meters.	274	Cook	0 00 00.02	59.83
	275	Hump	3 38 41.07	41.30
	276	Saddle	61 19 00.66	00.18
	277	Badland	102 47 22.58	22.83
	278	Rainy	110 37 51.39	51.54
	279	Black	137 00 08.21	08.04
	273	Blue	316 08 09.11	09.34
Saddle, 1.28 meters	272	Cook	0 00 59.97	59.63
	268	Rainy	227 58 11.52	11.80
	269	Badland	257 34 54.46	54.20
	270	Sentinel	318 30 15.01	14.97
	271	Hump	329 06 21.73	22.09
Hump, 1.22 meters	282	Cook	0 00 00.02	00.02
	283	Saddle	73 24 55.15	55.17
	280	Sentinel	185 08 30.31	30.14
	281	Blue	308 28 04.85	04.99
Cook, 1.21 meters	285	Hump	0 00 00.02	59.94
	286	Sentinel	1 29 48.36	48.64
	287	Blue	97 01 11.35	10.98
	288	Trotter	139 34 02.53	02.39
	289	Flat	150 43 32.73	32.90
	284	Saddle	284 18 30.03	30.20
Blue, 1.29 meters	292	Flat	0 00 00.04	00.18
	293	Trotter	25 03 25.15	24.98
	294	Cook	59 36 26.54	26.86
	295	Hump	91 03 22.49	22.79
	296	Sentinel	100 13 17.39	16.86
	290	Lovering	295 11 32.12	31.92
	291	Sheep	344 45 22.85	23.01
Flat, 1.33 meters	300	Cook	0 00 59.98	59.91
	301	Trotter	16 59 35.30	35.36
	302	Blue	66 41 13.79	13.60
	303	Lovering	147 15 41.71	41.94
	304	Sheep	210 35 54.11	54.06
Trotter, 1.26 meters	299	Cook	0 00 59.97	00.00
	297	Blue	102 54 07.79	07.90
	298	Flat	208 09 05.79	05.64
Lovering, 1.23 meters.	305	Jackson	0 00 00.01	59.65
	306	Buford	31 45 16.96	17.08
	307	Sheep	96 55 04.02	04.18
	308	Flat	124 33 05.20	05.03
	309	Blue	159 10 11.87	12.10
Sheep, 1.17 meters	310	Flat	0 00 00.02	59.96
	311	Blue	20 50 43.31	43.35
	312	Lovering	89 01 49.76	49.44
	313	Jackson	116 21 25.84	26.35
	313a	Montana	143 16 34.09	34.12
	314	Buford	149 46 28.06	27.88
Jackson, 1.30 meters.	330	Lovering	0 00 00.01	00.29
	323	Snake	192 48 26.90	26.49
	325	Lanark	194 56 01.34	00.92
	324	Bainville	196 07 40.19	40.39
	326	Cutoff	232 13 53.60	53.83
	327	Montana	235 36 26.65	26.44
	328	Buford	237 32 30.81	31.46
	329	Sheep	304 14 39.43	39.12
Buford, 1.24 meters	317	Jackson	0 00 00.03	00.04
	318	Montana	8 20 03.62	03.44
	319	Bainville	76 25 16.46	17.08
	320	Snake	87 36 54.68	54.78
	321	Bull	110 53 52.67	52.71
	322	Williston	154 10 39.52	39.05
	315	Sheep	280 07 05.91	05.73
	316	Lovering	334 12 44.71	44.81
Cutoff, 0.98 meter	348	Jackson	0 00 00.07	59.62
	349	Lanark	100 20 36.34	36.12
	350	Montana	188 41 28.57	28.55
	351	Mondak	208 37 31.54	31.97
	352	Ferry	231 02 19.22	19.47
Mondak, 1.25 meters	362	Montana	0 00 59.99	00.40
	360	Ferry	223 14 56.04	56.16
	361	Cutoff	274 20 07.65	07.13
Ferry, 0.28 meter	363	Cutoff	0 00 59.98	59.77
	364	Montana	86 11 44.09	44.36
	365	Mondak	106 30 01.43	01.36
Montana, 1.18 meters.	357	Jackson	0 00 00.03	59.92
	358	Cutoff	5 18 56.35	56.29
	359	Lanark	61 10 17.19	17.85
	353	Buford	190 16 08.24	08.28
	354	Sheep	275 33 17.26	17.48
	355	Mondak	290 54 53.26	52.91
	356	Ferry	313 51 32.05	31.69
Bainville, 1.30 meters.	342	Snake	0 00 00.01	00.45
	343	Buford	135 12 00.52	59.99
	344	Jackson	197 21 53.35	53.43
Lanark, 1.09 meters	347	Jackson	0 00 00.02	00.47
	345	Montana	281 50 43.73	43.10
	346	Cutoff	317 38 29.23	29.41
Bull, 1.32 meters	368	Williston	0 00 59.97	00.41
	369	Buford	59 45 10.05	09.81
	366	Gladys	287 55 21.16	20.79
	367	Bonetraill	305 24 33.83	34.06
	370	Snake	116 48 35.36	35.32
Snake, 1.25 meters	331	Bull	0 00 00.04	00.19
	332	Williston	41 09 48.35	48.49
	333	Buford	99 39 37.74	37.65
	334	Bainville	133 16 01.06	00.71
	335	Jackson	147 18 39.80	39.97
Williston, 1.25 meters.	341	Marmon	0 00 00.03	59.98
	336	Buford	186 31 01.72	02.23
	337	Snako	241 27 31.02	30.65
	338	Bull	263 29 08.16	08.11
	339	Gladys	304 26 15.67	15.56
	340	Bonetraill	311 29 24.32	24.41
Bonetraill, 1.27 meters.	374	Marmon	0 00 00.01	00.29
	371	Williston	85 29 01.71	02.04
	372	Bull	162 53 21.03	20.21
	373	Gladys	231 51 54.47	54.66
Gladys, 1.40 meters	375	Howard	0 00 00.01	59.94
	376	Muddy	30 47 24.37	24.20
	377	Marmon	74 25 24.06	24.19
	378	Bonetraill	116 10 34.78	34.67
	379	Williston	142 44 33.99	33.34
	380	Bull	209 42 46.29	47.17
Marmon, 1.28 meters	381	Williston	0 00 00.03	00.15
	382	Bonetraill	46 00 24.56	23.79
	383	Gladys	56 07 07.62	07.89
	384	Howard	106 24 04.09	04.28
	385	Muddy	150 14 28.56	28.73
Muddy, 1.42 meters	386	Marmon	0 00 00.00	59.64
	387	Gladys	42 14 39.76	40.24
	388	Howard	77 24 40.43	40.57
	389	Stady	153 06 10.50	10.03
	390	Crosby	179 45 31.34	31.53
Howard, 9.27 meters	391	Norge	0 00 00.01	00.02
	392	Stady	32 50 36.22	36.49
	393	Crosby	33 25 50.64	50.55
	394	Muddy	73 30 37.30	37.13
	395	Marmon	132 15 32.90	32.91
	396	Gladys	187 33 13.56	13.53

Station occupied and elevation of instrument above station mark.	Number of direction.	Object observed.	Observed direction reduced to sea level.	Final seconds after figure adjustment.
			° ′ ″	″
Stady, 1.37 meters	399	Norge	0 00 $\overline{59.97}$	$\overline{59.60}$
	400	Crosby	81 25 15.10	15.40
	397	Muddy	195 58 20.42	20.74
	398	Howard	259 36 51.57	51.32
Crosby, 9.25 meters	403	Stady	0 00 00.03	$\overline{59.71}$
	404	Norge	63 16 36.70	36.48
	405	Bowie	100 48 59.14	59.43
	406	Ambrose southwest base.	117 35 01.79	02.34
	407	Ambrose	168 04 59.73	59.65
	401	Muddy	321 12 26.24	26.22
	402	Howard	358 46 49.88	49.67
Norge, 6.35 meters	418	Stady	0 00 $\overline{59.97}$	00.20
	419	Howard	46 46 16.05	16.27
	415	Bowie	241 13 49.88	49.39
	416	Ambrose southwest base.	284 52 32.85	33.48
	417	Crosby	324 41 52.95	52.37

Station occupied and elevation of instrument above station mark.	Number of direction.	Object observed.	Observed direction reduced to sea level.	Final seconds after figure adjustment.
			° ′ ″	″
Ambrose, 1.35 meters.	409	Ambrose southwest base.	0 00 $\overline{59.97}$	00.27
	410	Bowie	0 56 35.24	35.31
	411	School	74 02 54.17	54.04
	408	Crosby	267 48 51.92	51.67
Bowie, 1.27 meters	420	School	0 00 00.00	$\overline{59.64}$
	421	Ambrose	27 36 38.57	38.84
	422	Ambrose southwest base.	28 25 26.13	26.05
School, 1.15 meters	414	Bowie	0 00 00.00	$\overline{58.96}$
	412	Ambrose	280 42 56.81	56.50
	413	Ambrose southwest base.	332 59 22.94	24.29
Ambrose southwest base, 9.25 meters.	425	School	0 00 00.02	$\overline{59.71}$
	426	Ambrose	53 40 38.69	38.33
	427	Crosby	90 59 32.76	32.57
	428	Norge	176 51 47.79	48.22
	429	Bowie	235 26 00.16	00.57

CONDITION EQUATIONS.

ONE HUNDRED AND FOURTH MERIDIAN.

No.

1. $0=+1.82-(2)+(4)-(5)+(7)-(12)+(14)$
2. $0=-0.81-(6)+(7)+(8)-(11)-(12)+(13)$
3. $0=+0.70-(3)+(4)-(5)+(6)-(8)+(9)$
4. $0=+2.87-(10)+(11)-(13)+(15)-(30)+(31)$
5. $0=-0.33-(1)+(3)-(9)+(10)-(31)+(32)$
6. $0=+0.38-(15)+(17)-(21)+(23)-(28)+(30)$
7. $0=-0.85-(19)+(20)-(22)+(23)-(28)+(29)$
8. $0=+0.61-(16)+(17)+(18)-(20)-(21)+(22)$
9. $0=-0.62-(23)+(24)-(26)+(28)-(36)+(37)$
10. $0=-0.05-(23)+(25)-(27)+(28)-(38)+(39)$
11. $0=-0.96-(26)+(27)-(35)+(37)-(39)+(40)$
12. $0=-1.80-(41)+(42)-(43)+(45)-(50)+(51)$
13. $0=+0.19-(33)+(34)-(44)+(45)-(50)+(52)$
14. $0=-0.99-(34)+(35)-(40)+(42)-(43)+(44)$
15. $0=+1.03-(45)+(46)-(48)+(50)-(57)+(58)$
16. $0=+2.70-(46)+(47)-(56)+(57)-(59)+(61)$
17. $0=+1.04-(48)+(49)-(56)+(58)-(60)+(61)$
18. $0=-0.33-(55)+(56)-(61)+(63)-(64)+(65)$
19. $0=-0.02-(53)+(55)-(65)+(66)-(71)+(73)$
20. $0=+1.00-(53)+(56)-(61)+(62)-(72)+(73)$
21. $0=-2.20-(54)+(55)-(65)+(67)-(76)+(77)$
22. $0=-0.12-(66)+(67)-(70)+(71)-(76)+(78)$
23. $0=-0.55-(67)+(68)-(74)+(76)-(87)+(88)$
24. $0=+1.36-(68)+(69)-(79)+(81)-(86)+(87)$
25. $0=-0.34-(74)+(75)-(80)+(81)-(86)+(88)$
26. $0=-0.62-(81)+(83)-(85)+(86)-(89)+(90)$
27. $0=-0.07-(82)+(83)-(89)+(91)-(96)+(97)$
28. $0=-0.41-(84)+(85)-(90)+(91)-(96)+(98)$
29. $0=+0.52-(91)+(92)-(94)+(96)-(108)+(109)$
30. $0=+0.62-(92)+(93)-(99)+(101)-(107)+(108)$
31. $0=-0.79-(94)+(95)-(100)+(101)-(107)+(109)$
32. $0=+1.00-(101)+(102)-(105)+(107)-(123)+(124)$
33. $0=-0.52-(102)+(104)-(114)+(116)-(121)+(123)$
34. $0=+2.06-(101)+(103)-(106)+(107)-(110)+(111)$
35. $0=-0.74-(105)+(106)-(111)+(112)-(122)+(124)$
36. $0=+1.10-(112)+(113)-(115)+(116)-(121)+(122)$
37. $0=-0.25-(116)+(117)-(119)+(121)-(127)+(128)$
38. $0=+1.24-(117)+(118)-(126)+(127)+(131)-(134)$
39. $0=+0.05-(116)+(118)-(120)+(121)+(130)-(134)$

No.

40. 0=−2.25+(126)−(129)−(131)+(132)−(150)+(151)
41. 0=−0.39−(125)+(126)−(131)+(133)−(137)+(139)
42. 0=+0.86−(132)+(133)−(137)+(141)−(148)+(150)
43. 0=+0.39−(140)+(141)−(148)+(149)−(152)+(154)
44. 0=+2.42−(138)+(140)−(154)+(157)−(158)+(159)
45. 0=+0.44−(155)+(157)−(158)+(161)−(166)+(168)
46. 0=+0.13−(135)+(140)−(154)+(155)−(168)+(169)
47. 0=+0.92−(136)+(140)−(154)+(156)−(163)+(164)
48. 0=+0.01−(135)+(136)−(164)+(165)−(167)+(169)
49. 0=−0.41−(160)+(161)+(162)−(165)−(166)+(167)
50. 0=−1.31−(140)+(142)−(153)+(154)−(170)+(171)
51. 0=+2.15−(147)+(149)−(152)+(153)−(171)+(172)
52. 0=−2. 28−(141)+(143)−(146)+(148)−(174)+(176)
53. 0=−1.33−(142)+(143)+(170)−(173)−(174)+(175)
54. 0=+96.5+7.31(2)−13.75(3)+6.44(4)−0.45(5)−68.67(6)+69.12(7)−92.35(12)−94.80(13)+2.45(14)
55. 0=−9.4+2.91(1)−10.22(2)+7.31(3)−1.38(9)−3.02(10)+4.40(11)+6.21(30)−7.68(31)+1.47(32)
56. 0=+15.8+1.73(15)−5.91(16)+4.18(17)+9.93(21)−10.84(22)+0.91(23)+6.70(28)−24.68(29)+17.98(30)
57. 0=+4.7+4.04(23)−6.46(24)+2.42(25)+1.90(26)−1.42(27)−0.48(28)−0.40(38)−2.90(39)+3.30(40)
58. 0=+5.1+0.63(33)−3.03(34)+2.40(35)+3.39(43)−3.91(44)+0.52(45)+1.59(50)−4.02(51)+2.43(52)
59. 0=−2.3+1.16(45)−5.81(46)+4.65(47)+3.20(48)−4.12(49)+0.92(50)+2.14(56)−2.56(57)+0.42(58)
60. 0=−6.9−1.20(53)+3.21(55)−2.01(56)−4.10(61)+6.46(62)−2.36(63)−0.99(64)+3.73(65)−2.74(66)−2.89(71)
    +4.92(72)−2.03(73)
61. 0=−31.0−46.55(53)+47.75(54)−1.20(55)−2.74(65)+7.85(66)−5.11(67)−0.91(76)+28.28(77)−27.37(78)
62. 0=+12.0+7.57(67)−8.81(68)+1.24(69)−0.02(79)−5.91(80)+5.93(81)+0.58(86)−1.70(87)+1.12(88)
63. 0=−0.2+0.47(81)−6.67(82)+6.20(83)+3.38(84)−4.33(85)+0.95(86)+3.10(96)−5.25(97)+2.15(98)
64. 0=+1.6−2.15(91)+2.85(92)−0.70(93)−3.48(99)+6.56(100)−3.08(101)+0.83(107)+3.34(108)−4.17(109)
65. 0=+0.2+9.67(102)−17.77(103)+8.10(104)+1.13(114)−3.38(115)+2.25(116)+4.94(121)−9.40(122)+4.46(123)
66. 0=+23.5−0.16(101)−9.67(102)+9.83(103)+7.83(105)−11.14(106)+3.31(107)+3.92(122)−4.46(123)+0.54(124)
67. 0=−5.5+2.98(116)−2.68(117)−0.30(118)−0.91(126)−3.03(127)+3.94(128)−11.09(130)+5.53(131)+5.56(134)
68. 0=−14.3−2.67(125)+2.41(126)+0.26(129)+5.30(137)−5.55(139)+0.25(141)+1.91(148)−6.41(150)+4.50(151)
69. 0=+19.6+4.47(135)−8.42(138)+3.95(140)+2.83(154)−8.54(155)+5.71(157)−0.19(158)−2.30(159)+2.49(161)
    +4.62(166)−4.62(168)
70. 0=+53.5+21.65(155)−29.69(156)+8.04(157)−1.76(158)−20.31(160)+22.07(161)+20.34(166)−26.61(167)+6.27(168)
71. 0=+40.2+7.70(135)−19.73(136)+12.03(138)+3.03(159)−25.10(160)+22.07(161)+20.34(166)−19.63(167)−0.71(169)
72. 0=+7.2+0.92(140)−6.48(141)+5.56(142)+5.84(147)−7.83(148)+1.99(149)+1.89(152)−3.53(153)+1.64(154)
73. 0=+15.4−6.48(141)+17.19(142)−10.71(143)−4.91(146)+12.74(147)−7.83(148)−4.67(174)+4.73(175)−0.06(176)
74. 0=+18.0−0.05(2)+0.05(3)−0.41(8)+0.41(9)+1.88(10)−1.88(12)+0.24(11)−0.24(14)+1.77(16)−1.77(18)
    +4.06(25)−4.06(26)+1.82(27)−2.78(54)−1.82(67)−2.91(1)+2.91(2)+2.78(4)+0.52(5)−0.52(7)+2.34(12)
    −2.34(14)−0.47(17)+0.43(21)−0.43(23)−2.42(24)+2.42(25)+0.48(26)−0.48(28)+1.47(30)−1.47(32)−0.63(33)
    +0.63(35)+1.78(36)−1.78(37)−0.40(38)+0.40(40)−1.71(41)+1.71(42)+0.52(43)−1.68(45)+1.16(47)−3.20(48)
    +3.20(49)+2.43(51)−2.43(52)−1.32(54)+1.32(55)+0.42(56)−0.42(58)+1.61(59)−1.61(60)−0.81(61)+0.81(63)
    +0.99(64)−0.99(65)−3.68(75)+4.79(76)−1.11(77)−0.02(79)+0.02(80)−3.70(79a)+3.70(79b)−2.30(69a)
    +2.30(69)+1.19(433)−1.19(434)−0.67(430)+0.67(432)
75. 0=+0.32−(145)+(146)−(176)+(177)−(185)+(186)
76. 0=−0.03−(177)+(178)−(179)+(180)−(184)+(185)
77. 0=−2.28−(180)+(181)−(183)+(184)−(187)+(188)
78. 0=−0.63−(144)+(145)+(182)−(186)−(195)+(196)
79. 0=+2.70−(189)+(191)−(193)+(194)−(197)+(198)
80. 0=+0.57−(189)+(190)−(192)+(194)−(205)+(206)
81. 0=−0.53−(192)+(193)−(198)+(199)−(204)+(206)
82. 0=+1.17−(182)+(183)−(188)+(189)−(194)+(195)
83. 0=+0.03−(199)+(201)−(203)+(204)−(207)+(208)
84. 0=−0.69−(199)+(200)−(202)+(204)−(216)+(217)
85. 0=−0.82−(202)+(203)−(208)+(209)−(215)+(217)
86. 0=+0.97−(209)+(210)−(213)+(215)−(222)+(223)
87. 0=+1.11−(209)+(211)−(214)+(215)−(224)+(225)
88. 0=−0.47−(210)+(211)−(221)+(222)−(224)+(226)
89. 0=+0.57−(210)+(212)−(220)+(222)−(228)+(230)
90. 0=+0.84−(220)+(221)−(226)+(227)−(229)+(230)
91. 0=+0.69−(218)+(220)−(230)+(231)−(236)+(237)
92. 0=−2.36−(219)+(220)−(230)+(232)−(238)+(239)

No.

93. 0=−2.28−(231)+(232)−(235)+(236)−(238)+(240)
94. 0=−1.41−(234)+(235)−(240)+(242)−(248)+(249)
95. 0=−1.78−(233)+(235)−(240)+(241)−(246)+(247)
96. 0=+0.10−(233)+(234)−(245)+(247)−(249)+(250)
97. 0=+1.16−(244)+(245)−(250)+(252)−(258)+(259)
98. 0=−1.58−(243)+(245)−(250)+(251)−(256)+(257)
99. 0=+2.63−(251)+(252)−(255)+(256)−(258)+(260)
100. 0=−0.34−(253)+(255)−(260)+(261)−(278)+(279)
101. 0=+0.79−(261)+(263)−(276)+(278)−(268)+(270)
102. 0=+0.43−(254)+(255)−(260)+(262)−(264)+(265)
103. 0=−0.05−(261)+(262)−(264)+(266)−(277)+(278)
104. 0=−1.61−(266)+(267)−(269)+(270)−(276)+(277)
105. 0=+0.48−(270)+(272)−(274)+(276)−(284)+(286)
106. 0=+1.92−(273)+(274)−(286)+(287)−(294)+(296)
107. 0=+0.93−(271)+(272)−(282)+(283)−(284)+(285)
108. 0=+0.52−(273)+(275)−(280)+(281)−(295)+(296)
109. 0=−0.95−(274)+(275)−(280)+(282)−(285)+(286)
110. 0=−0.60−(287)+(289)−(292)+(294)−(300)+(302)
111. 0=−0.80−(287)+(288)−(293)+(294)+(297)−(299)
112. 0=−0.62−(288)+(289)−(298)+(299)−(300)+(301)
113 0=−1.16−(290)+(292)−(302)+(303)−(308)+(309)
114. 0=−0.22−(291)+(292)−(302)+(304)−(310)+(311)
115. 0=+0.87−(303)+(304)−(307)+(308)−(310)+(312)
116. 0=−0.46−(306)+(307)−(312)+(314)−(315)+(316)
117. 0=−1.94−(305)+(307)−(312)+(313)−(329)+(330)
118. 0=−0.02−(305)+(306)−(316)+(317)−(328)+(330)
119. 0=−0.52−(317)+(318)−(327)+(328)−(353)+(357)
120. 0=+0.03−(313a)+(314)−(315)+(318)−(353)+(354)
121. 0=−1.41−(317)+(320)−(323)+(328)−(333)+(335)
122. 0=−1.67−(317)+(319)−(324)+(328)−(343)+(344)
123. 0=+1.75−(319)+(320)−(333)+(334)−(342)+(343)
124. 0=+1.68−(320)+(322)−(332)+(333)−(336)+(337)
125. 0=−1.15−(325)+(326)−(346)+(347)−(348)+(349)
126. 0=−1.73−(345)+(346)−(349)+(350)−(358)+(359)
127. 0=+1.75−(321)+(322)−(336)+(338)−(368)+(369)
128. 0=+0.17−(331)+(332)−(337)+(338)−(368)+(370)
129. 0=+0.82−(326)+(327)+(348)−(350)−(357)+(358)
130. 0=−2.28−(338)+(339)−(366)+(368)−(379)+(380)
131. 0=+0.57−(339)+(341)−(377)+(379)−(381)+(383)
132. 0=+0.80−(338)+(340)−(367)+(368)−(371)+(372)
133. 0=−1.05−(350)+(352)−(356)+(358)−(363)+(364)
134. 0=+0.68−(351)+(352)−(360)+(361)−(363)+(365)
135. 0=−1.67−(350)+(351)−(355)+(358)−(361)+(362)
136. 0=−2.60−(366)+(367)−(372)+(373)−(378)+(380)
137. 0=−0.89−(373)+(374)−(377)+(378)−(382)+(383)
138. 0=−1.04−(376)+(377)−(383)+(385)−(386)+(387)
139. 0=−0.08−(375)+(377)−(383)+(384)−(395)+(396)
140. 0=+0.30−(375)+(376)−(387)+(388)−(394)+(396)
141. 0=+0.22−(388)+(390)−(393)+(394)−(401)+(402)
142. 0=+1.62−(388)+(389)−(392)+(394)−(397)+(398)
143. 0=−0.69−(391)+(393)−(402)+(404)−(417)+(419)
144. 0=+1.02−(392)+(393)+(398)−(400)−(402)+(403)
145. 0=−1.58−(399)+(400)−(403)+(404)−(417)+(418)
146. 0=−0.09−(404)+(405)−(415)+(417)−(423)+(424)
147. 0=+0.08−(405)+(407)−(408)+(410)−(421)+(423)
148. 0=−0.18−(404)+(406)−(416)+(417)−(427)+(428)
149. 0=−1.09−(415)+(416)−(422)+(424)−(428)+(429)
150. 0=+1.35−(409)+(410)−(421)+(422)+(426)−(429)
151. 0=+2.83−(413)+(414)−(420)+(422)+(425)−(429)
152. 0=+0.30−(410)+(411)−(412)+(414)−(420)+(421)
153. 0=−1.50+6.63(144)−8.63(145)+2.00(146)+0.08(176)−3.87(177)+3.79(178)+0.54(179)−0.87(180)+0.33(181)
+1.68(187)−3.34(188)+1.66(189)+1.45(194)−3.66(195)+2.21(196)

No.

154. 0=+3.60-0.60(192)-6.44(193)+7.04(194)+3.14(197)-4.23(198)+1.09(199)+5.37(204)-8.43(205)+3.06(206)

155. 0=-3.00+1.41(199)-4.29(200)+2.88(201)+3.89(202)-4.16(203)+0.27(204)+0.84(207)-2.83(208)+1.99(209)

156. 0=+5.40+1.16(209)-10.43(210)+9.27(211)+7.04(213)-8.70(214)+1.66(215)+3.07(221)-2.72(222)-0.35(223)

157. 0=-0.90+10.43(210)-12.51(211)+2.08(212)+2.90(220)-5.62(221)+2.72(222)+2.53(228)-14.65(229)+12.12(230)

158. 0=+8.50+3.31(218)-10.39(219)+7.08(220)+0.80(230)-1.85(231)+1.05(232)+2.56(235)-3.69(236)+1.13(237)+3.55(238)-5.56(239)+2.01(240)

159. 0=+2.60+3.54(233)-4.53(234)+0.99(235)+1.63(240)-3.80(241)+2.17(242)+0.59(248)-3.55(249)+2.96(250)

160. 0=-3.00+1.95(243)-1.62(244)-0.33(245)+3.60(250)-5.28(251)+1.68(252)+0.27(258)-3.51(259)+3.24(260)

161. 0=-1.5-2.19(253)+3.58(254)-1.39(255)-1.58(260)+13.04(261)-11.46(262)-1.22(264)+0.78(265)+0.44(266)-15.29(277)+19.54(278)-4.25(279)

162. 0=+6.20+11.46(261)-15.15(262)+3.69(263)+3.70(268)-4.87(269)+1.17(270)+2.38(276)-17.67(277)+15.29(278)

163. 0=-7.10+11.25(270)-14.77(271)+3.52(272)+33.05(274)-34.38(275)+1.33(276)+0.54(284)-81.13(285)+80.59(286)

164. 0=-25.70-1.93(273)+33.05(274)-31.12(275)-80.85(285)+80.59(286)+0.26(287)-3.44(294)+16.49(295)-13.05(296)

165. 0=-4.30+2.29(287)-12.96(288)+10.67(289)+4.50(292)-7.56(293)+3.06(294)+6.89(300)-8.68(301)+1.79(302)

166. 0=-1.50+0.99(290)-7.73(291)+6.74(292)+4.02(307)-7.07(308)+3.03(309)+5.49(310)-5.53(311)+0.04(312)

167. 0=+7.80+3.66(305)-3.40(306)-0.26(307)+4.07(312)-7.26(313)+3.19(314)+0.38(315)-4.36(316)+3.98(317)

168. 0=+58.4+4.15(313)-22.63(313a)+18.48(314)+0.07(315)-14.36(317)+14.29(318)+61.52(327)-62.34(328)+0.82(329)

169. 0=+4.45-(136)+(143)-(162)+(164)-(174)+(178)-(179)+(181)-(187)+(191)-(197)+(201)-(207)+(212)-(228)+(232)-(238)+(242)+(252)-(258)+(263)-(268)+(272)-(284)+(289)-(300)+(304)-(310)+(313a)-(354)+(355)

170. 0=+21.7+0.51(317)-11.15(319)+10.64(320)+36.29(323)-38.68(324)+2.39(328)+3.17(333)-11.59(334)+8.42(335)

171. 0=-1.20+4.89(320)-7.13(321)+2.24(322)+2.77(331)-2.41(332)-0.36(333)+0.49(336)-5.20(337)+4.71(338)

172. 0=+19.10+2.76(325)-38.45(326)+35.69(327)+2.92(345)-5.23(346)+2.31(347)+22.63(357)-24.06(358)+1.43(359)

173. 0=-1.50+1.89(338)-17.01(339)+15.12(340)+6.68(366)-8.18(367)+1.50(368)+4.34(378)-4.21(379)-0.13(380)

174. 0=-8.90+17.01(339)-18.87(340)+1.86(341)+2.36(377)-6.57(378)+4.21(379)+2.03(381)-13.84(382)+11.81(383)

175. 0=+5.20+5.80(350)-10.91(351)+5.11(352)+4.38(355)-4.97(356)+0.59(358)-0.62(363)-5.69(364)+6.31(365)

176. 0=+0.7+2.94(375)-3.53(376)+0.59(377)+1.75(383)-3.94(384)+2.19(385)+0.47(386)-2.99(387)+2.52(388)

177. 0=-66.50+0.54(388)-4.73(389)+4.19(390)+202.98(392)-205.43(393)+2.45(394)+2.62(401)-98.91(402)+96.29(403)

178. 0=+0.40+0.54(388)-4.73(389)+4.19(390)+3.26(391)-5.71(392)+2.45(394)+2.62(401)-3.68(403)+1.06(404)+2.97(417)-4.95(418)+1.98(419)

179. 0=+6.90+1.51(404)-6.99(405)+5.48(406)+2.21(415)-4.74(416)+2.53(417)+5.73(422)-6.19(423)+0.46(424)

180. 0=+22.50-6.99(405)+8.73(406)-1.74(407)+0.08(408)+127.83(409)-127.91(410)-148.32(421)+154.51(422)-6.19(423)

181. 0=-14.8-6.99(405)+8.73(406)-1.74(407)+0.08(408)+0.52(409)-0.60(411)-1.63(412)+5.76(413)-4.13(414)-3.89(420)+10.08(422)-6.19(423)

182. 0=-1.40+4.47(135)-4.47(138)-3.78(141)+3.78(143)-2.00(145)+2.00(146)+3.43(148)-3.43(149)+0.38(152)+0.99(154)-1.37(157)+0.19(158)-0.19(159)+0.96(166)-0.96(169)-0.88(174)+0.88(176)-3.79(177)+3.79(178)+0.54(179)-0.87(180)+0.33(181)-0.65(182)+0.65(183)+2.05(185)-2.05(186)+1.68(187)-1.68(188)+2.14(189)-2.14(191)-0.08(192)+0.08(193)+1.45(194)-1.45(195)+4.23(197)-4.23(198)-2.88(200)+2.88(201)-0.27(202)+1.69(204)-1.42(206)+0.84(207)-0.84(209)-1.38(210)+1.38(212)-0.83(213)+0.83(215)+2.42(216)-2.42(217)-1.83(218)+1.83(220)+1.12(222)-1.12(223)+1.79(228)-1.79(230)-1.05(231)+1.05(232)-0.99(233)+0.99(235)+1.13(236)-1.13(237)+0.48(238)-0.48(240)-2.17(241)+2.17(242)-1.62(243)+1.62(244)+1.08(246)-1.08(247)+0.59(248)-0.89(250)+0.30(252)-2.19(253)+2.19(254)-0.25(255)+0.25(257)+1.66(258)-1.66(259)-1.05(260)+1.05(262)+1.22(264)-1.22(265)-0.46(266)+0.46(267)+1.17(269)-3.55(270)+2.38(272)-2.19(273)+2.19(274)+3.10(277)-3.10(279)+0.48(284)-0.48(286)-1.55(287)+1.55(289)-0.99(290)+0.99(292)+2.46(294)-2.36(296)+0.91(300)-0.91(302)-1.06(303)+1 06(304)+0.26(305)-0.26(307)+3.05(308)-3.05(309)+0.04(310)-0.04(312)-3.19(313)+3.19(314)+0.38(315)-0.38(317)-0.91(320)+0.91(322)-2.13(323)+2.13(328)+1.43(329)-1.43(330)-2.41(331)+2.41(332)+1.92(333)-1.92(335)+1.48(336)-1.48(337)-1.44(339)+1.44(341)-0.68(366)-0.38(368)+1.06(370)-0.59(375)+0.59(377)+0.89(379)-0.89(380)+1.41(381)-1.41(383)-2.19(384)+2.19(385)+0.47(386)-0.01(388)-0.46(390)-3.19(391)+3.19(393)+1.46(395)-1.46(396)+2.74(401)-2.74(402)-1.74(406)+1.74(407)-0.08(408)-0. 52(409)+0.60(411)+1.63(412)-1.63(413)-2.53(416)+2.82(417)-0.29(419)+0.15(427)-0.15(428)

183. 0=+2.49-(24c)+(24d)-(26)+(27a)-(35a)+(37)

184. 0=-2.25-(23)+(24a)-(27a)+(28)-(24b)+(24c)

185. 0=-39.0+0.44(23)-1.72(24)+1.28(24a)-0.07(26)-11.00(27a)+11.07 (28)+15.49(35a)-16.86(36)+1.37(37)

No.

186. 0=+4.81−(24a)+(25)−(38)+(42)−(43)+(47)−(59)+(63)−(64)+(69)−(79)+(83)−(89)+(93)−(99)+(104)
−(114)+(118)+(133)−(134)+(136)−(137)+(162)−(164)

259. 0=+1.50−(69a)+(69b)−(431)+(432)+(433)−(435)

260. 0=−0.28−(79a)+(79b)−(430)+(431)−(433)+(434)

261. 0=+2.53−(79)+(79b)−(69a)+(69)−(430)+(432)

262. 0=+11.530−0.023(69a)+2.356(69b)−2.333(69)−10.279(79)+10.316(79a)−0.037(79b)+0.065(431)−0.065(432)

257. 0=+5.36+(1)−(5)+(8)−(15)+(17)−(19)+(23)−(29)+(33)−(39)+(43)−(50)+(4)−(5)+(7)−(12)+(17)−(21)
+(24a)

258. 0=+13.4−2.02(68)−0.28(69)−0.47(81)+0.47(83)−3.38(84)+3.38(85)+4.81(86)−4.81(87)+2.80(89)−2.80(90)
−2.98(92)+2.98(93)+0.82(94)+1.33(96)−2.15(98)+0.96(99)−0.96(101)−4.16(102)+4.16(104)−1.93(105)
+1.93(107)+3.34(104)−3.34(109)−0.56(114)+0.56(116)−1.22(117)+1.22(118)+0.65(119)−0.65(121)
+1.74(123)−1.74(124)+0.26(126)+3.03(127)−3.03(128)−0.26(129)−2.37(131)−1.83(132)+1.83(133)
+2.37(134)−4.47(135)+0.25(137)+4.47(138)−0.25(141)−3.43(148)+3.43(149)+4.50(150)−4.50(151)
−0.38(152)−0.99(154)+1.37(157)−0.19(158)+0.19(159)−0.96(166)+0.96(169)−1.19(433)+1.19(434)
+0.67(430)−0.67(432)+3.70(79a)−3.70(79b)+2.30(69a)

ROCKY MOUNTAIN SERIES.

187. 0=+0.68+(1)−(4)−(5)+(6)

188. 0=−0.22−(1)+(2)+(5)−(8)−(14)+(15)

189. 0=+0.27−(3)+(4)−(6)+(7)−(12)+(13)

190. 0=−1.08−(7)+(8)−(11)+(12)−(15)+(16)

191. 0=−0.13−(10)+(11)−(16)+(17)−(19)+(20)

192. 0=−1.27−(9)+(10)−(20)+(21)−(26)+(27)

193. 0=+0.19−(21)+(22)−(24)+(26)−(37)+(38)

194. 0=−0.23−(22)+(23)−(29)+(31)−(36)+(37)

195. 0=+0.61−(24)+(25)−(30)+(31)−(36)+(38)

196. 0=+0.47−(17)+(18)+(19)−(23)−(28)+(29)

197. 0=+0.61−(31)+(33)−(35)+(36)−(39)+(40)

198. 0=+1.37−(31)+(32)−(34)+(36)−(48)+(49)

199. 0=+1.13−(32)+(33)−(39)+(41)−(47)+(48)

200. 0=−1.00−(41)+(42)−(45)+(47)−(58)+(59)

201. 0=−1.44−(41)+(43)−(46)+(47)−(50)+(51)

202. 0=+0.39−(45)+(46)−(51)+(52)−(57)+(59)

203. 0=+0.76−(43)+(44)+(50)−(55)−(60)+(61)

204. 0=−0.18+(4)−(5)−(52)−(56)+(57)+(65)

205. 0=+2.31−(54)+(55)−(61)+(63)−(66)+(67)

206. 0=−1.09−(4)+(5)−(16)+(27)+(54)−(67)

236. 0=−0.79+5.52(1)−1.42(2)−1.43(3)+4.00(4)−1.72(11)+4.30(12)−2.58(13)−1.79(14)+4.11(15)−2.32(16)

237. 0=−0.64−1.72(9)+3.05(10)−1.33(11)−1.45(16)+7.56(17)−6.11(18)−1.78(25)+2.21(26)−0.43(27)−6.88(28)
+10.26(29)−3.38(30)

238. 0=−0.18+1.04(21)−4.09(22)+3.05(23)+3.15(24)−3.48(25)+0.33(26)+0.09(27)−1.44(30)+1.35(31)

239. 0=+2.44+4.11(31)−5.69(32)+1.58(33)+1.19(39)−4.20(40)+3.00(41)−0.10(47)−2.42(48)+2.52(49)

240. 0=+7.68+1.86(41)−5.41(42)+3.55(43)+4.71(45)−4.87(46)+0.16(47)+0.67(50)−3.14(51)+2.47(52)

241. 0=−4.36−2.24(5)−0.14(16)+1.82(27)+3.55(42)−7.97(43)+4.42(44)+2.88(56)−3.37(57)+0.49(58)+1.91(60)
−2.53(61)+0.62(63)+2.38(65)+0.99(66)−2.80(67)

242. 0=+6.35+2.78(4)−0.14(5)+0.24(11)−0.24(14)+1.91(16)−1.77(18)+1.09(25)−5.17(54)+2.39(55)+0.62(61)
−3.90(62)+3.28(63)−1.09(66)

254. 0=+5.76−1.42(1)+1.42(2)−2.56(4)−0.91(5)+0.91(6)−0.11(7)+0.11(8)−1.72(9)+1.72(10)+1.72(11)−1:72(12)
+1.79(14)−1.79(15)−1.45(16)+1.45(17)+0.90(19)−0.90(20)−3.05(22)+3.05(23)−0.34(24)+0.77(26)−0.43(27)
+0.09(29)−1.67(31)+1.58(33)−1.63(34)+1.63(35)+2.97(37)−2.97(38)+1.19(39)−1.19(40)−3.55(42)+3.55(43)
−0.16(45)+0.06(47)+0.10(49)+0.67(50)−0.67(52)+2.78(54)−2.88(56)+2.88(57)+2.04(58)−2.04(59)−2.38(65)
+1.82(67)−2.78(4)+2.38(5)−0.81(3)+0.81(5)+0.41(8)−0.41(9)−1.88(10)−0.24(11)+1.88(12)+0.24(14)
−2.85(17)+2.85(18)−3.17(25)+1.35(27)

EL PASO BASE NET.

207. 0=−0.17−(4)+(5)−(6)+(8)−(17)+(19)

208. 0=−0.76−(3)+(4)−(8)+(9)−(10)+(12)

209. 0=+0.41−(3)+(5)−(11)+(12)−(17)+(18)

210. 0=+1.33+(1)−(4)−(7)+(8)−(22)+(23)

211. 0=+0.38+(1)−(5)−(15)+(17)−(22)+(24)

212. 0=+0.07−(1)+(3)−(12)+(13)−(21)+(22)

213. 0=+1.24−(2)+(3)−(12)+(14)−(25)+(26)

No.
214. 0=−2.12+(2)−(5)−(16)+(17)−(26)+(27)
215. 0=−2.60−(1)+(2)−(20)+(22)−(26)+(28)
243. 0=+7.79−1.60(3)+2.91(4)−1.31(5)−5.65(10)+7.54(11)−1.89(12)−1.65(17)+7.61(18)−5.96(19)
244. 0=+21.22−6.06(7)+6.47(8)−0.41(9)−1.89(10)+15.95(12)−14.06(13)−12.80(21)+20.22(22)−7.42(23)
245. 0=−10.97−0.77(6)+6.06(7)−5.29(8)−1.98(15)+3.63(17)−1.65(19)−5.41(22)+7.42(23)−2.01(24)
246. 0=−15.94−3.30(11)+4.33(12)−1.03(14)−8.79(16)+11.64(17)−2.85(18)−4.06(25)+23.43(26)−19.37(27)
247. 0=+1.59−3.30(11)+4.33(12)−1.03(14)−1.98(15)+4.83(17)−2.85(18)−0.40(20)+2.41(22)−2.01(24)−4.06(25)
+8.14(26)−4.08(28)

COLORADO SERIES.

216. 0=+1.44+(20)−(28)−(214)+(215)−(223)+(224)
217. 0=+0.10−(213)+(214)−(219)+(220)−(224)+(225)
218. 0=−3.17−(205)+(206)−(212)+(213)−(220)+(221)
219. 0=−1.59+(210)−(215)−(217)+(218)−(222)+(223)
220. 0=−2.85−(203)+(204)−(210)+(211)−(216)+(217)
221. 0=+3.92−(202)+(203)−(206)+(207)−(211)+(212)
222. 0=−0.20−(198)+(199)−(200)+(202)−(207)+(208)
223. 0=+0.28−(190)+(192)−(197)+(198)−(208)+(209)
224. 0=−2.21−(191)+(192)−(197)+(199)−(200)+(201)
225. 0=+1.00−(188)+(189)−(192)+(193)−(195)+(197)
226. 0=+1.59−(181)+(182)−(187)+(189)−(195)+(196)
227. 0=−1.03−(180)+(182)−(187)+(188)−(193)+(194)
228. 0=−1.18−(169)+(170)−(182)+(184)−(186)+(187)
229. 0=−0.33−(178)+(179)−(182)+(183)−(185)+(187)
230. 0=−0.42−(170)+(171)−(177)+(179)−(185)+(186)
231. 0=−2.85−(163)+(164)+(165)−(168)−(175)+(176)
232. 0=+1.57−(162)+(164)−(171)+(173)−(175)+(177)
233. 0=+0.13−(154)+(155)−(166)+(167)−(172)+(174)
234. 0=−1.61−(154)+(162)−(173)+(174)
235. 0=−0.86−(155)+(163)−(165)+(166)
248. 0=−13.3−1.34(20)−0.21(28)−2.24(202)+5.09(203)−2.85(204)−1.48(205)+2.93(206)−1.45(207)−0.98(216)
+0.08(217)+0.90(218)−0.57(219)+1.95(220)−1.38(221)−3.76(222)+5.10(223)+2.03(224)−1.82(225)
249. 0=+4.9+2.94(197)−2.72(198)−0.22(199)+2.64(200)−4.53(201)+1.89(202)+1.11(207)−4.11(208)+3.00(209)
250. 0=+3.7+2.45(180)−3.32(181)+0.87(182)+1.44(187)−3.25(188)+1.81(189)+0.45(195)−2.69(196)+2.24(197)
251. 0=+5.5+0.35(169)+2.33(170)−2.68(171)−2.40(182)+6.33(183)−3.93(184)−3.54(185)+3.85(186)−0.31(187)
252. 0=+1.4−3.23(154)+7.25(155)+7.42(163)−7.10(164)−1.90(171)+3.22(172)−1.32(174)−7.37(175)+7.74(176)
−0.37(177)
253. 0=−16.0−3.23(154)+7.25(155)+10.43(162)−10.11(163)−13.15(172)+14.47(173)−1.32(174)
255. 0=−11.1+0.81(3)−0.81(5)−0.41(8)+0.41(9)+1.88(10)−1.88(12)−1.45(13)+1.45(14)−1.77(16)+2.85(17)
−1.08(18)+2.11(20)−0.77(21)+3.17(25)−3.17(27)+1.18(154)+3.97(162)−3.97(164)−0.35(169)+0.35(171)
−1.80(173)+1.80(174)+0.22(175)−0.22(177)+1.36(178)−1.36(179)+0.87(180)−0.87(182)−3.93(183)+3.93(184)
−0.31(185)+0.31(187)+1.81(188)−1.81(189)+0.78(190)−0.78(171)−1.38(193)+1.38(194)−0.45(195)
+0.23(197)+0.22(199)−2.64(200)+2.64(201)+2.24(202)−2.24(203)+1.48(205)−1.48(206)−1.11(207)
+1.11(209)−0.32(211)+0.32(212)+2.66(214)−2.66(215)+0.57(219)−1.96(220)+1.39(221)−1.34(223)
−1.82(224)+1.82(225)
256. 0=−3.34+(1)−(5)+(8)−(15)+(17)−(19)+(23)−(29)+(33)−(39)+(43)−(50)+(54)−(67)+(225)−(219)+(221)
−(205)+(209)−(190)+(194)−(180)+(184)−(169)+(174)−(154)

ACCURACY AS INDICATED BY CORRECTIONS TO OBSERVED DIRECTIONS.

The corrections to observed directions resulting from the figure adjustments indicated by the preceding observation equations are as follows:

Table of corrections to observed directions.

ROCKY MOUNTAIN SERIES.

Number of direction.	Correction to direction.	Number of direction.	Correction to direction.	Number of direction.	Correction to direction.	Number of direction.	Correction to direction.
	"		"		"		"
1	+0.038	21	+0.020	36	−0.120	51	+0.945
2	+1.020	22	+0.327	37	+0.392	52	−0.128
3	−0.263	23	−0.080	38	−0.178	54	+0.434
4	+0.187	24	+0.060	39	+0.641	55	−0.049
5	+0.225	25	−0.453	40	+0.368	56	−0.024
6	−0.307	26	+0.133	41	−0.410	57	−0.445
7	−0.207	27	+0.261	42	+0.404	58	+0.330
8	+0.289	28	+0.510	43	−0.275	59	+0.139
9	−0.462	29	−0.006	44	−0.727	60	+0.476
10	+0.224	30	+0.159	45	−0.236	61	+0.199
11	+0.123	31	+0.121	46	−0.140	62	−0.064
12	+0.467	32	−0.227	47	+0.139	63	−0.611
13	−0.352	33	−0.555	48	+0.389	65	+0.838
14	+0.120	34	+0.363	49	−0.153	66	+0.583
15	−0.576	35	−0.457	50	−0.081	67	−0.435
16	−0.336						
17	+0.497						
18	+0.295						
19	+0.168						
20	−0.434						

EL PASO BASE NET.

	"		"		"		"
1	−0.623	11	−0.362	21	+0.510	25	+0.137
2	+0.998	12	−0.236	22	−0.112	26	−0.498
3	−0.332	13	+0.027	23	+0.191	27	−0.727
4	−0.051	14	+0.492	24	−0.415	28	+0.234
5	+0.008	15	+0.219				
6	−0.702	16	−0.583				
7	+0.678	17	+0.774				
8	−0.383	18	−0.103				
9	+0.408	19	+0.565				
10	+0.078	20	−0.360				

COLORADO SERIES.

	"		"		"		"
225	+0.131	205	−0.621	190	+0.428	175	−0.260
224	+0.575	204	−0.120	189	−0.300	174	+0.100
223	+0.922	203	−0.414	188	+0.299	173	−0.144
222	−0.734	202	−0.214	187	+0.181	172	−0.518
221	+0.335	201	+0.841	186	−0.466	171	+0.642
220	+0.036	200	−0.093	185	+0.286	170	+0.010
219	−0.369	199	+0.144	184	+0.274	169	−0.089
218	+0.218	198	−0.010	183	−0.034	168	−0.884
217	+0.352	197	−0.082	182	−0.161	167	+0.095
216	−0.570	196	−0.263	181	+0.473	166	+0.755
215	−0.403	195	+0.211	180	−0.552	165	+0.035
214	+0.096	194	+0.493	179	+0.060	164	+0.413
213	+0.158	193	−0.028	178	−0.247	163	−0.335
212	−0.811	192	+0.079	177	−0.477	162	+0.979
211	+1.298	191	−0.973	176	+0.924	155	−0.475
						154	−0.387
210	−0.338						
209	−0.165						
208	−0.163						
207	−0.332						
206	+1.282						

Table of corrections to observed directions—Continued.

ONE HUNDRED AND FOURTH MERIDIAN.

Number of direction.	Correction to direction.	Number of direction.	Correction to direction.	Number of direction.	Correction to direction.	Number of direction.	Correction to direction.
	″		″		″		″
1	+0.025	73	−0.479	151	+0.989	231	−0.410
2	−0.719	74	−0.466	152	+0.418	232	+0.668
3	−0.163	75	+0.221	153	−0.319	233	−0.332
4	−0.263	76	−0.851	154	+0.244	234	−0.239
5	+0.105	77	+1.249	155	+0.185	235	+0.036
6	−0.484	78	−0.152	156	+0.188	236	+0.629
7	−1.332	79	+0.756	157	−0.716	237	−0.093
8	+0.558	79a	−0.371	158	+0.211	238	−0.885
9	+0.545	79b	−0.555	159	−0.065	239	+0.511
10	−0.335	80	+0.632	160	+0.229	240	−0.272
11	−0.768	81	−0.285	161	−0.375	241	+0.454
12	+0.813	82	+0.060	162	−0.471	242	+0.192
13	+1.142	83	−0.237	163	+0.365	243	+0.110
14	−0.031	84	−0.101	164	+0.108	244	−0.440
15	−0.612	85	−0.441	165	−0.002	245	+0.378
16	−0.217	86	−0.139	166	−0.934	246	−0.367
17	−1.096	87	+0.246	167	+0.550	247	+0.320
18	+0.354	88	+0.435	168	+0.114	248	−0.299
19	−0.222	89	+0.100	169	+0.270	249	+0.373
20	−0.132	90	+0.367	170	−0.045	250	+0.238
21	+0.600	91	+0.265	171	+0.370	251	+0.102
22	+0.382	92	+0.093	172	−0.381	252	−0.414
23	+0.292	93	−0.823	173	+0.056	253	−0.198
24	+0.109	94	−0.030	174	−0.516	254	+0.706
24a	−0.896	95	+0.095	175	−0.138	255	+0.330
24b	−1.072	96	−0.375	176	+0.410	256	−1.143
24c	+0.648	97	−0.171	177	+0.015	257	+0.305
24d	+0.424	98	+0.481	178	+0.231	258	+0.754
25	−0.488	99	+0.468	179	−0.229	259	−0.570
26	−0.398	100	+0.094	180	−0.174	260	+0.113
27	+0.338	101	+0.110	181	+0.402	261	+0.243
27a	−1.774	102	+0.115	182	+0.359	262	+0.312
28	−0.056	103	−0.310	183	−0.590	263	−0.853
29	+0.792	104	−0.477	184	+0.173	264	−0.144
30	+0.352	105	−0.514	185	−0.065	265	−0.398
31	−0.327	106	+0.980	186	+0.123	266	−0.060
32	+1.073	107	−0.590	187	−0.401	267	+0.602
33	+0.263	108	+0.064	188	+0.537	268	+0.278
34	−0.567	109	+0.060	189	+0.282	269	−0.259
35	−0.945	110	+0.355	190	+0.184	270	−0.043
35a	+1.162	111	+0.283	191	−0.602	271	+0.361
36	−0.188	112	−0.042	192	+0.019	272	−0.337
37	+0.275	113	−0.596	193	+0.597	273	+0.230
38	−0.426	114	−0.341	194	−0.433	274	−0.195
39	+0.800	115	+0.817	195	−0.396	275	+0.225
40	−0.197	116	−0.094	196	+0.212	276	−0.482
41	−0.106	117	−0.216	197	+0.493	277	+0.250
42	−0.072	118	−0.166	198	−0.291	278	+0.144
43	−0.457	119	+0.106	199	−0.173	279	−0.172
44	+0.789	120	−0.658	200	−0.014	280	−0.172
45	+0.807	121	−0.153	201	−0.015	281	+0.144
46	−0.124	122	+0.211	202	+0.130	282	+0.004
47	−1.015	123	+0.710	203	−0.214	283	+0.024
48	+0.579	124	−0.216	204	+0.133	284	+0.169
49	−0.493	125	−0.337	205	−0.015	285	−0.083
50	−0.402	126	+0.652	206	−0.036	286	+0.273
51	+0.099	127	−0.308	207	+0.215	287	−0.376
52	+0.217	128	+0.323	208	−0.318	288	−0.147
53	−0.025	129	−0.330	209	+0.361	289	+0.164
54	−0.249	130	−0.150	210	+0.070	290	−0.207
55	+0.215	131	+0.001	211	−0.153	291	+0.156
56	+0.186	132	−0.192	212	−0.175	292	+0.138
57	−0.506	133	+0.006	213	+0.062	293	−0.176
58	+0.377	134	+0.335	214	+0.275	294	+0.318
59	+0.842	135	−0.436	215	−0.261	295	+0.302
60	−0.117	136	−0.055	216	−0.302	296	−0.531
61	−0.275	137	+0.288	217	+0.225	297	+0.110
62	−0.202	138	+0.519	218	−0.018	298	−0.144
63	−0.248	139	−0.312	219	+0.124	299	+0.034
64	−0.269	140	−0.666	220	+0.074	300	−0.065
65	+0.063	141	+0.278	221	−0.251	301	+0.068
66	+0.041	142	−0.335	222	+0.213	302	−0.185
67	−0.302	143	+0.721	223	−0.143	303	+0.229
68	+0.449	144	−0.011	224	−0.051	304	−0.047
69	−0.252	145	−0.229	225	−0.114	305	−0.355
69a	+0.508	146	−0.339	226	+0.179	306	+0.123
69b	−0.236	147	+0.075	227	−0.014	307	+0.163
70	−0.043	148	+0.575	228	+0.116	308	−0.168
71	−0.283	149	−0.587	229	−0.024	309	+0.237
72	+0.805	150	−0.472	230	−0.349	310	−0.060

Table of corrections to observed directions—Continued.

ONE HUNDRED AND FOURTH MERIDIAN—Continued.

Number of direction.	Correction to direction.	Number of direction.	Correction to direction.	Number of direction.	Correction to direction.	Number of direction.	Correction to direction.
	"		"		"		"
311	+0.041	345	−0.631	375	−0.068	405	+0.294
312	−0.324	346	+0.182	376	−0.173	406	+0.558
313	+0.503	347	+0.449	377	+0.128	407	−0.077
313a	+0.027	348	−0.449	378	−0.115	408	−0.247
314	−0.189	349	−0.212	379	−0.651	409	+0.302
315	−0.190	350	−0.019	380	+0.880	410	+0.074
316	+0.094	351	+0.431	381	+0.126	411	−0.128
317	+0.006	352	+0.249	382	−0.770	412	−0.310
318	−0.187	353	+0.033	383	+0.275	413	+1.349
319	+0.613	354	+0.216	384	+0.198	414	−1.039
320	+0.100	355	−0.359	385	+0.170	415	−0.488
321	+0.041	356	−0.366	386	−0.358	416	+0.632
322	−0.477	357	−0.114	387	+0.489	417	−0.586
323	−0.410	358	−0.067	388	+0.144	418	+0.222
324	+0.202	359	+0.656	389	−0.463	419	+0.219
325	−0.420	360	+0.118	390	+0.188	420	−0.358
326	+0.226	361	−0.523	391	+0.014	421	+0.272
327	−0.210	362	+0.405	392	+0.270	422	−0.078
328	+0.648	363	−0.211	393	−0.091	423	+0.244
329	−0.315	364	+0.276	394	−0.175	424	−0.082
330	+0.279	365	−0.065	395	+0.010	425	−0.310
331	+0.151	366	−0.376	396	−0.029	426	−0.360
332	+0.135	367	+0.225	397	+0.318	427	−0.184
333	−0.096	368	+0.436	398	−0.248	428	+0.440
334	−0.356	369	−0.245	399	−0.370	429	+0.414
335	+0.166	370	−0.042	400	+0.300	430	+0.167
336	+0.502	371	+0.334	401	−0.030	431	+0.124
337	−0.374	372	−0.811	402	−0.208	432	−0.291
338	−0.051	373	+0.195	403	−0.319	433	−0.283
339	−0.109	374	+0.282	404	−0.220	434	+0.224
						435	+0.058
340	+0.085						
341	−0.053						
342	+0.443						
343	−0.530						
344	+0.087						

The maximum correction to an observed direction for the different sections is shown in the following table:

Maximum correction to an observed direction by sections.

Section.	Direction number.	Between stations.	Correction.
			"
El Paso base net	2	El Paso east base and Big Springs	1.00
Rocky Mountain series	2	Tushar and Mount Ellen	1.02
Colorado series	211	Square Bluffs and Hugo	1.30
El Paso to Cheyenne	7	Divide and Hilltop	1.33
Cheyenne to Provo	151	Alkali and Manville	0.99
Provo to Ambrose	256	Black and Whetstone	1.14

The maximum correction to a direction on the ninety-eighth meridian triangulation was 1″.96, and the average maximum correction for the 17 sections into which that arc was divided was 0″.99.

The probable error of an observed direction is

$$d = 0.674\sqrt{\frac{\Sigma\, v^2}{c}}$$

in which $\Sigma\, v^2$ is the sum of the squares of the corrections to directions and c is the number of conditions.

The probable error of an observed direction resulting from the new adjustment for each of the three sections of the thirty-ninth parallel was found to be slightly larger than that resulting from the original adjustment.

El Paso base net, original adjustment, ±0″.40 became ±0″.44.

Rocky Mountain series, original adjustment, ±0″.32 became ±0″.40.

Colorado series, original adjustment, ±0″.50 became ±0″.52.[1]

[1] Only a part of the Kansas-Colorado series considered.

The probable error of an observed direction resulting from the figure adjustment for the entire one hundred and fourth meridian is $\pm 0''.38$. When considered as divided into three sections by the base lines, the probable error of an observed direction for each section is as follows:

Divide-Pikes Peak to Cheyenne base $\pm 0''.41$.[1]
Cheyenne base to Provo base $\pm 0''.39$.
Provo base to Ambrose base $\pm 0''.36$.

ACCURACY AS INDICATED BY CORRECTIONS TO ANGLES AND CLOSURES OF TRIANGLES.

The correction to each angle is the algebraic sum of the corrections to two directions. In order to make it possible to study the corrections to the separate angles, they are shown in the following table for every triangle in the primary scheme. There are shown the corrections to the angles resulting from the figure adjustment, the errors of closure of the triangles, the corrected spherical angles, and the spherical excess for each triangle. The plus sign prefixed to the error of closure of a triangle indicates that the sum of the angles is less than 180° plus the spherical excess. The spherical excess is a convenient indication of the size of the triangle, since it is proportional to the area.

Table of triangles.

ROCKY MOUNTAIN SERIES.

Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.
	"	"	° ' "	"
Wasatch	−0.53		113 25 30.46	
Tushar	+0.04	−0.68	27 11 27.36	21.64
Mount Nebo	−0.19		39 23 23.82	
Mount Ellen	−0.70		49 36 36.88	
Tushar	+0.98	+0.22	55 56 26.70	34.33
Wasatch	−0.06		74 27 30.75	
Patmos Head	−0.82		39 09 43.24	
Wasatch	+0.10	−0.27	85 03 64.27	22.15
Mount Nebo	+0.45		55 46 34.64	
Patmos Head	+0.34		50 46 41.57	
Mount Ellen	+0.24	+1.08	42 10 57.45	33.55
Wasatch	+0.50		87 02 54.53	
Mount Waas	−0.60		66 55 24.67	
Mount Ellen	+0.83	+0.13	55 25 23.72	48.71
Patmos Head	−0.10		57 39 60.32	
Tavaputs	+0.13		78 24 37.01	
Mount Waas	+0.45	+1.27	50 48 50.78	31.62
Patmos Head	+0.69		50 46 63.83	
Uncompahgre	−0.52		17 00 38.51	
Mount Ellen	−0.20	−0.47	19 00 53.69	35.59
Mount Waas	+0.25		143 58 63.39	
Uncompahgre	+0.17		31 54 61.57	
Mount Waas	−0.10	+0.65	98 16 41.16	46.15
Tavaputs	+0.58		49 48 63.42	
Treasury Mountain	+0.51		57 48 40.15	
Uncompahgre	+0.13	+0.23	87 35 56.19	45.18
Mount Waas	−0.41		34 35 68.84	
Treasury Mountain	−0.06		93 10 60.85	
Uncompahgre	−0.04	−0.61	55 40 54.62	48.38
Tavaputs	−0.51		31 08 52.91	
Treasury Mountain	−0.57		35 22 20.70	
Mount Waas	+0.31	−0.19	63 40 32.32	49.35
Tavaputs	+0.07		80 57 56.33	
Mount Ouray	−0.27		60 29 29.62	
Uncompahgre	−0.68	−0.61	53 06 51.77	25.55
Treasury Mountain	+0.34		66 23 64.16	
Mount Elbert	+0.25		51 40 39.27	
Mount Ouray	−1.05	−1.13	95 30 63.61	23.13
Uncompahgre	−0.33		32 48 40.25	
Mount Elbert	−0.29		92 45 10.58	
Mount Ouray	−0.78	−1.89	35 01 33.99	11.64
Treasury Mountain	−0.82		52 13 27.07	
Mount Elbert	−0.54		41 04 31.31	
Uncompahgre	−0.35	−1.37	20 18 11.52	14.06
Treasury Mountain	−0.48		118 37 31.23	
Bison	−0.19		45 54 08.24	
Mount Ouray	+0.81	+1.00	48 32 24.41	16.69
Mount Elbert	+0.38		85 33 44.04	
Pikes Peak	+1.03		38 34 45.12	
Mount Ouray	+0.13	+1.44	79 13 59.50	22.36
Mount Elbert	+0.28		62 11 37.74	
Pikes Peak	−0.05		72 24 49.46	
Mount Ouray	−0.68	+0.05	30 41 35.09	16.13
Bison	+0.78		76 53 51.58	
Pikes Peak	−1.08		33 50 04.34	
Mount Elbert	+0.10	−0.39	23 22 06.30	10.46
Bison	+0.59		122 47 59.82	
Plateau	−0.28		47 45 08.98	
Mount Ouray	−0.45	−0.76	25 27 44.75	17.95
Pikes Peak	−0.03		106 47 24.22	
Divide	+0.73		41 30 13.05	
Pikes Peak	−0.13	+0.18	102 17 57.38	7.72
Bison	−0.42		36 11 57.29	
Big Springs	−1.02		64 54 16.03	
Plateau	−0.81	−2.31	73 43 16.16	7.63
Pikes Peak	−0.48		41 32 35.44	
Big Springs	−0.29		49 12 60.27	
Pikes Peak	+0.69	+1.09	37 07 13.50	5.60
Divide	+0.69		93 39 51.83	
Coral Bluffs	....		62 35 09.40	
Big Springs	−0.45	....	80 31 35.02	3.87
Plateau	−0.54		36 53 19.45	

[1] This probable error when computed after the introduction of the Laplace azimuth at Watkins astronomic was $\pm 0''.56$.

Table of triangles—Continued.

EL PASO BASE NET.

Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.	Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.
	″	″	° ′ ″	″		″	″	° ′ ″	″
Coral Bluffs	+0.85		96 29 37.91		Holcolm Hills	+0.25		79 12 08.36	
Divide	+0.48	+0.47	49 54 42.72	1.91	Big Springs	+0.73	+2.60	27 18 38.29	0.96
Big Springs	−0.86		33 35 41.28		El Paso east base	+1.62		73 29 14.31	
El Paso west base	+1.11		148 54 54.32		Holcolm Hills	−0.06		125 34 08.84	
Divide	+0.67	+1.34	15 28 13.79	0.19	Big Springs	+0.96	+0.10	21 06 23.86	1.09
Coral Bluffs	−0.44		15 36 52.08		Divide	−0.80		33 19 28.39	
El Paso east base	−1.33		88 39 22.04		Holcolm Hills	−0.62		9 20 30.46	
Big Springs	−0.63	−1.24	27 23 26.85	1.10	Coral Bluffs	+0.26	−0.07	8 30 53.35	0.16
Coral Bluffs	+0.72		63 57 12.21		El Paso east base	+0.29		162 08 36.35	
El Paso east base	+0.28		52 50 51.20		Holcolm Hills	−0.32		25 10 53.00	
Coral Bluffs	−0.31	+0.76	48 09 17.78	0.34	Coral Bluffs	−0.05	−0.64	56 40 11.13	0.72
El Paso west base	+0.79		78 59 51.36		El Paso west base	−0.27		98 08 56.59	
El Paso east base	+0.34		111 01 24.13		Holcolm Hills	−0.93		55 42 30.94	
Coral Bluffs	+0.13	−0.41	32 32 25.70	0.48	Coral Bluffs	+0.39	−0.86	41 03 19.05	1.10
Divide	−0.88		36 26 10.65		Divide	−0.32		83 14 11.11	
El Paso east base	+0.06		58 10 32.93		Holcolm Hills	+0.30		15 50 22.54	
El Paso west base	+0.32	+0.17	69 55 02.96	0.33	El Paso east base	−0.57	−1.33	145 00 32.45	0.22
Divide	−0.21		51 54 24.44		El Paso west base	−1.06		19 09 05.23	
El Paso east base	+0.99		160 19 13.83		Holcolm Hills	−0.30		46 22 00.49	
Divide	+1.36	+2.12	13 28 32.07	0.33	El Paso east base	−0.63	−0.38	86 49 59.52	0.46
Big Springs	−0.23		6 12 14.43		Divide	+0.55		46 47 60.45	
Holcolm Hills	+0.87		69 51 37.90		Holcolm Hills	−0.61		30 31 37.94	
Big Springs	+0.10	+1.43	54 42 05.14	1.90	El Paso west base	+1.38	+1.12	50 45 57.73	0.57
Coral Bluffs	+0.46		55 26 18.86		Divide	+0.35		98 42 24.90	

COLORADO SERIES.

Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.	Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.
	″	″	° ′ ″	″		″	″	° ′ ″	″
Square Bluffs	−0.50		38 21 33.21		Kit Carson	−0.64		35 15 04.09	
Big Springs	+0.34	−1.44	84 16 15.29	2.76	Overland	−0.47	−1.59	39 53 01.00	2.07
Holcolm Hills	−1.28		57 22 14.26		Eureka	−0.48		104 51 56.98	
Cramer Gulch	+0.40		74 58 26.45		Landsman	+0.31		57 00 59.18	
Big Springs	−0.44	−0.10	49 05 18.18	2.44	Kit Carson	+0.13	+0.33	41 18 58.04	1.85
Square Bluffs	−0.06		55 56 17.81		Eureka	−0.11		81 40 04.63	
Holt	−0.14		113 09 57.85		First View	+0.10		57 33 37.43	
Square Bluffs	+0.07	+1.59	37 35 49.93	1.70	Kit Carson	+0.44	+1.18	69 28 41.44	2.10
Holcolm Hills	+1.66		29 14 13.92		Eureka	+0.64		52 57 43.23	
Hugo	+0.29		36 25 45.47		First View	+0.73		99 35 36.87	
Square Bluffs	+1.64	+2.85	78 24 60.37	2.22	Kit Carson	+0.31	+1.27	28 09 43.40	1.25
Holt	+0.92		65 09 16.38		Landsman	+0.23		52 14 40.98	
Adobe	+1.90		55 00 03.43		First View	+0.63		42 01 59.44	
Cramer Gulch	+0.30	+3.17	56 38 46.93	2.18	Eureka	−0.75	+0.42	28 42 21.40	1.00
Square Bluffs	+0.97		68 21 11.82		Landsman	+0.54		109 15 40.16	
Adobe	−1.61		55 25 51.10		Cheyenne Wells	−0.98		52 09 06.37	
Square Bluffs	−2.11	−3.92	81 20 06.86	2.84	First View	−1.16	−3.54	47 49 53.10	0.70
Hugo	−0.20		43 14 04.88		Landsman	−1.40		80 01 01.23	
Overland	+0.15		58 07 43.77		Monotony	−1.31		11 24 49.24	
Adobe	+0.17	+0.20	35 00 49.39	3.36	First View	+0.37	−0.88	8 16 48.70	0.29
Hugo	−0.12		86 51 30.20		Cheyenne Wells	+0.06		160 18 22.35	
Aroya	−1.40		69 40 18.42		Monotony	−0.56		27 55 20.57	
Adobe	+0.17	−2.29	62 08 26.06	3.50	First View	−0.79	−1.57	56 06 41.80	1.34
Hugo	−1.06		48 11 19.02		Landsman	−0.22		95 57 58.97	
Aroya	−0.35		115 08 24.23		Monotony	+0.75		16 30 31.33	
Adobe	0.00	−0.28	27 07 36.67	2.12	Cheyenne Wells	+0.92	+2.85	147 32 31.28	0.35
Overland	+0.07		37 44 01.22		Landsman	+1.18		15 56 57.74	
Aroya	+1.05		45 28 05.81		Arapahoe	−0.09		33 03 37.76	
Hugo	+0.94	+2.21	38 40 11.18	1.98	First View	+0.62	−0.13	57 47 23.05	1.83
Overland	+0.22		95 51 44.99		Cheyenne Wells	−0.66		89 09 01.02	
Eureka	−0.60		49 18 43.05		Arapahoe	+0.38		60 41 14.90	
Aroya	−0.11	−1.00	52 45 27.41	1.79	First View	+0.25	+1.61	49 30 34.35	2.80
Overland	−0.29		77 55 51.33		Monotony	+0.98		69 48 13.55	
Kit Carson	+1.03		32 24 49.58		Arapahoe	+0.47		27 37 37.14	
Aroya	+0.41	+1.62	109 32 21.98	1.89	Cheyenne Wells	+0.72	+0.86	71 09 21.33	1.26
Overland	+0.18		38 02 50.33		Monotony	−0.33		81 13 02.79	
Kit Carson	+0.39		67 39 53.67						
Aroya	+0.52	+1.03	56 46 54.57	2.17					
Eureka	+0.12		55 33 13.93						

Table of triangles—Continued.

ONE HUNDRED AND FOURTH MERIDIAN.

Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.
	″	″	° ′ ″	″
Elbert	−0.01		59 51 04.09	
Divide	−0.59	−0.70	102 02 23.21	2.48
Pikes Peak	−0.10		18 06 35.18	
Hilltop	+0.33		1 18 22.139	
Divide	−0.85	+0.81	1 44 40.274	0.06
Elbert	+1.33		176 56 57.646	
Hilltop	−0.84		42 01 49.05	
Divide	−1.43	−1.82	103 47 03.49	5.74
Pikes Peak	+0.45		34 11 13.20	
Hilltop	−1.17		40 43 26.91	
Elbert	−1.31	−1.93	123 11 58.27	3.20
Pikes Peak	+0.55		16 04 38.02	
Morrison	−0.68		15 19 44.86	
Hilltop	−1.76	−2.87	129 47 58.48	2.70
Elbert	−0.43		34 52 19.36	
Morrison	+0.72		55 01 14.51	
Hilltop	−0.59	−0.61	89 04 31.57	10.61
Pikes Peak	−0.74		35 54 24.53	
Morrison	+1.40		39 41 29.65	
Elbert	−0.88	+0.33	88 19 38.91	11.11
Pikes Peak	−0.19		51 58 62.55	
Douglas	−0.58		122 43 40.87	
Hilltop	+0.40	−0.62	50 35 37.78	0.81
Morrison	−0.44		6 40 42.16	
Indian	−0.22		11 58 04.27	
Hilltop	−0.87	−0.61	26 45 32.34	0.19
Douglas	+0.48		141 16 23.58	
Indian	−0.31		78 31 21.96	
Hilltop	−0.47	−0.38	77 21 10.12	3.08
Morrison	+0.40		24 07 31.00	
Indian	−0.09		66 33 17.69	
Douglas	+0.10	+0.85	95 59 55.55	2.08
Morrison	+0.84		17 26 48.84	
Watkins astronomic	+1.72		90 56 20.85	
Indian	−1.19	+2.25	78 17 40.90	1.37
Morrison	+1.72		10 45 59.62	
Watkins astronomic	+1.50		122 06 16.48	
Indian	−1.01	−0.86	50 46 52.24	1.39
Boulder	−1.35		7 06 52.67	
Watkins astronomic	−0.22		31 09 55.63	
Morrison	−1.38	−2.49	91 57 32.95	4.46
Boulder	−0.89		56 52 35.88	
Boulder	+0.46		49 45 43.21	
Indian	−0.18	+0.62	27 30 48.68	4.44
Morrison	+0.34		102 43 32.57	
Brighton	+1.23		64 41 56.60	
Indian	−0.78	+0.05	68 35 22.08	5.64
Morrison	−0.40		46 42 46.96	
Brighton	+0.23		100 39 56.33	
Indian	−0.60	+0.39	41 04 33.42	5.09
Boulder	+0.76		38 15 35.34	
Brighton	−1.00		35 57 59.73	
Morrison	+0.74	+0.96	56 00 45.61	3.89
Boulder	+1.22		88 01 18.55	
Horsetooth	+0.12		40 52 37.08	
Brighton	+0.09	−1.00	65 51 29.28	7.33
Boulder	−1.21		73 15 60.97	
Dewey	+1.25		28 19 29.16	
Brighton	+0.12	+0.98	116 50 20.55	5.90
Boulder	−0.38		34 50 16.19	
Dewey	+1.27		76 02 14.80	
Brighton	+0.03	+1.80	50 58 51.27	7.52
Horsetooth	+0.50		52 58 61.45	
Dewey	+0.02		47 42 45.64	
Boulder	−0.83	−0.19	38 25 44.78	8.95
Horsetooth	+0.62		93 51 38.53	
Warren	−0.96		52 35 47.22	
Dewey	−1.82	−2.69	61 06 08.93	7.61
Horsetooth	+0.09		66 18 11.46	
Twin	−0.69		39 28 32.88	
Warren	−1.12	−2.70	120 36 32.34	4.62
Dewey	−0.89		19 54 59.40	
Twin	+0.19		78 39 26.82	
Warren	−0.16	−1.04	68 00 45.12	4.76
Horsetooth	−1.07		33 19 52.82	
Twin	+0.88		39 10 53.94	
Dewey	−0.93	−1.03	41 11 09.53	7.75
Horsetooth	−0.98		99 38 04.28	
Wadill	+0.33		64 44 11.88	
Warren	+0.03	+0.33	68 54 54.02	2.15
Twin	−0.03		46 20 56.25	
Russell	+1.09		36 02 15.11	
Wadill	+0.30	+1.35	102 14 31.16	2.03
Warren	−0.04		41 43 15.76	
Russell	−0.19		82 09 06.29	
Wadill	−0.03	+0.02	37 30 19.28	1.63
Twin	+0.24		60 20 33.03	
Russell	−1.28		46 06 51.18	
Warren	+0.07	−1.00	27 11 38.26	1.75
Twin	+0.21		106 41 32.31	
Greentop	+0.70		66 31 40.94	
Wadill	−0.33	+0.12	22 24 26.10	0.98
Russell	−0.25		91 03 53.94	
Greentop	+2.10		62 16 09.59	
Wadill	−0.36	+2.20	59 54 45.38	2.53
Twin	+0.46		57 49 07.56	
Greentop	−1.40		4 15 31.35	
Twin	−0.22	−2.06	2 31 28.50	0.08
Russell	−0.44		173 13 00.23	
Whitaker	−0.12		90 40 07.63	
Wadill	+0.05	−1.15	59 34 20.17	1.20
Greentop	−1.08		29 45 33.40	
Ragged	+0.38		23 39 48.16	
Whitaker	−1.04	−1.36	110 12 31.52	1.16
Wadill	−0.70		46 07 41.48	
Ragged	+0.57		74 41 55.29	
Whitaker	−0.92	+0.34	19 32 23.89	0.72
Greentop	+0.69		85 45 41.54	
Ragged	+0.19		51 02 07.13	
Wadill	+0.75	+0.55	13 26 38.69	0.76
Greentop	−0.39		115 31 14.94	
Cheyenne west base	−0.46		107 42 24.75	
Whitaker	−1.31	−2.53	29 46 08.36	0.24
Wadill	−0.76		42 31 27.13	
Cheyenne east base	+0.51		60 27 51.19	
Cheyenne west base	−0.05	+0.28	89 53 01.93	0.20
Whitaker	−0.18		29 39 07.08	
Cheyenne east base	−0.17		179 21 50.84	
Whitaker	−1.12	−1.31	0 07 01.29	0.00
Wadill	−0.02		0 31 01.87	
Cheyenne east base	−0.34		120 10 11.97	
Wadill	−0.75	−1.50	42 00 25.25	0.04
Cheyenne west base	−0.41		17 49 22.82	
Chugwater	+0.27		36 58 37.75	
Whitaker	+0.05	+0.62	77 25 17.54	3.29
Ragged	+0.30		65 36 08.00	
Notch	+0.20		21 50 37.50	
Chugwater	+0.17	+0.07	140 38 42.01	2.61
Whitaker	−0.30		17 30 43.10	
Notch	+0.85		44 26 22.52	
Chugwater	−0.10	+0.41	103 40 04.26	4.29
Ragged	−0.34		31 53 37.51	
Notch	+0.65		22 35 45.02	
Whitaker	+0.35	+0.96	59 54 34.44	4.97
Ragged	−0.04		97 29 45.51	
Coleman	0.00		32 13 49.37	
Chugwater	−0.17	−0.52	36 24 45.60	3.46
Notch	−0.35		111 21 28.49	

Table of triangles—Continued.

ONE HUNDRED AND FOURTH MERIDIAN—continued.

Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.	Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.
	"	"	° ′ "	"		"	"	° ′ "	"
Haystack	−0.37		31 10 02.08		Provo west base	−0.28		95 03 45.53	
Chugwater	−1.09	−1.93	71 39 41.09	5.96	Cottonwood	−0.96	−2.42	56 53 22.09	1.37
Notch	−0.47		77 10 22.79		Parker	−1.18		28 02 53.75	
Haystack	−0.35		65 33 54.32		Provo east base	+1.05		24 28 40.05	
Chugwater	−0.92	−0.62	35 14 55.49	6.33	Provo west base	−0.59	−0.44	135 17 31.94	0.45
Coleman	+0.65		79 11 16.52		Cottonwood	−0.90		20 13 48.46	
Haystack	+0.02		34 23 52.24		Provo east base	+1.20		114 32 48.44	
Notch	+0.12	+0.79	34 11 05.70	3.83	Provo west base	−0.31	+1.85	40 13 46.41	0.74
Coleman	+0.65		111 25 05.89		Parker	+0.96		25 13 25.89	
Hobbs	−0.07		53 10 21.67		Provo east base	+0.15		90 04 08.39	
Haystack	−0.42	−2.06	94 24 03.84	2.73	Cottonwood	−0.06	−0.13	36 39 33.63	1.66
Coleman	−1.57		32 25 37.22		Parker	−0.22		53 16 19.64	
Willow	+0.50		25 16 29.26		Provo astronomic	+0.84		35 28 56.73	
Hobbs	−0.39	−0.32	142 26 34.70	0.56	Provo west base	+0.02	−0.05	129 50 38.85	0.26
Haystack	−0.43		12 16 56.60		Cottonwood	−0.91		14 40 24.68	
Willow	−0.43		75 40 54.04		Provo astronomic	+0.58		135 17 41.93	
Hobbs	−0.32	+0.74	89 16 13.03	1.70	Provo west base	+0.30	+1.45	34 46 53.32	0.34
Coleman	+1.49		15 02 54.63		Parker	+0.57		9 55 25.09	
Willow	−0.93		50 24 24.78		Provo astronomic	−0.26		99 48 45.20	
Haystack	+0.01	−1.00	82 07 07.24	3.87	Cottonwood	−0.05	−0.92	42 12 57.41	1.45
Coleman	−0.08		47 28 31.85		Parker	−0.61		37 58 18.84	
Rawhide	+1.16		61 42 24.88		Provo astronomic	−0.37		155 52 39.35	
Haystack	−0.17	+1.94	14 34 12.43	0.51	Cottonwood	+0.01	−0.80	5 33 23.78	0.16
Hobbs	+0.95		103 43 23.20		Provo east base	−0.44		18 33 57.03	
Rawhide	+0.25		104 48 25.01		Provo astronomic	−0.11		56 03 54.15	
Haystack	−0.60	+0.52	26 51 09.03	1.31	Parker	+0.39	−0.01	15 18 00.80	0.37
Willow	+0.87		48 20 27.27		Provo east base	−0.29		108 38 05.42	
Rawhide	−0.91		43 06 00.13		Provo astronomic	−0.47		168 38 23.92	
Hobbs	−0.56	−1.10	113 50 02.10	0.24	Provo east base	+1.49	+0.41	5 54 43.02	0.03
Willow	+0.37		23 03 58.01		Provo west base	−0.61		5 26 53.09	
Manville	+0.63		34 46 44.47		Elk	+0.38		24 16 25.49	
Rawhide	−0.12	+0.25	38 08 35.60	0.84	Parker	+1.06	+1.33	11 07 21.67	0.76
Willow	−0.26		107 04 40.77		Sullivan	−0.11		144 36 13.60	
Kirtley	−0.48		20 45 25.53		Elk	+0.93		112 35 58.77	
Rawhide	−0.07	−0.05	98 00 51.92	2.00	Parker	+0.44	+2.28	29 07 53.48	4.01
Willow	+0.50		61 13 44.55		Alkali	+0.91		38 16 11.76	
Kirtley	−0.33		41 36 24.74		Elk	+0.55		88 19 33.28	
Rawhide	+0.05	−1.24	59 52 16.32	2.93	Sullivan	+0.44	+1.40	68 27 42.98	1.44
Manville	−0.96		78 31 21.87		Alkali	+0.41		23 12 45.18	
Kirtley	+0.15		20 50 59.21		Cambria	+0.19		45 46 47.23	
Willow	−0.76	−0.94	45 50 56.22	1.77	Elk	−0.40	−0.32	87 45 17.34	3.45
Manville	−0.33		113 18 06.34		Alkali	−0.11		46 27 58.88	
Alkali	+1.46		25 05 35.14		Crow	+0.05		75 44 52.92	
Kirtley	−0.19	+2.25	72 01 61.32	8.65	Elk	+0.22	+0.03	29 04 20.52	1.69
Manville	+0.98		82 52 32.19		Cambria	−0.24		75 10 48.25	
Parker	−0.61		20 46 14.29		Laird	+0.93		51 22 49.19	
Kirtley	+0.01	+0.39	121 00 12.32	5.81	Crow	+0.59	+2.28	81 10 48.42	0.82
Manville	+0.99		38 13 39.20		Cambria	+0.76		47 20 23.21	
Parker	−0.01		83 15 08.97		Inyankara	+0.04		55 24 14.64	
Kirtley	+0.20	−0.86	48 58 11.00	11.97	Laird	−0.26	−1.17	51 41 47.21	1.28
Alkali	−1.05		47 46 52.00		Cambria	−0.95		72 53 59.43	
Parker	+0.60		62 28 54.68		Inyankara	+0.60		43 40 18.72	
Manville	−0.01	+1.00	44 38 52.99	14.81	Cambria	+0.24	+0.63	118 42 01.88	2.55
Alkali	+0.41		72 52 27.14		Alkali	−0.21		17 37 41.95	
Cottonwood	−0.18		100 09 43.36		Terry	−0.78		26 28 13.83	
Alkali	−1.16	−0.39	31 31 35.76	4.87	Laird	−0.89	−2.70	135 25 47.38	0.92
Parker	+0.95		48 18 45.75		Inyankara	−1.03		18 05 59.71	
Sullivan	+0.42		61 37 23.17		Sundance	−0.15		21 25 20.50	
Parker	+0.33	+1.31	66 19 17.56	2.85	Terry	−0.66	−1.60	62 38 01.41	2.22
Cottonwood	+0.56		52 03 22.12		Laird	−0.79		95 56 40.31	
Sullivan	−0.33		146 50 03.42		Sundance	−0.17		55 59 15.04	
Parker	−0.62	−0.45	18 00 31.81	1.81	Terry	+0.12	+0.53	36 09 47.58	3.34
Alkali	+0.50		15 03 26.58		Inyankara	+0.58		87 50 60.72	
Sullivan	−0.75		85 18 40.25		Sundance	−0.02		34 33 54.54	
Cottonwood	−0.74	−2.15	48 06 21.24	3.83	Laird	−0.10	−0.57	39 29 07.07	2.04
Alkali	−0.66		46 35 02.34		Inyankara	−0.45		105 56 60.43	

Table of triangles—Continued.

ONE HUNDRED AND FOURTH MERIDIAN—continued.

Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.
	″	″	° ′ ″	″
Wymonkota	+0.53	+0.09	41 01 44.61	8.57
Terry	+0.16		56 15 62.09	
Sundance	0.00		82 42 21.87	
Castle	−0.53	−0.03	31 42 38.58	10.73
Terry	+0.16		92 27 15.10	
Sundance	+0.34		55 50 17.05	
Castle	+0.14	+0.10	68 19 17.31	9.58
Terry	0.00		36 11 13.01	
Wymonkota	−0.04		75 29 39.26	
Castle	+0.67	+0.82	36 36 38.73	7.42
Sundance	−0.34		26 52 04.82	
Wymonkota	+0.49		116 31 23.87	
Moreau	−0.06	−1.11	67 05 55.79	4.69
Castle	−0.51		61 06 05.85	
Wymonkota	−0.54		51 48 03.05	
Harding	+0.46	+0.47	37 41 41.93	1.12
Moreau	+0.23		130 53 39.91	
Castle	−0.22		11 24 39.28	
Harding	+0.11	+0.61	99 33 42.68	1.48
Moreau	+0.29		63 47 44.12	
Wymonkota	+0.21		16 38 34.68	
Harding	−0.35	−0.97	61 51 60.75	5.05
Castle	−0.29		49 41 26.57	
Wymonkota	−0.33		68 26 37.73	
Reva	−0.14	−0.20	39 44 06.99	5.06
Castle	−0.02		45 16 54.07	
Moreau	−0.04		94 59 04.00	
Reva	−0.47	−0.57	49 35 31.12	7.36
Castle	−0.24		56 41 33.35	
Harding	+0.14		73 43 02.89	
Reva	−0.33	−0.84	9 51 24.13	1.18
Moreau	−0.19		134 07 16.09	
Harding	−0.32		36 01 20.96	
Table	−0.72	−0.69	61 44 12.66	6.74
Reva	−0.06		69 16 05.85	
Harding	+0.09		48 59 48.23	
Lodge	+1.39	+2.36	30 40 52.57	3.45
Reva	+1.02		132 45 40.75	
Harding	−0.05		16 33 30.13	
Lodge	+0.61	+2.28	77 03 53.49	3.61
Reva	+1.08		63 29 34.90	
Table	+0.59		39 26 35.22	
Lodge	−0.78	−0.77	46 22 60.92	0.90
Harding	+0.14		32 26 18.10	
Table	−0.13		101 10 47.88	
Butte	+0.69	+1.78	62 55 11.42	4.19
Lodge	+0.72		52 16 47.96	
Table	+0.37		64 48 04.81	
Whetstone	+0.07	+1.41	43 44 49.58	4.80
Lodge	+0.46		96 22 42.29	
Table	+0.28		39 52 32.93	
Whetstone	+0.54	−0.47	74 24 24.96	3.41
Lodge	−0.26		44 05 54.33	
Butte	−0.75		61 29 44.12	
Whetstone	−0.13	−0.10	30 39 35.38	2.80
Table	+0.09		24 55 31.88	
Butte	−0.06		124 24 55.54	
Rainy	−1.32	−1.16	51 44 00.96	2.57
Whetstone	−0.66		81 45 03.62	
Butte	+0.82		46 30 57.99	
Black	−1.47	−2.63	45 55 02.71	2.59
Rainy	−0.64		82 39 43.42	
Whetstone	−0.52		51 25 16.46	
Black	−0.02	+0.11	90 39 07.00	1.83
Rainy	+0.68		30 55 42.46	
Butte	−0.55		52 25 12.37	

Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.
	″	″	° ′ ″	″
Black	+1.45	+1.58	50 44 04.29	1.81
Whetstone	−0.14		30 19 47.16	
Butte	+0.27		98 56 10.30	
Badland	−0.26	−0.43	59 52 45.69	2.45
Rainy	+0.20		63 35 56.77	
Black	−0.37		56 31 19.99	
Sentinel	−0.10	+0.05	7 50 28.71	1.09
Badland	+0.08		161 44 44.23	
Rainy	+0.07		10 24 48.15	
Sentinel	−0.42	+0.82	34 12 45.21	3.68
Badland	+0.34		101 51 58.54	
Black	+0.90		43 55 19.93	
Sentinel	−0.32	+0.34	26 22 16.50	5.04
Rainy	+0.13		53 11 08.62	
Black	+0.53		100 26 39.92	
Saddle	−0.54	−2.45	29 36 42.40	2.28
Rainy	−1.17		29 44 24.12	
Badland	−0.74		120 38 55.76	
Saddle	−0.32	−0.79	90 32 03.17	6.80
Rainy	−1.10		40 09 12.27	
Sentinel	+0.63		49 18 51.36	
Saddle	+0.22	+1.61	60 55 20.77	3.43
Badland	+0.66		77 36 20.01	
Sentinel	+0.73		41 28 22.65	
Hump	−0.19	−0.50	111 43 34.97	0.97
Saddle	+0.40		10 36 07.12	
Sentinel	−0.71		57 40 18.88	
Cook	−0.25	−0.93	75 41 29.74	2.43
Saddle	−0.70		30 53 37.54	
Hump	+0.02		73 24 55.15	
Cook	+0.11	−0.48	77 11 18.44	3.45
Saddle	−0.30		41 29 44.66	
Sentinel	−0.29		61 18 60.35	
Cook	+0.36	+0.95	1 29 48.70	0.05
Hump	+0.17		174 51 29.88	
Sentinel	+0.42		3 38 41.47	
Blue	−0.02	−0.45	31 26 55.93	2.00
Cook	−0.29		97 01 11.04	
Hump	−0.14		51 31 55.03	
Blue	−0.85	−1.92	40 36 50.00	2.83
Cook	−0.65		95 31 22.34	
Sentinel	−0.42		43 51 50.49	
Blue	−0.83	−0.52	9 09 54.07	0.88
Hump	+0.31		123 19 34.85	
Sentinel	0.00		47 30 31.96	
Trotter	+0.08	+0.80	102 54 07.90	1.19
Cook	+0.23		42 32 51.41	
Blue	+0.49		34 33 01.88	
Flat	+0.13	+0.62	16 59 35.45	0.32
Cook	+0.31		11 09 30.51	
Trotter	+0.18		151 50 54.30	
Flat	−0.12	+0.60	66 41 13.69	2.29
Cook	+0.54		53 42 21.92	
Blue	+0.18		59 36 26.68	
Flat	−0.25	−0.82	49 41 38.24	0.78
Trotter	−0.26		105 14 57.74	
Blue	−0.31		25 03 24.80	
Lovering	+0.40	+1.16	34 37 07.07	3.67
Flat	+0.42		80 34 28.34	
Blue	+0.34		64 48 28.26	
Sheep	+0.10	+0.22	20 50 43.39	1.02
Flat	+0.14		143 54 40.46	
Blue	−0.02		15 14 37.17	
Sheep	−0.26	−0.87	89 01 49.48	2.45
Flat	−0.28		63 20 12.12	
Lovering	−0.33		27 38 00.85	

Table of triangles—Continued.

ONE HUNDRED AND FOURTH MERIDIAN—continued.

Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.
	"	"	° ′ "	"
Sheep	−0.36		68 11 06.09	
Blue	+0.36	+0.07	49 33 51.09	5.10
Lovering	+0.07		62 15 07.92	
Jackson	+0.59		55 45 21.17	
Sheep	+0.83	+1.94	27 19 36.91	2.61
Lovering	+0.52		96 55 04.53	
Buford	+0.28		54 05 39.08	
Sheep	+0.14	+0.46	60 44 38.44	4.62
Lovering	+0.04		65 09 47.10	
Buford	+0.19		79 52 54.31	
Sheep	−0.69	−1.46	33 25 01.53	3.50
Jackson	−0.96		66 42 07.66	
Buford	−0.09		25 47 15.23	
Lovering	+0.48	+0.02	31 45 17.43	1.49
Jackson	−0.37		122 27 28.83	
Montana	+0.18		85 17 09.20	
Buford	0.00	−0.03	88 12 57.71	0.67
Sheep	−0.21		6 29 53.76	
Montana	−0.15		169 43 51.64	
Buford	−0.19	+0.52	8 20 03.40	0.06
Jackson	+0.86		1 56 05.02	
Montana	−0.33		84 26 42.44	
Sheep	−0.48	−0.91	26 55 07.77	2.89
Jackson	−0.10		68 38 12.68	
Lanark	+1.08		78 09 17.37	
Montana	+0.77	+2.06	61 10 17.93	0.82
Jackson	+0.21		40 40 25.52	
Cutoff	+0.23		100 20 36.50	
Jackson	+0.65	+1.15	37 17 52.91	0.47
Lanark	+0.27		42 21 31.06	
Cutoff	+0.20		88 20 52.43	
Lanark	+0.81	+1.73	35 47 46.31	0.30
Montana	+0.72		55 51 21.56	
Cutoff	−0.43		171 18 31.07	
Montana	+0.05	−0.82	5 18 56.37	0.05
Jackson	−0.44		3 22 32.61	
Mondak	+0.93		85 39 53.27	
Cutoff	+0.45	+1.67	19 56 03.42	0.07
Montana	+0.29		74 24 03.38	
Ferry	+0.48		86 11 44.59	
Cutoff	+0.27	+1.05	42 20 50.92	0.11
Montana	+0.30		51 27 24.60	
Ferry	+0.14		106 30 01.59	
Cutoff	−0.18	−0.68	22 24 47.50	0.00
Mondak	−0.64		51 05 10.97	
Ferry	−0.34		20 18 17.00	
Montana	−0.01	−0.06	22 56 38.78	0.02
Mondak	+0.29		136 45 04.24	
Bainville	+0.61		62 09 53.44	
Buford	+0.61	+1.67	76 25 17.04	1.55
Jackson	+0.45		41 24 51.07	
Snake	−0.26		33 30 23.06	
Buford	−0.52	−1.75	11 11 37.70	0.30
Bainville	−0.97		135 11 59.54	
Snake	+0.26		47 39 02.32	
Buford	+0.09	+1.41	87 36 54.74	2.03
Jackson	+1.06		44 44 04.97	
Snake	+0.52		14 02 39.26	
Bainville	+0.36	+1.49	162 38 07.02	0.18
Jackson	+0.61		3 19 13.90	
Bull	+0.20		57 03 25.51	
Buford	−0.06	−0.10	23 16 57.93	0.90
Snake	−0.24		99 39 37.40	
Williston	−0.88		54 56 28.42	
Buford	−0.57	−1.63	66 33 44.27	1.85
Snake	−0.23		58 29 49.10	

Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.
	"	"	° ′ "	"
Williston	−0.56		76 58 05.88	
Buford	−0.51	−1.75	43 16 46.34	1.62
Bull	−0.68		59 45 09.40	
Williston	+0.32		22 01 37.46	
Snake	−0.01	−0.17	41 09 48.30	0.67
Bull	−0.48		116 48 34.91	
Bonetraill	−1.15		77 24 18.17	
Williston	+0.14	−0.80	48 00 16.30	0.82
Bull	+0.21		54 35 26.35	
Gladys	−0.54		26 33 58.67	
Bonetraill	−0.14	−0.48	146 22 52.62	0.14
Williston	+0.20		7 03 08.85	
Gladys	+0.99		93 32 12.50	
Bonetraill	+1.01	+2.60	68 58 34.45	0.22
Bull	+0.60		17 29 13.27	
Gladys	+1.53		66 58 13.83	
Williston	−0.06	+2.28	40 57 07.45	0.90
Bull	+0.81		72 04 39.62	
Marmon	−0.89		46 00 23.64	
Williston	−0.14	−0.98	48 30 35.57	0.96
Bonetraill	+0.05		85 29 01.75	
Marmon	+0.15		56 07 07.74	
Williston	+0.06	−0.57	55 33 44.42	1.31
Gladys	−0.78		68 19 09.15	
Marmon	+1.04		10 06 44.10	
Bonetraill	+0.09	+0.89	128 08 05.63	0.21
Gladys	−0.24		41 45 10.48	
Howard	−0.04		55 17 40.62	
Marmon	−0.08	+0.08	50 16 56.39	1.26
Gladys	+0.20		74 25 24.25	
Muddy	+0.84		42 14 40.60	
Marmon	−0.10	+1.04	94 07 20.84	1.43
Gladys	+0.30		43 37 59.99	
Muddy	+0.50		77 24 40.93	
Marmon	−0.02	+0.66	43 50 24.45	1.16
Howard	+0.18		58 44 55.78	
Muddy	−0.34		35 10 00.33	
Gladys	−0.10	−0.30	30 47 24.26	0.99
Howard	+0.14		114 02 36.40	
Stady	−0.57		03 38 30.58	
Muddy	−0.61	−1.62	75 41 29.46	0.68
Howard	−0.44		40 40 00.64	
Crosby	−0.30		38 47 33.49	
Muddy	+0.66	+0.38	20 39 21.50	0.33
Stady	+0.02		114 33 05.34	
Crosby	−0.19		37 34 23.45	
Muddy	+0.05	−0.22	102 20 50.96	0.99
Howard	−0.08		40 04 46.58	
Crosby	−0.11		1 13 10.04	
Howard	−0.36	−1.02	0 35 14.06	0.02
Stady	−0.55		178 11 35.92	
Norge	+0.81		35 18 07.83	
Crosby	+0.10	+1.58	63 10 36.77	0.40
Stady	+0.67		81 25 15.80	
Norge	+0.80		82 04 23.90	
Crosby	−0.01	+0.69	64 29 46.81	1.24
Howard	−0.10		33 25 50.53	
Norge	−0.01		46 46 16.07	
Stady	−0.12	+0.13	100 23 08.28	0.82
Howard	+0.26		32 50 36.47	
Bowie	+0.28		28 25 26.41	
School	−2.39	−2.83	27 00 34.67	0.22
Ambrose southwest base	−0.72		124 33 59.14	
Ambrose	−0.23		0 56 35.04	
Ambrose southwest base	−0.77	−1.35	178 14 37.76	0.01
Bowie	−0.35		0 48 47.21	

Table of triangles—Continued.

ONE HUNDRED AND FOURTH MERIDIAN—continued.

Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.	Station.	Correction to angles from figure adjustment.	Error of closure of triangle.	Corrected spherical angles.	Spherical excess.
	″	″	° ′ ″	″		″	″	° ′ ″	″
Ambrose	−0.20		73 06 18.73		Crosby	−0.63		50 29 57.31	
Bowie	+0.63	−0.30	27 36 39.20	0.39	Ambrose southwest base	+0.17	+0.09	37 18 54.24	0.15
School	−0.73		79 17 02.46		Ambrose	+0.55		92 11 08.60	
Ambrose	−0.43		74 02 53.77		Norge	+1.12		43 38 44.09	
Ambrose southwest base	−0.05	+1.18	53 40 38.62	0.18	Bowie	−0.01	+1.09	77 47 03.68	0.30
School	+1.66		52 16 27.79		Ambrose southwest base	−0.02		58 34 12.35	
Crosby	+0.26		16 46 02.91		Norge	−0.09		83 28 02.98	
Bowie	+0.32	+1.18	18 47 29.25	0.16	Bowie	−0.33	+0.09	58 59 34.61	0.54
Ambrose southwest base	+0.60		144 26 28.00		Crosby	+0.51		37 32 22.95	
Crosby	−0.37		67 16 00.22		Norge	−1.21		39 49 18.89	
Bowie	−0.03	−0.08	19 36 16.46	0.32	Ambrose southwest base	+0.62	+0.18	85 52 15.05	0.40
Ambrose	+0.32		93 07 43.64		Crosby	+0.77		54 18 25.86	

The maximum correction 2″.39 to any angle is to the angle at School between Ambrose southwest base and Bowie.

The statistics as to closures of triangles and the mean error of an angle for the sections of the one hundred and fourth meridian are given in the following table. The mean error of an angle $a=\sqrt{\frac{\Sigma\Delta^2}{3n}}$, in which $\Sigma\Delta^2$ is the sum of the squares of the closing errors of the triangle and n is the number of triangles in the season's work or in the section.

Season.	Number of triangles.			Average closure.	Maximum closure.	Mean error of an angle.
	Total.	With plus closures.	With minus closures.			
				″	″	″
Pikes Peak-Divide to Cheyenne base	41	18	23	1.14	2.87	±0.81
Cheyenne base to Provo base	40	19	21	0.96	2.42	±0.68
Provo base to Ambrose base	105	54	51	0.94	2.83	±0.69
For the whole arc	186	91	95	0.99	2.87	±0.71

The average closing error of a triangle for the 186 triangles of the one hundred and fourth meridian arc is 0″.99. This mean closing error indicates that the methods employed and the number of observations made will give the accuracy called for by the general instructions, viz, 1″.00 on an average. The instructions also state that the closing error shall seldom exceed 3″.00. The one hundred and fourth meridian arc has no triangle with a closure as great as 3″.00, and there are only 23 of the 186 triangles which have closing errors greater than 2″.00. It is not desirable to cut down the standard number of positions, 16, selected in 1900. Nor is it necessary to increase the number of observations in order to obtain greater accuracy. If the triangulation of the Survey should consistently have much smaller closing errors than 1″.00 on an average, then it would probably be advisable to reduce the number of observations if by so doing time and cost could be lessened. See under the heading "Discussion of errors" the changes made in the method and time of observing in an effort to secure smaller deviation of the triangulation in azimuth.

Of the six definite arcs of primary triangulation in the United States the one hundred and fourth meridian arc stands third in accuracy, using the average closing error of a triangle as the standard.

The comparison of the average closing errors is given below:

	Average closing error. ″
Texas-California	0.90
Ninety-eighth meridian	0.92
One hundred and fourth meridian	0.99
Transcontinental triangulation	1.06
Eastern oblique	1.19
California-Oregon	1.22

No attempt has been made here to set forth the agreement of the separate measures of each direction as a criterion of accuracy, since it is well known that it is of little value for that purpose. A close agreement of the separate measures of a given direction is of little consequence, since such measures are usually subject to constant errors of considerable size, which become evident as soon as the closures of the triangles are studied or an attempt is made to adjust a figure.

ACCORD OF BASES.

As already stated, there are six bases which serve to fix the length in the triangulation under discussion. Four of these bases are connected directly by the triangles adjusted. The Salt Lake base determines the length of the line Tushar-Mount Nebo adjacent to the base net, with little loss of accuracy. The Salina base is more remote from the line Arapahoe-Monotony, which was the fixed length in this adjustment, and the outstanding discrepancy is consequently somewhat greater than would have been the case if the intervening triangles had been readjusted.

In solving the normal equations of the figure adjustment the length equation was, as usual, assigned to the last place, so that after all the conditions relating to triangle closures and ratios of lengths had been satisfied the discrepancy in length became known. In the following table the discrepancies developed between bases are given in terms of the seventh place of logarithms and are also expressed as ratios. A plus sign before the discrepancy expressed in terms of logarithms means that the first base mentioned is longer as measured than as computed through the intervening triangulation from the second base mentioned.

Bases.	Discrepancy in seventh place of logarithms.	Discrepancy expressed as a ratio.
Arapahoe-Monotony to El Paso	+31	1:140 000
El Paso to Tushar-Mount Nebo (Salt Lake)	+6	1:724 000
El Paso to Cheyenne	+141	1:30 800
Cheyenne to Provo	+108	1:40 200
Provo to Ambrose	−40	1:109 000

ACCORD OF AZIMUTHS.

Laplace azimuths were computed at three stations of the one hundred and fourth meridian triangulation, viz, at Watkins astronomic, Provo astronomic, and Mondak. It was reasonably certain that the Laplace azimuths computed for these stations were more accurate than the geodetic azimuth computed through the triangulation, and they were therefore introduced into the triangulation. The azimuth equations which reconciled the computed and the Laplace azimuths were placed at or near the last of the group of normal equations so that after the conditions relating to triangle closures and ratios of lengths had been satisfied, the discrepancy in azimuth became known.

The azimuth computed to Watkins astronomic station, through the triangulation, from the North American Datum azimuth at the edge of the Salt Lake base net, was found to be too large by 5″.05 when compared with the Laplace azimuth at Watkins. The azimuth computed to Provo astronomic station, through the triangulation, from the Watkins Laplace azimuth, was too large by 2″.37 when compared with the Laplace azimuth at Provo. The azimuth computed to Mondak, through the triangulation, from the Provo Laplace azimuth, was too small by 1″.08 when compared with the Laplace azimuth at Mondak.

STUDY OF ERRORS.

While the primary triangulation done by the Coast and Geodetic Survey is sufficiently accurate for geographic and geodetic purposes, at the same time it is well to search for the causes of the larger errors and to try to eliminate them, if possible without an increase in the time and cost of the triangulation. Or, if the causes of the largest errors can be found and removed, it might be possible to obtain the present accuracy with fewer observations over each direction in the scheme of triangulation. It is known to all observers of experience that large errors are likely to occur in observations made on a heliotrope before the late afternoon, when the wind makes the support of the instrument vibrate badly, and when a line passes close to a steep slope or a factory or heated stack. There must be other more obscure sources of error. In the text below are given data which may help to discover some of the sources of errors in primary triangulation.

Beginning with the season of 1904 each observer on the northern portion of the ninety-eighth meridian triangulation and on the Texas-California arc kept a record, called the *error book,* in which he made notes of the weather conditions, the character of the line observed over, and the appearance of the object observed upon. For each period of observations of primary horizontal angles there were entered in the record the date, with the hour; the direction of the wind; the strength of the wind; the station observed; the intensity, size, and degree of steadiness of the image of the heliotrope or lamp; the character of the image, whether symmetrical or asymmetrical; and the character of the line, whether high, low, grazing, or clear only at night as a result of elevation by refraction. In a column of remarks notes were made regarding the condition of the atmosphere, whether clear, hazy, or smoky. It has been impossible for the author, in the limited time at his disposal for such work, to make an analysis of all the accumulated data.[1]

High, low, grazing, and refraction lines.—As considered in the error book, a high line is one with its greater portion elevated well above the ground and obstructions. This usually occurs when the line crosses a depression or valley. A low line passes over a very flat country or just over ridges, trees, houses, or other obstructions. Grazing was the term employed to describe a line which was barely clear during the day. A refraction line was one which was clear only at night as a result of great refraction. A refraction line is, strictly speaking, a grazing line.

The following table gives certain data regarding the number of high, low, and grazing or refraction lines on the triangulation along the one hundred and fourth meridian and the average corrections to directions for the different kinds of lines:

	Number.	Percentage of all.	Average correction to a direction.
			"
All lines	420	100	0.32
High lines	352	84	0.31
Low lines	50	12	0.37
Grazing or refraction lines	18	4	0.41

The mean correction to a direction for high lines is about 17 per cent smaller than for low lines and about 29 per cent smaller than for grazing or refraction lines.

[1] See also pages 224 to 231 of Appendix 4, Report for 1911, Triangulation along the ninety-eighth meridian, Nebraska to Canada and connection with the Great Lakes, and pages 59 to 63 of Special Publication No. 11, "The Texas-California Arc of Primary Triangulation."

The following table gives the number of large corrections to all the directions and the number of them on the several classes of lines:

	Corrections greater than 0''.34.		Corrections greater than 0''.49.	
	Number.	Percentage of all.	Number.	Percentage of all.
On all lines	151	100	80	100
On high lines	122	81	63	79
On low lines	21	14	11	14
On grazing or refraction lines	8	5	6	7

The evidence in this table is that the large corrections come on the low and the grazing or refraction lines more in proportion than on the high lines.

Corrections to directions observed in a single period and in two or more periods.—The following tables are similar to the preceding, except that the lines are classified with regard to the number of periods during which they were observed instead of with regard to height. The total number of directions and the total number of corrections exceeding a certain amount may not be exactly equal in the different tables owing to the fact that a few lines may have been omitted from a table when information was lacking for classifying the line in that particular table.

	Number.	Percentage of all.	Average correction to a direction.
			''
All lines	436	100	0.32
Lines observed in but one period	194	44	0.31
Lines observed in more than one period	242	56	0.33

	Corrections greater than 0''.34.		Corrections greater than 0''.49.	
	Number.	Percentage of all.	Number.	Percentage of all.
On all lines	156	100	82	100
On lines observed in but one period	62	40	34	41
On lines observed in more than one period	94	60	48	59

The data in the above two tables are slightly in favor of the observations made in only one period.

Inasmuch as there were only four directions observed in daytime alone, no comparison is obtained between day and night observations. The mean correction to the four directions observed in the daytime only is 0''.34.

DEVIATION OF TRIANGULATION IN AZIMUTH.

In many cases the geodetic azimuth as computed through an arc of triangulation differs from the Laplace or true azimuth by an amount much greater than can be accounted for by the accidental errors in the observations of the triangulation. This deviation of triangulation in azimuth has been studied for years by geodesists without any definite conclusion as to the cause of the systematic errors.

In the United States Coast and Geodetic Survey publication entitled "The California-Washington Arc of Primary Triangulation" (Special Publication No. 13), the author, A. L. Baldwin, made the statement:

> Confronted with these values for twist (differences between the computed and Laplace azimuths), the writer suggests that they may be caused by the unequal heating of the theodolite by the sun, even though the theodolite is protected from the direct rays. On triangulation extending in a north-and-south direction, as this arc does. where

the observations were mainly made in the late afternoon, the west side of the instrument is undoubtedly warmer than the east side, and the resulting angles opening to the west and to the east should be subject to systematic errors of opposite signs, and therefore twist would develop. If this theory is correct, an east-and-west arc should develop only a small amount of twist, well within the limits for the expected error. Arcs on which the observing was done at night should develop no twist exceeding that allowed by the probable error, for the temperature of the east and west sides of the instrument would be equal. It is expected that this theory will be tested in the near future on all of the arcs of primary triangulation now existing in the United States.

In the following tables are given the data, for each section of primary triangulation in the United States, which may throw some light upon this deviation in triangulation. It is believed that if similar data for tho primary triangulation of other countries were in print it would be possible eventually to discover the cause or causes of deviation in triangulation, and with this knowledge to carry on the work in such a way as to minimize or eliminate its effect.

The sections of triangulation between Laplace stations are arranged in two tables. In the first are given data for the sections whose axes lie approximately in the meridian, while in the second table data are given for those sections which run east and west or nearly so.

On page 74 are given the data for three sections of the Eastern Oblique Arc.

Explanation of tables.—The data for any section are given in the direction south to north. In columns 1 and 2 are given the names of the Laplace stations at tho south and north ends of the section, respectively.

Column 3 contains the correction necessary to make the computed and adjusted azimuth agree with the Laplace azimuth at the northern end of the section in question. In each case the triangulation started with a truo or Laplace azimuth at the southern end and the difference given is the amount of the accumulated systematic error or the deviation of the triangulation in azimuth at the northern end. This correction results from the figure adjustment and the adjustment for discrepancy in length between bases. It does not include the effects of any adjustment for latitude, longitude, or azimuth.

Where the triangulation had been adjusted without equations for latitude, longitude, or azimuth, the values for the corrections in column 3 were taken from the table on page 20 of the "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy."

Where an equation for latitude, longitude, or azimuth was used in the adjustment of the triangulation to the North American datum, various expedients were adopted to obtain the values for column 3, and the numbers given are subject to some error.

Column 4 contains the values of the probable error of the adjusted azimuth. The method of deriving these values is explained below in the text relating to column 8.

In column 5 are given for each section the values of the ratio of the deviation itself (column 3) to the probable error of the deviation (column 4).

If the deviation of triangulation in azimuth were due to accidental errors alone and the probable error in column 4 were free from errors of computation, then tho values of the ratio between the value and its probable error for any section should on an average be about unity (theoretically 1.18), with few values as great as 2 or 3. It will be seen in the tables on pages 67 and 69 that the values of this ratio are frequently larger than 3 and the mean is 3.7 without regard to sign.

In columns 6 and 10 is given the number of lines between the Laplace stations at the ends of the sections for the eastern and the western sides of the scheme of triangulation, respectively.

In column 7 are given the corrections necessary to make the azimuth carried along the eastern side of the scheme from the south agree with the Laplace azimuth at the second or northern station. The computation starts with the Laplace azimuth at the first station and is carried through the observed directions. These directions are unadjusted, except for any local conditions at the stations at which they were observed.

The above paragraph applies also to column 11, except that in this case the azimuth is carried through the unadjusted directions on the west side of the scheme of triangulation.

Deviation data for north-and-south arcs.

No. of section.	Section of triangulation. (1) From (station)—	Section of triangulation. (2) To (station)—	(3) Accumulated correction to adjusted azimuth.	(4) Probable error of adjusted azimuth.	(5) Ratio (3)+(4).	Eastern side of triangulation. (6) Number of lines between stations.	Eastern side of triangulation. (7) Accumulated correction to observed azimuth.	Eastern side of triangulation. (8) Probable error of observed azimuth.	Eastern side of triangulation. (9) Ratio (7)+(8).	Western side of triangulation. (10) Number of lines between stations.	Western side of triangulation. (11) Accumulated correction to observed azimuth.	Western side of triangulation. (12) Probable error of observed azimuth.	Western side of triangulation. (13) Ratio (11)+(12).	(14) Time of observing line.	(15) Apparent convergence (7)—(11).	(16) Probable error of convergence.	(17) Ratio (15)+(16).	Accumulation per direction. (18) In adjusted azimuth.	Accumulation per direction. (19) In observed azimuth, east side.	Accumulation per direction. (20) In observed azimuth, west side.	Accumulation per direction. (21) In convergence.
			″	″			″	″			″	″			″	″		″	″	″	″
1	Donna, Tex.	Alice, Tex.	+ 1.73	0.68	+ 2.5	15	+ 1.47	1.40	+1.0	13	+ 2.88	1.40	+2.1	N.	− 1.41	1.98	−0.71	+0.062	+0.052	+0.103	−0.050
2	Alice, Tex.	Austin (capitol) Tex.	−10.51	1.14	− 9.2	15	−12.09	2.23	−5.4	16	−10.65	2.31	−4.6	D. & N.	− 1.44	3.21	−0.45	−0.339	−0.390	−0.344	−0.046
3	Austin (capitol), Tex.	Bowie northwest base, Tex.	+ 2.44	0.86	+ 2.8	13	− 1.45	1.61	−0.90	16	+ 2.55	1.83	+1.4	D. & N.	− 4.00	2.44	−1.6	+0.084	−0.050	+0.088	−0.138
4	Bowie northwest base, Tex.	Salina west base, Kans.	+ 1.99	1.22	+ 1.6	24	+ 2.22	2.48	+0.90	22	+ 4.45	2.40	+1.9	D. & N.	− 2.23	3.45	−0.65	+0.043	+0.048	+0.097	−0.048
5	Salina west base, Kans.	Page southwest base, Nebr.	+11.09	0.97	+11.4	15	+11.54	1.85	+6.2	17	+ 4.72	2.03	+2.3	D.	+ 6.82	2.75	+2.5	+0.347	+0.361	+0.148	+0.213
6	Page southwest base, Nebr.	Dalton (astronomic station), Minn.	+ 6.62	1.28	+ 5.2	19	+ 1.40	2.50	+0.56	21	+ 5.79	2.63	+2.2	D. & N.	− 4.39	3.63	−1.2	+0.166	+0.035	+0.145	−0.110
7	Dalton (astronomic station), Minn.	Stephen west base, Minn.	+ 3.00	0.94	+ 3.2	13	+ 4.13	1.81	+2.3	16	+ 4.16	1.93	+2.2	D. & N.	− 0.03	2.65	−0.01	+0.103	+0.142	+0.143	−0.001
8	San Diego (astronomic station), Cal.	Gazelle (astronomic station), Cal.	+11.91	1.68	+ 7.1	22	+14.50	3.30	+4.4	22	+ 8.88	3.33	+2.7	D.	+ 5.62	4.69	+1.2	+0.271	+0.330	+0.202	+0.128
9	Gazelle (astronomic station), Cal.	Eugene (astronomic station), Oreg.	+ 2.98	0.88	+ 3.4	6	+ 4.55	1.76	+2.6	6	+ 2.05	1.76	+1.2	D.	+ 2.50	2.49	+1.0	+0.249	+0.379	+0.171	+0.208
10	Eugene (astronomic station), Oreg.	Tacoma (astronomic station), Wash.	+ 3.95	1.27	+ 3.1	10	+ 1.06	2.49	+0.43	11	+ 6.29	2.60	+2.4	D.	− 5.23	3.61	−1.4	+0.188	+0.050	+0.300	−0.249
11	Tacoma (astronomic station), Wash.	Port Townsend (azimuth station), Wash.	+ 1.3	2.54	+ 0.5	22	+11.59	5.02	+2.3	22	− 8.55	5.14	−1.7	D.	+20.14	7.19	+2.8	+0.030	+0.263	−0.194	+0.458
12	Watkins (astronomic), Colo.	Provo (astronomic), S. Dak.	− 2.37	0.93	− 2.5	12	− 4.78	1.86	−2.6	11	− 3.63	1.86	−1.9	D. & N.	− 1.15	2.63	−0.44	−0.103	−0.208	−0.158	−0.050
13	Provo (astronomic), S. Dak.	Mondak, Mont.	+ 1.08	1.06	+ 1.0	16	+ 0.45	2.15	+0.21	15	+ 0.03	2.08	+0.01	D. & N.	+ 0.42	2.99	+0.14	+0.035	+0.015	+0.001	+0.014
14	Parkersburg, Ill.	Willow Springs, Ill.	+ 1.91	0.90	+ 2.1	16	+ 5.41	1.74	+3.1	17	− 0.07	1.86	−0.04	D.	+ 5.48	2.55	+2.1	+0.058	+0.164	−0.002	+0.166
15	Willow Springs, Ill.	Ford River (2), Mich.	− 1.30	1.82	− 0.71	26	− 4.41	3.83	−1.2	26	+ 2.93	3.44	+0.85	D.	− 7.34	5.15	−1.4	−0.025	−0.085	+0.056	−0.141

Columns 8 and 12 contain the values of the probable error of the azimuths carried through the observed directions on the eastern and western sides, respectively, of the scheme of triangulation. These are the azimuths referred to in columns 7 and 11.

The probable error, ε_α, of the azimuth as carried through one side of the scheme is computed by the formula

$$\varepsilon_\alpha = \varepsilon\sqrt{d},$$

where ε is the probable error of a single observed direction and d is the number of directions used to carry the azimuth.

As there are four independent ways for carrying the azimuth through a scheme of quadrilaterals with the diagonals also observed, then the probable error of the azimuth carried through the scheme which has been adjusted for figure or for figure and length conditions is obtained by the approximate formula,

$$\varepsilon_A = \frac{\varepsilon_\alpha}{\sqrt{4}}.$$

ε_A is the probable error of the adjusted azimuth, and ε_α is the same as in the preceding paragraph.

In column 9 are given the values of the ratio of the difference between the observed and Laplace azimuth to the corresponding probable error of the observed azimuth. The observed azimuth referred to is that carried through the observed directions on the eastern side of the triangulation. Column 13 contains similar data for the western side of the scheme.

The time at which the observing was done is given in column 14, D standing for day and N for night.

There are given in column 15 the apparent convergences of the two sides of the scheme of triangulation. This is the value in column 7 minus the value in column 11.

In column 16 are given the values of the probable errors of the apparent convergences. The probable error is the square root of the sum of the squares of the probable errors of the corrections to the azimuth as carried by the two sides of the scheme of the triangulation.

There are given in column 17 the ratios of the apparent convergence to the probable error of that convergence.

The last four columns—18 to 21—give the accumulation for a single direction, in the adjusted azimuth, in the azimuth as carried through the observed directions on the eastern side of the scheme, the same for the western side of the scheme, and in the convergence. The figures are obtained by dividing the numbers in columns 3, 7, 11, and 15, respectively, by the sum of the corresponding numbers in columns 6 and 10.

Deviation data for east-and-west arcs.

No. of section.	Section of triangulation. (1) From (station)—	(2) To (station)—	(3) Accumulated correction to adjusted azimuth.	(4) Probable error of adjusted azimuth.	(5) Ratio (3)÷(4).	Northern side of triangulation. (6) Number of lines between stations.	(7) Accumulated correction to observed azimuth.	(8) Probable error of observed azimuth.	(9) Ratio (7)÷(8).	Southern side of triangulation. (10) Number of lines between stations.	(11) Accumulated correction to observed azimuth.	(12) Probable error of observed azimuth.	(13) Ratio (11)÷(12).	(14) Time of observing line.	(15) Apparent convergence (7)−(11).	(16) Probable error of convergence.	(17) Ratio (15)÷(16).	Accumulation per direction. (18) In adjusted azimuth.	(19) In observed azimuth, north side.	(20) In observed azimuth, south side.	(21) In convergence.
			″	″			″	″			″	″			″	″		″	″	″	″
1	Mount Weather, Va.	Parkersburg, Ill.	−2.31	1.44	−1.6	26	+ 6.93	2.79	+2.5	25	− 6.47	2.99	−2.2	D. & N.	+13.40	4.09	+3.3	−0.045	+0.136	−0.127	+0.263
2	Parkersburg, Ill.	Berger, Mo.	+6.44	1.36	+4.7	13	+12.66	2.66	+4.8	14	+ 2.86	2.76	+1.0	D. & N.	+ 9.80	3.83	+2.6	+0.239	+0.469	+0.106	+0.363
3	Berger, Mo.	Knob Noster, Mo.	−4.66	1.22	−3.8	9	− 3.72	2.57	−1.4	10	− 4.84	2.33	−2.1	D.	+ 1.12	3.47	+0.32	−0.245	−0.196	−0.255	+0.059
4	Knob Noster, Mo.	Salina west base, Kans.	−6.11	0.96	−6.4	14	− 2.90	1.95	−1.5	13	−10.04	1.91	−5.3	D.	+ 7.14	2.73	+2.6	−0.226	−0.107	−0.372	+0.264
5	Salina west base, Kans.	Wallace, Kans.	−1.18	1.27	−0.93	14	+ 1.10	2.59	+0.42	13	− 0.41	2.49	−0.17	D.	+ 1.51	3.59	+0.42	−0.044	+0.041	−0.015	+0.056
6	Wallace, Kans.	Gunnison, Colo.	−0.50	1.16	−0.43	13	+ 3.18	2.41	+1.3	12	+ 0.71	2.23	+0.32	D.	+ 2.47	3.28	+0.75	−0.020	+0.127	+0.028	+0.099
7	Gunnison, Colo.	Salt Lake, Utah.	+3.69	0.58	+6.4	7	+ 4.81	1.11	+4.3	7	+ 3.53	1.20	+3.0	D.	+ 1.28	1.64	+0.78	+0.264	+0.344	+0.252	+0.091
8	Ogden, Utah	Gazelle, Cal.	+5.88	1.05	+5.6	12	+ 9.83	1.72	+5.7	15	− 0.87	2.49	−0.35	D.	+10.70	3.03	+3.5	+0.218	+0.364	−0.032	+0.396
9	Fronton, Tex.	Donna, Tex.	−2.88	0.43	−6.7	6	− 3.59	0.86	−4.2	7	− 1.43	0.86	−1.6	N.	− 2.16	1.21	−1.8	−0.222	−0.276	−0.110	−0.167
10	Bowie, Tex.	Stanton, Tex.	+2.23	1.05	+2.1	16	− 2.08	2.04	−1.0	18	+ 6.64	2.15	+3.1	D. & N.	− 8.72	2.96	−2.9	+0.066	−0.061	+0.195	−0.256
11	Stanton, Tex.	Jarilla, N. Mex.	+2.38	0.94	+2.5	16	+ 4.86	1.87	+2.6	16	+ 2.29	1.87	+1.2	D. & N.	+ 2.57	2.64	+0.97	+0.074	+0.152	+0.072	+0.080
12	Jarilla, N. Mex.	San Diego, Cal.	+0.96	1.06	+0.91	15	+ 3.82	2.45	+1.6	11	− 2.36	1.80	−1.3	D. & N.	+ 6.18	3.04	+2.0	+0.037	+0.147	−0.091	+0.238
13	Mannsville, N. Y.	Tonawanda, N. Y.	−0.44	0.99	−0.44	9	+ 1.51	2.14	+0.71	11	+ 1.66	1.82	+0.91	D.	− 0.15	2.81	−0.05	−0.022	+0.076	+0.083	−0.007
14	Tonawanda, N. Y.	Bundey, Mich.	−6.87	1.25	−5.5	22	− 7.88	2.35	−3.4	21	− 7.54	2.64	−2.9	D.	− 0.34	3.54	−0.10	−0.160	−0.183	−0.175	−0.008
15	Bunday, Mich.	Willow Springs, Ill.	+8.04	0.86	+9.3	11	+ 4.55	1.57	+2.9	13	+12.08	1.88	+6.4	D.	− 7.53	2.45	−3.1	+0.335	+0.190	+0.503	−0.314
16	Ford River, Mich.	Minnesota Point, Minn.	+2.17	1.32	+1.6	15	+ 4.95	2.50	+2.0	16	− 5.44	2.79	−1.9	D.	+10.39	3.75	+2.8	+0.070	+0.160	−0.175	+0.335
17	Minnesota Point, Minn.	Dalton, Minn.	+5.60	1.16	+4.8	20	+ 8.18	2.31	+3.5	20	+ 8.04	2.31	+3.5	D.	+ 0.14	3.27	+0.04	+0.140	+0.204	+0.201	+0.003
18	Watkins, Colo.	Gunnison, Colo.	−1.48	0.70	−2.1	7	− 2.32	1.58	−1.5	5	− 1.01	1.23	−0.82	D. & N.	− 1.31	2.00	−0.65	−0.123	−0.193	−0.084	−0.109

The explanation on pages 66 to 68 of the table giving data for the north-and-south sections applies to the above table for the east-and-west sections of triangulation, except that for eastern should be placed the word northern and for western the word southern. It is not necessary to repeat the explanation. The azimuth is carried westward from the east end of the section. The columns with the same number in the two tables contain similar data, except as noted above.

Analysis of data in the above tables.—In order that one may fully comprehend and see the bearing of the data in the above two tables, it was thought advisable to give the summaries contained in the following six tables. The first three relate to the north-and-south arcs and the others to the arcs which run in an east-and-west direction.

The correction to an adjusted or observed azimuth carried from one station to another through the triangulation is positive when the azimuth is smaller than the Laplace or true geodetic azimuth at the second station. As the azimuths are reckoned clockwise, a positive correction indicates that the azimuth as carried through the triangulation has worked to the left, or westward, looking north. If the azimuth had been computed southward, the correction would have been negative, showing that the azimuth had worked to the right, but again westward. It is readily seen that the effect of systematic error in azimuth is to make curved what otherwise might be a straight line. If either end of the curved line is held coincident with the straight line, the other end will go to the westward. If the curvatures are reversed, the line as actually observed will deviate to the eastward regardless of which end is held to a Laplace azimuth.

The data for the north-and-south sections given in the preceding and following tables were gotten by computing from south to north; hence a positive correction indicates a westerly deviation of the azimuth and a negative correction an easterly deviation.

Summary for all north-and-south sections.

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence E − W.
		Eastern side.	Western side.	
Number of sections	15	15	15	15
Number of + values	12	11	11	6
Number of − values	3	4	4	9
	″	″	″	″
Mean value, sign not considered	4.28	5.40	4.51	4.55
Mean + value	4.17	5.30	4.07	6.83
Mean − value	4.73	5.68	5.72	3.02
Mean value, sign considered	+2.39	+2.37	+1.46	+0.92
Weighted mean of accumulation per direction	+0.072	+0.072	+0.044	+0.028

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence E − W.
		Eastern side.	Western side.	
Number of + ratios (corrn. to p. e.)	12	11	11	6
Number of − ratios	3	4	4	9
Mean of ratios, sign not considered	3.8	2.3	1.9	1.2
Mean of + ratios	3.7	2.2	1.9	0.9
Mean of − ratios	4.1	2.5	2.1	1.6
Mean ratio, sign considered	+2.1	+0.9	+0.8	+0.13
Probable error of mean ratio	±0.79	±0.49	±0.36	±0.25

There are 15 north-and-south sections considered in this investigation, and in 12 of them the adjusted azimuth deviates to the west. The mean values per section of the deviation without and with regard to sign are respectively 4″.28 and +2″.39.

The mean, without regard to sign, of the ratios between the correction to the azimuth as adjusted and the probable error of the azimuth is 3.8. This means that the correction is on an average much greater than the probable error of the azimuth and clearly indicates systematic error. This fact is shown also by the mean ratio with regard to sign of +2.1. If there were no systematic or constant error in the observed horizontal directions, the mean ratio without regard to sign should be close to unity and with regard to sign it should be close to zero.

The third and fourth columns in the above table give data for the azimuths as carried northward through the observed directions on the eastern and western sides of the scheme of triangulation. The azimuth by each side deviates to the west, but the deviation is 62 per cent greater for the east than for the west sides, 2″.37 against 1″.46. The rate of accumulation of the deviation is about 60 per cent greater for the eastern than the western sides, +0″.072 against +0″.044.

The evidence is strong that the western side of the scheme is less affected by systematic error than the eastern side.

In the last column in the above table are given data regarding the convergence of the two sides of the triangulation.

There is given below a summary of azimuth data for those north-and-south sections which were observed entirely during the day.

Summary for north-and-south sections observed in the day.

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence E − W.
		Eastern side.	Western side.	
Number of sections	7	7	7	7
Number of + values	6	6	5	5
Number of − values	1	1	2	2
Mean value, sign not considered	″ 4.92	″ 7.58	″ 4.78	″ 7.59
Mean + value	5.52	8.11	4.97	8.11
Mean − value	1.30	4.41	4.31	6.28
Mean value, sign considered	+4.55	+6.32	+2.32	+4.00
Weighted mean of accumulation per direction	+0.134	+0.186	+0.068	+0.118

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence E − W.
		Eastern side.	Western side.	
Number of + ratios (corrn. to p. e.)	6	6	5	5
Number of − ratios	1	1	2	2
Mean of ratios, sign not considered	4.0	2.9	1.6	1.8
Mean of + ratios	4.6	3.2	1.9	1.9
Mean of − ratios	0.7	1.2	0.8	1.4
Mean ratio, sign considered	+3.8	+2.5	+1.1	+1.0
Probable error of mean ratio	±1.06	±0.61	±0.41	±0.44

Of the 15 north-and-south sections there were 7 on which all of the observations were made during the day. The objects sighted upon were heliotropes, poles, and various kinds of targets.

The data given above show that the observations made during the day were much more subject to the effect of systematic error than the mean of all of the north-and-south sections, the data for which are summarized on page 70.

The above table shows also that the western side of the scheme carries the azimuth with much less systematic error than the eastern side of the scheme. The mean value for the accumulation without regard to sign is 59 per cent greater on the east than on the west, while the mean value with regard to sign is nearly three times greater on the eastern than on the western side, 6″.32 against 2″.32.

The values given in the last column of the table for the convergence show that the mean of all sections has less systematic error than the mean of the day sections.

In the table below is given a summary of the data for 8 north-and-south sections observed entirely at night or partly in daylight and partly at night.

Summary for north-and-south sections observed at night and both day and night.

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence E − W.
		Eastern side.	Western side.	
Number of sections	8	8	8	8
Number of + values	6	5	6	1
Number of − values	2	3	2	7
Mean value, sign not considered	″ 3.72	″ 3.50	″ 4.27	″ 1.88
Mean + value	2.81	1.93	3.31	0.42
Mean − value	[1] 6.44	[2] 6.11	[3] 7.14	2.09
Mean value, sign considered	+0.50	−1.08	+0.70	−1.78
Weighted mean of accumulation per direction	+0.015	−0.034	+0.021	−0.055

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence E − W.
		Eastern side.	Western side.	
Number of + ratios (corrn. to p. e.)	6	5	6	1
Number of − ratios	2	3	2	7
Mean of ratios, sign not considered	3.5	1.7	2.0	0.6
Mean of + ratios	2.7	1.0	2.0	0.1
Mean of − ratios	5.8	3.0	3.2	0.8
Mean ratio, sign considered	+0.6	−0.5	+0.4	−0.6
Probable error of mean ratio	±1.07	±0.61	±0.64	±0.14

[1] Only two values, −10″.51 and −2″.37.
[2] Only three values, −12″.09, −1″.45, and −4″.78.
[3] Only two values, −10″.65 and −3″.63.

The data given above for the 8 sections observed entirely or partly during the night show less systematic error in the azimuth than the data given on page 70.

That there is some systematic error present is indicated by the fact that most of the sections have positive corrections to the azimuths, which shows that in general the line deviates to the westward. This is the same direction of deviation as obtains when the observing was done during the day.

The mean positive values of the accumulation of error to the azimuth are much smaller than for day observations, and the positive accumulation is only 1″.93 against 8″.11 for the day work. The largest positive value for the adjusted azimuth is only 6″.62, this being the only positive value greater than 4″.00.

For the eastern side of the scheme the largest positive value is only 4″.13.

The western side has three positive values greater than 4″.00, with the largest one 5″.79.

The negative values are all comparatively small except for one section. That value is more than 10″.00 for the adjusted azimuth, the azimuth by the east side and the azimuth by the west side. If that one section were not considered, the mean values for the negative azimuths would be comparable with the mean positive values.

The mean value of the convergence for the night observations is only about one-half that for the day work and is of opposite sign.

Discussion of data for east-and-west arcs.—In the following table is a summary of the data given in the table on page 69 for the sections of triangulation which run in an east-and-west direction:

Summary for all sections of east-and-west arcs.

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence N − S.
		Northern side.	Southern side.	
Number of sections	18	18	18	18
Number of + values	9	12	8	12
Number of − values	9	6	10	6
Mean value, sign not considered	″ 3.54	″ 4.94	″ 4.35	″ 4.83
Mean + value	4.75	5.53	4.73	5.56
Mean − value	2.94	3.75	4.04	3.37
Mean value, sign considered	+0.61	+2.44	−0.14	+2.58
Weighted mean of the accumulations per direction	+0.022	+0.089	−0.005	+0.094

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence N − S.
		Northern side.	Southern side.	
Number of + ratios (corrn. to p. e.)	9	12	8	12
Number of − ratios	9	6	10	6
Mean of ratios, sign not considered	3.6	2.5	2.1	1.6
Mean of + ratios	4.2	2.7	2.4	1.7
Mean of − ratios	3.1	2.2	1.9	1.4
Mean ratio, sign considered	+0.56	+1.07	+0.04	+0.63
Probable error of mean ratio	±0.75	±0.52	±0.43	±0.33

One-half the sections in the above table deviate in adjusted azimuth to the south and one-half to the north. The deviation is on an average 3.6 times the probable error of the deviation, and therefore it must be concluded there is much systematic error in the adjusted azimuth.

For the accumulated correction to the azimuth, as carried along the northern side of the scheme through the unadjusted observations, there are 12 plus and 6 minus corrections. This shows a decided tendency for the lines on the northern side of the triangulation to bend toward the south. This is clearly shown by the mean value of the accumulation in azimuth with regard to sign, which is +2″.44. The value of the accumulation per direction is also comparatively large, +0″.089.

On the south side of the triangulation the azimuth has 8 positive and 10 negative values, with a mean value of only −0″.14, and a value of −0″.005 for the accumulation per direction, sign considered. It is true that the average value of the accumulation per section without regard to sign for the southern side shows systematic error in azimuth; at the same time these errors for many sections act as accidental errors.

The last column gives the data for the convergence, which naturally agree closely with the values shown for the accumulated error in azimuth through lines on the northern side of the scheme.

In the following table are given the data for the 11 sections on east-and-west arcs which were observed in daylight only:

Summary for east-and-west sections observed in the day.

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence N −S.
		Northern side.	Southern side.	
Number of sections	11	11	11	11
Number of + values	5	8	5	8
Number of − values	6	3	6	3
	″	″	″	″
Mean values, sign not considered	4.10	4.78	5.01	3.89
Mean + value	5.08	4.76	5.20	4.34
Mean − value	3.29	4.83	4.86	2.67
Mean value, sign considered	+0.51	+2.14	−0.28	+2.43
Weighted mean of accumulation per direction	+0.019	+0.079	−0.011	+0.090

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence N −S.
		Northern side.	Southern side.	
Number of + ratios (corrn. to p. e.)	5	8	5	8
Number of − ratios	6	3	6	3
Mean of ratios, sign not considered	4.1	2.5	2.4	1.3
Mean of + ratios	5.5	2.6	2.8	1.4
Mean of − ratios	2.9	2.1	2.1	1.1
Mean ratio, sign considered	+0.9	+1.3	+0.13	+0.7
Probable error of mean ratio	±1.04	±0.56	±0.67	±0.36

For the sections considered in the above table, 5 have positive and 6 negative values for the accumulated error in azimuth as carried through the adjusted triangulation, but the positive values are the larger, and the mean value, sign considered, is $+0''.51$. The mean value of the ratio between the accumulated azimuth and its probable error (4.1) indicates the presence of systematic error.

The accumulated azimuth carried by the observed directions in the northern side of the scheme are mostly positive, 8 of the 11 sections having that sign. The mean value with regard to sign is $+2''.14$ which shows large systematic error.

The column giving data for the southern side has 5 positive and 6 negative values. The mean value with regard to sign is $-0''.28$, which is less than one-seventh of the value for the northern side and is of the opposite sign.

The values in the column headed "Convergence" follow closely those given in the column for the accumulated azimuth for the northern side of the triangulation.

In the table which follows there are given mean data for the seven east-and-west sections which were observed at night or partly during the night.

Summary for east-and-west sections observed at night and both day and night.

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence N −S.
		Northern side.	Southern side.	
Number of sections	7	7	7	7
Number of + values	4	4	3	4
Number of − values	3	3	4	3
	″	″	″	″
Mean values, sign not considered	2.67	5.18	3.29	6.31
Mean + value	3.00	7.07	3.93	7.99
Mean − value	2.22	2.66	2.82	4.06
Mean value, sign considered	+0.76	+2.90	+0.07	+2.82
Weighted mean of accumulation per direction	+0.027	+0.104	+0.003	+0.101

	Accumulated correction to adjusted azimuth.	Accumulated correction to observed azimuth.		Convergence N −S.
		Northern side.	Southern side.	
Number of + ratios (corr'n. to p. e.)	4	4	3	4
Number of − ratios	3	3	4	3
Mean of ratios, sign not considered	2.9	2.6	1.6	2.0
Mean of + ratios	2.6	2.9	1.8	2.2
Mean of − ratios	3.5	2.2	1.5	1.8
Mean ratio, sign considered	−0.03	+0.69	−0.09	+0.50
Probable error of mean ratio	±0.96	±0.78	±0.48	±0.60

Of the seven sections considered in the above table there were three on which nearly all the observing was done during the day. There were three other sections on which about 75 per cent of the observing was done at night.

The data in the above table, for the sections observed entirely or in part at night, show definitely that the deviation by the observed directions on the southern side is much smaller than for the northern side. The mean values per section are, respectively, $3''.29$ and $5''.18$, while the means with regard to sign are, respectively, $+0''.07$ and $+2''.90$. While the southern side carried the azimuth better than it did with the day observations, the northern side of the sections, observed all or in part at night, did not carry the azimuth any better than the sections observed entirely during the day. The sections in the above table are about equally divided between positive and negative values.

Deviation of eastern oblique arc in azimuth.—The axis of this arc of primary triangulation runs in a northeast and southwest direction. The arc may be considered in three sections, as is shown in the small table below.

Eastern oblique arc.	Lines.[1]	Accumulated correction to adjusted azimuth.	Probable error of adjusted azimuth.
		"	"
Cambridge, Mass.-Mount Weather, Va.	25	−1.17	1.50
Mount Weather-Atlanta middle base, Ga.	15	−3.76	1.53
Atlanta middle base-Fort Morgan, Ala.	20	−0.26	1.54

[1] Values given are in each case one-half the sum of the lines on the two sides of the scheme.

The computation was carried from northeast toward the southwest, therefore the deviation of the triangulation in azimuth is toward the northwest. As all of the observations were made in the day and the greater percentage of them in the late afternoon, when the sun was in the west, it is seen that the deviation in azimuth is toward the sun. This is in agreement with what was found for the sections running north and south and for those in an east-and-west direction. The small deflection may be due to the fact that during the observing the sun was on an average not far from the center line of the arc.

That the deviation for each of these sections is small is shown by the fact that it is comparable in size with the probable error of the section. The deviation of the triangulation in azimuth as carried by the two sides of the scheme and the convergence of the two sides were not computed.

It may be concluded that in triangulation running north and south: (1) The work done in whole or in part at night carries the azimuth much better than the day work; (2) there is very little difference in the size of the accumulated errors in azimuth as carried by the eastern and the western sides of the triangulation for the night or night-and-day sections; (3) the accuracy of the azimuth as carried by the observations in the western side of the scheme is much greater than that in the eastern side in day work; (4) there is a strong tendency for the north and south arcs of triangulation to deviate in azimuth to the westward and toward the sun; (5) it seems to be probable that sections observed entirely at night would be almost free from systematic error in the azimuth and that the convergence would also be of an accidental nature; (6) as the day work shows the greatest effect of systematic error, the cause of that error must be unequal heating of the different parts of the instrument by the sun; (7) the day observations on the western side of the scheme give results freer from systematic error in azimuth than the eastern side because the instrument on the western side is better protected from the heat of the sun. Practically all the day observations were made in the afternoon.

The data given for the east-and-west sections justify the conclusions that: (1) The deviation of triangulation in azimuth is less for the sections observed entirely or in part at night than for the sections observed during the day; (2) the unadjusted directions on the southern side of the scheme carry the azimuth with less deviation than on the northern side; (3) the deviation of the triangulation in azimuth is in general to the south and toward the sun; (4) the data for the east-and-west sections also indicate that the unequal heating of the instrument is a cause of the deviation of triangulation in azimuth, but the evidence that this is true is not so strong as that from the north-and-south sections.

The observer on the triangulation in Texas made observations for horizontal directions only at night. This work is shown as section 1 in the table on page 67 and section 9 in the table on page 69. The accumulated errors in azimuth for these sections are comparatively small.

A party which began observing on the arc of primary triangulation which extends from Memphis, Tenn., to Huntsville, Ala., was directed to observe over the main-scheme lines only at night. The results of that work are not available as this report goes to press.

The writer, believing the unequal heating of the circle of the theodolite to be the principal cause of systematic error in the azimuth, recommended to the Superintendent of the Coast and Geodetic Survey, in October, 1913, that the theodolites be equipped with nickel-iron circles instead of circles of brass. The former metal has a coefficient of only 0.000004 per degree centigrade, while the brass has a coefficient of about 0.000018, or more than four times as great. One of the theodolites is now (May, 1914) equipped with a nickel-iron circle and it will be used on the Memphis-Huntsville triangulation. The results should be of great interest.

The observer was also requested to change the circle about 180° in azimuth for each new position by using the settings given in the table below in place of those shown on page 14 of Special Publication No. 11.

Circle readings for initial directions.

Position.	Telescope direct.	Telescope reversed.	Position.	Telescope direct.	Telescope reversed.
	° ′ ″	° ′ ″		° ′ ″	° ′ ″
1	0 00 40	180 00 40	9	128 00 40	308 00 40
2	195 01 50	15 01 50	10	323 01 50	143 01 50
3	30 03 10	210 03 10	11	158 03 10	338 03 10
4	225 04 20	45 04 20	12	353 04 20	173 04 20
5	64 00 40	244 00 40	13	192 00 40	12 00 40
6	259 01 50	79 01 50	14	27 01 50	207 01 50
7	94 03 10	274 03 10	15	222 03 10	42 03 10
8	289 04 20	109 04 20	16	57 04 20	237 04 20

While the deviation of triangulation in azimuth can at certain places be eliminated by the introduction of Laplace stations into the scheme, it is nevertheless most desirable that this error be minimized by changed methods of observations if practicable. For geographic purposes the amount of remaining deviations at points between Laplace stations is of no importance, but in geodetic investigations, when the deflection of the vertical in the prime vertical is wanted, the deviation of the triangulation in azimuth remaining after the adjustment is a serious matter.

It is believed that with the theodolite equipped with a nickel-iron horizontal circle and with the observations made entirely at night and the circle moved nearly 180° in azimuth between each two positions or series the deviation will be much smaller than at present, and possibly almost entirely absent.

It is possible that these changes may add somewhat to the accuracy of the triangulation, as indicated by the closing errors of the triangles and the probable error of an observed direction.

It should be noted that the deviation of the triangulation in azimuth in the United States is of the same order as that found in other countries carrying on triangulation of the highest grade.

Effect of the deflection of the vertical.—A computation was made to determine the effect of the deflections of the vertical at stations to the north of Pikes Peak, Colo., on the angles of the triangulation. The results indicated that the greatest error caused by ignoring the deflections was 0″.52 for one direction, that the accumulated effect was small, and that for an arc of triangulation so long that the station error undergoes several changes of sign the separate values follow closely the law of accidental errors in their size and sign. It may therefore be concluded that the effect of the deflection of the vertical on the deviation of triangulation in azimuth is negligible in comparison with the much greater systematic effects from other causes.

The effect of twist in the instrument support.—For many years the observers of the Coast and Geodetic Survey engaged upon primary triangulation shielded the signal (on which the instrument was mounted) from the direct rays of the sun by canvas or other material. This was done to prevent movements in the wooden structure which might cause a shift of the instrument in azimuth and produce errors in the observed angles. Since the beginning of the season of 1902 no screens have been used.

In the report [1] on the work done in 1902 its author, Prof. J. F. Hayford, in commenting upon the possible effect of twist, stated that:

> About two days were spent by computers at the office in examining the records after the close of the season for evidence of twist. No convincing evidence that any systematic twist occurs could be found. Whatever twisting of the tripod head in azimuth occurs, if regular and continuous in one direction for considerable periods, is so slow as to be concealed by accidental errors in pointing and reading. There is possibly a very irregular twisting, with frequent reversals or stops, the effect of which is to introduce errors of the accidental class into the results which can not be separated from the other accidental errors.

No further investigations for the effect of twist have been made. It is generally held that the effect of the sun is to twist the signal in the same direction. If this is true and the motion is continuous and constant in rate, then the mean of two series of observations made in opposite directions and at uniform speed should eliminate the effect of twist. If the motion is irregular, the effect can be eliminated only if many observations are made. After sundown the signal should twist in the opposite direction for an indefinite time, and again affect a single series of observations taken in the early part of the night.

It is probable that the effect of twist may increase slightly the sizes of the accidental errors, but there seems to be no reason why it should cause a systematic deviation of triangulation in azimuth.

EFFECT OF DRAG.

The observed angles or directions at a station may be affected by two sources of error which are sometimes confused or not clearly distinguished. One is the twisting of the signal, on which the theodolite is mounted, by the sun. If the signal is not protected by screens from the direct rays of the sun, the material of the structure (assumed to be wood in this discussion), is unequally heated or dried and as the sun changes in azimuth during the observations, the structure may also change in azimuth. This change is probably not at a uniform rate, but by a series of jerky movements. The effect on the mean angles at the station is probably the same as if the motion were uniform. The effect of this torsion will be made negligible by the method of observing in which one-half of the observations in any position of the circle are made in a clockwise direction and the other half immediately afterwards, counterclockwise. The directions or angles in one case will be too small and in the other too large, but the means should be free from the effect. This will be practically true for the mean of the observations made in 16 positions of the circle.

The other error has its source in the lost motion or nonelasticity of the materials forming the structure on which the theodolite stands and the base of the theodolite itself. When the alidade of the theodolite is moved in azimuth, the friction between the movable parts, even though very small, will tend to drag the lower part of the instrument with it. The error due to this may be termed the *effect of drag*. It tends to make the measured angle too small whether the alidade is moved from left to right or from right to left.

When the motion of the alidade ceases the lower part of the instrument will assume its previous position only if it and the support (all considered as one structure) are perfectly elastic.

If the elasticity is not perfect then the telescope revolved through 360° should register 360° minus the drag or effect of nonelasticity in the instrument and stand. The alidade of the instrument is assumed to move continuously in one direction. For instance, let it be assumed that the theodolite is graduated clockwise, then if some object is sighted on and the reading of the circle is zero or 360° the reading at the second pointing on the same object, after revolving the alidade 360° should be something less than 360° or zero. Also, if the first reading is zero and the instrument is turned counterclockwise or right to left, the second reading should be greater than zero or 360°. These differences in the readings will be the same in amount if the degree of pliability is the same for the two directions.

It would also be reasonable to assume that in a series of angles all of the effect of drag would appear in the first or left-hand angle for the first round of observations (made from left

[1] U. S. Coast and Geodetic Survey Report for 1903, Appendix 4, p. 824.

to right), and on the last angle (the right hand one of the series) for the second round which would be in a direction opposite to that of the first round. This assumption is based on the idea that after the lower part of the instrument and the support have been dragged as a result of revolving the alidade to the second direction the structure will be perfectly elastic to any further strains due to the movement of the alidade to the third, fourth, and other directions. That is, after the telescope has been turned to the second direction, all of the drag caused by moving the telescope farther from the initial will be due to the flexibility of the materials of the lower part of the instrument and its support and not to looseness of the parts. The structure should act as if it were perfectly elastic and should recover the same position it had at the second direction.

If the above theory is correct, one-half the total effect of drag should be present in the angle which lies between the first or initial and the second directions and one-half in the angle formed by the last direction and the initial one (if the horizon were closed in the round). If the horizon is not closed then the first and last angles would each be affected by one-half the amount of the drag. The intermediate angles should be free from the effect of drag.

To test these theories an investigation was made of the work done on the one hundred and fourth meridian in 1912.

The observers in the United States Coast and Geodetic Survey work do not try to prevent "overshooting" the mark and therefore it may be assumed that in some cases the telescope went beyond and had to be brought back, that is moved in the reverse order in which the directions were being made. One therefore will not get as definite an idea of the effect of drag as if the telescope had always stopped exactly on the mark.

Of the stations occupied by Assistant E. H. Pagenhart, there were 17 at which he closed the horizon in each one of the double measurements of the directions. In all the horizon was closed for 297 such measurements.

Of the 297 times the horizon was closed while revolving the telescope from left to right, there were 146 cases where the last pointing on the initial was greater than the first, and in 136 cases the reverse was true. The sum of the plus closures was 244″.2, while that of the negative closures was 245″.0. The averages were, respectively, 1″.67 and 1″.80.

There seems to be no effect of drag in these observations.

Of the 297 measures closing the horizon when the telescope was swung from right to left, 106 had positive closures, with a total of 174″.8 and an average of 1″.65, and 172 had negative closures, with a total closing error of 290″.9 and an average of 1″.75. The closure is considered positive if the second reading passes the first one in the revolution of the telescope.

The evidence is strong that the right-to-left measures are affected by drag. Why there should be drag in these measures and not in the left-to-right ones is not clear. The resultant drag in each position—that is, the mean of the two measures of a position—is 0″.20. The sum of the angles at a station is affected by this amount, and averages only 359° 59′ 59″.80.

Values of first and last angles of a position, left to right, and the reverse.—If the drag is only on the first angle of a series measured in any one direction, say left to right, then this angle should be free from drag when measuring this series in the reversed order—right to left.

In the work of Assistant Pagenhart on the one hundred and fourth meridian triangulation in 1912 he made observations at 49 primary stations and 8 subsidiary ones. Several stations were occupied a second time. Of the 863 measurements of the first angle of a series (the angle between the initial and second directions) the second half of the measurement was greater than the first in 437 cases. The first half of the measurement is greater than the second in 426 cases. The sums of the differences are, respectively, 1079″.2 and 1049″.1, and the averages are 2″.47 and 2″.46.

The first measure of the last angle of a series was greater than the second in 375 cases with a total difference of 921″.6 and an average difference of 2″.48. There were 400 cases in which the second measure of the angle was greater than the first, with a total of the differences of 985″.7 and an average difference of 2″.46.

There is no indication in the above data that there is any systematic effect of drag in the first and second measures of the first and last angles of a series.

Angles measured in series or singly.—In Mr. Pagenhart's work there were 28 angles measured partly in a series of angles and partly alone or singly.

The average of the single measures was greater than that of the measures in series in 14 cases and the reverse was true in the other 14 cases. The sum of the positive differences (series minus single) was 11″.5 and an average difference of 0″.82, while the sum of the negative differences was 8″.9 with an average of 0″.64. Thirty-five of the angles measured by Assistant C. V. Hodgson on the one hundred and fourth meridian triangulation were observed partly in a series of angles and partly singly. In 18 cases the measure in series was greater than the single measure, and in 17 cases the reverse was true. The sum of the differences when the series was larger was 16″.4 and the average difference 0″.91. The sum of the differences when the single measures were larger was 17″.0 and the average difference was 1″.00.

The above data do not indicate the presence of any systematic effect of drag.

If any errors of considerable size, due to drag, were present in the observed horizontal angles these angles would be too small and the sum of the observed angles of the triangles should on the average be less than 180° plus the spherical excess. The custom in the United States Coast and Geodetic Survey has been to take, whenever practicable, the extreme left-hand object as the initial direction, assuming that the observer is facing his scheme of triangulation. This applies only to the side points of the scheme and not to those stations which are within the area covered by the triangulation. Also in general the horizon is not closed, the initial station being observed upon only once in a half series, left to right or right to left. Therefore the angle, which is nearly always about 180°, necessary to close the horizon at stations on the sides of the scheme is not measured.

With the methods employed the drag, if present to any extent, should appear in those angles which form the triangles of the scheme.

The following table gives the data in regard to positive and negative closing errors for several arcs of primary triangulation in the United States.

The plus sign indicates that the sum of the observed angles of a triangle is less than 180° (plus the spherical excess of the triangle). The negative sign has, of course, the opposite meaning, that is, the sum of the three observed angles is more than 180° (plus the spherical excess of the triangle).

Arc.	Number of triangles closed.	Number of + closures.	Sum of + closures.	Number of − closures.	Sum of − closures.	Average + closures.	Average − closures.	Average closure of all triangles.	Average closures with regard to sign.
			″		″	″	″	″	″
Ninety-eighth meridian, Canada to Alice, Tex	729	366	328.76	363	334.31	0.898	0.921	0.909	−0.008
Texas-California	183	99	84.91	84	79.83	0.858	0.950	0.900	+0.028
California-Washington	148	72	75.81	76	105.07	1.053	1.382	1.220	−0.198
One hundred and fourth meridian	186	91	86.44	95	96.87	0.950	1.020	0.930	−0.056
Ninety-eighth meridian, Alice-Brownsville[1]	68	26	15.75	42	31.55	0.606	0.751	0.696	−0.232
Sum or mean	1314	654	591.67	660	647.63	0.905	0.998	0.943	−0.043

[1] Field computations.

The above table gives evidence which tends to disprove the presence of drag in the angles forming the triangles. As stated above, the effect of drag, if present at all, is to make the angles too small, and therefore the triangle should close too small; that is, the sum of the three angles should need a positive correction. This statement, of course, leaves out of account errors due to other causes than drag.

Of the 1314 triangles for which data are given in the above table 654 have the sum of the observed angles too small and 660 have them too large.

On four of the five arcs considered the average closing error with regard to sign is negative (the sum of the observed angles being too large), and the average closing error with regard to sign for the 1314 triangles is $-''.043$. This mean with regard to sign is so small that it can not be attributed safely to any cause except the unbalanced effect of accidental errors.

Conclusion in regard to study of drag.—As a result of the above investigations to discover the effect of drag in the observed horizontal directions or angles of the primary triangulation by the United States Coast and Geodetic Survey, it must be concluded that there is no appreciable systematic drag.

While the above data do not indicate the presence of any systematic error due to drag there may be some errors of an accidental nature in the results due to that cause. It is believed that the method of observing employed in India is somewhat preferable though probably slower in operation than that used by the United States Coast and Geodetic Survey. There the observer brings his cross wires up to the object but never overshoots it. The party of this survey now at work on the arc between Huntsville, Ala., and Memphis, Tenn., has been instructed to test the Indian method. After setting the circle for a new position, he will move the telescope to the left of the initial direction and will then bring it up to the initial from the left as will be done for the other directions. Similarly, when making the observations in the reversed order, he will move the telescope from right to left for each of the pointings, including the first. When using the tangent screw to make the contact he will not limit himself to the direction in which the observations are being made.

ACCURACY OF THE PRIMARY TRIANGULATION IN THE UNITED STATES.

In the following table, 66 sections of triangulation in the United States, for which the required tabular values can be conveniently obtained, have been arranged in the order of accuracy, the most accurate being placed first. The most severe, and therefore the best, test of accuracy is believed by the writer to be the quantity d, expressing the probable error of the observed direction as derived from the corrections to directions resulting from the figure adjustment before the introduction of equations necessary to hold fixed positions of previously adjusted triangulation. Accordingly the various sections of triangulation have been placed in the order of the values of d. In the few cases in which d is the same to the nearest hundredth of the second for several sections the next column, a, has been used to decide their relative rank. The methods of computing d and a have already been explained fully on pages 55 and 62.

Sections of triangulation in order of accuracy.

No.	Section.	Probable error of an observed direction $=d$.	Mean error of an angle $=a$.	Average closing error of a triangle.	Maximum correction to a direction.	Maximum closing error of a triangle.	Discrepancy between bases.[1]
		"	"	"	"	"	
1	Nevada-California series	±0.23	±0.42	0.57	0.60	1.57	+ 83
2	Stephenville base net to Lampasas base	±0.23	±0.45	0.56	0.60	2.09	− 47
3	Yolo base net	±0.24	±0.51	0.68	0.64	2.60	
4	Point Isabel base net	±0.25	±0.40	0.50	0.60	1.61	
5	Elliff-Nolan to Laguna Madre base	±0.25	±0.62	0.85	0.62	2.23	+ 73
6	Dauphin Island base net	±0.26	±0.51	0.83	0.49	1.25	
7	New England section	±0.26	±0.53	0.75	1.17	2.02	+ [2] 44
8	Meades Ranch-Waldo to Shelton base net	±0.27	±0.35	0.50	0.62	1.42	+ 75
9	Deming base net to San Jacinto-Cuyamaca	±0.28	±0.57	0.77	0.80	3.01	+ 72
10	Shelton base net to Page base	±0.29	±0.44	0.60	0.87	1.77	− 16
11	Olney base net	±0.29	±0.54	0.78	0.70	1.78	
12	Bowie base net to Stephenville base	±0.29	±0.63	0.90	0.70	2.50	− 77
13	Eastern oblique arc to Augusta	±0.30	±0.60	0.78	0.74	2.73	+ 85
14	Rocky Mountain series	±0.32	±0.57	0.84	0.80	2.31	
15	Stanton base to Deming base	±0.32	±0.64	0.87	0.72	2.91	− 59
16	Salt Lake base net	±0.32	±0.66	0.81	0.84	3.18	
17	Shelton base net	±0.33	±0.45	0.80	0.88	2.07	
18	Stephen base net to Canada	±0.33	±0.61	0.84	0.78	2.38	− 64
19	El Reno base to Bowie base	±0.33	±0.97	1.19	1.40	4.43	
20	Fire Island base net	±0.34	±0.49	0.70	1.43	1.43	− 6
21	Illinois series	±0.34	±0.57	0.79	0.99	1.72	
22	Holton base net	±0.34	±0.58	0.79	0.84	2.28	− 71
23	Indiana series	±0.34	±0.60	0.80	1.31	3.20	+ 2
24	Atlanta base net to Dauphin Island base net, IV	±0.34	±0.63	0.85	0.93	2.19	
25	Fergus Falls to Stephen base	±0.34	±0.63	0.85	0.90	3.07	+ 24

[1] The discrepancy between bases in the last column of the table is expressed in terms of the seventh decimal place of logarithms. It is the discrepancy remaining after the angle and side equations have been satisfied. A plus sign before the discrepancy means that the first base mentioned is longer as measured than as computed through the intervening triangulation from the second base mentioned.

[2] There were 3 bases connected by this section, Epping, Massachusetts, and Fire Island. The 3 discrepancies were +44, +3, and +41.

Sections of triangulation in order of accuracy—Continued.

No.	Section.	Probable error of an observed direction $=d$.	Mean error of an angle $=a$.	Average closing error of a triangle.	Maximum correction to a direction.	Maximum closing error of a triangle.	Discrepancy between bases.
		″	″	″	″	″	
26	Transcontinental triangulation to Anthony base	±0.35	±0.54	0.79	1.39	1.98	+ 41
27	Missouri-Kansas series	±0.35	±0.60	0.88	1.12	2.37	+ 169
28	Atlanta base net to Dauphin Island base net, V	±0.35	±0.68	0.97	1.12	2.87	+ 2
29	PROVO BASE TO AMBROSE BASE	±0.36	±0.69	0.94	1.14	2.83	− 40
30	Anthony base net to El Reno base net	±0.36	±0.69	1.05	0.84	2.17	+ 7
31	Brown Valley base net to Royalton base	±0.36	±0.70	0.96	0.98	3.84	+ 98
32	Atlanta base net to Dauphin Island base net, III	±0.36	±0.77	1.10	0.84	2.69	+ 2
33	Royalton base net to Duluth	±0.36	±0.86	1.16	1.22	4.41	+ 80
34	Kyle-McClenny to Stanton base	±0.37	±0.71	1.02	0.82	3.11	− 11
35	CHEYENNE BASE TO PROVO BASE	±0.39	±0.68	0.96	0.99	2.42	+ 108
36	Versailles base net	±0.40	±0.64	0.90	0.95	2.71	
37	El Paso base net	±0.40	±0.68	0.94	0.93	2.60	
38	Seguin base net to Alice base	±0.41	±0.78	1.04	1.09	3.25	− 144
39	EL PASO BASE NET TO CHEYENNE BASE	±0.41	±0.81	1.14	1.33	2.87	+ 141
40	Kent Island base net to Atlanta base net, I	±0.41	±0.88	1.14	1.48	3.60	
41	Yolo base net to Los Angeles base net	±0.41	±0.91	1.16	1.34	5.52	− 41
42	Kent Island base net	±0.41	±0.91	1.33	0.75	2.97	
43	Page base net to Brown Valley base	±0.42	±0.77	1.03	1.44	3.81	+ 65
44	Salina base net	±0.44	±0.75	1.13	1.11	2.37	
45	Los Angeles base net	±0.44	±0.91	1.39	1.22	3.09	
46	Lampasas base net to Seguin base	±0.45	±0.82	1.13	1.96	3.31	− 7
47	Ohio series	±0.45	±0.85	1.14	1.32	5.08	− 24
48	Allegheny series	±0.45	±0.98	1.37	1.37	4.03	+ 11
49	Epping base net	±0.47	±0.63	0.90	1.25	2.63	
50	Fire Island base net to Kent Island base net	±0.47	±0.86	1.29	2.02	3.35	+ 46
51	St. Albans base net	±0.47	±1.04	1.38	1.53	4.94	
52	Kansas-Colorado series	±0.50	±0.75	1.00	1.43	3.92	− 92
53	Los Angeles base net to Soledad-Cuyamaca	±0.50	±0.82	1.16	1.15	2.53	
54	Epping base net to Canadian boundary	±0.51	±0.74	1.15	1.12	2.09	
55	Dauphin Island westward, I	±0.53	±0.78	1.12	1.31	2.80	
56	California-Washington arc	±0.53	±0.97	1.22	2.03	6.35	+ [1] 79
57	Kent Island base net to Atlanta base net, III	±0.62	±0.78	1.66	1.72	4.03	
58	Atlanta base net	±0.65	±1.00	1.19	1.31	4.35	
59	Missouri series	±0.66	±0.81	1.09	1.89	4.64	+ 86
60	Atlanta base net to Dauphin Island base net, II	±0.67	±0.78	1.03	1.84	2.88	+ 2
61	Coast Range series	±0.67	±1.37	1.80	2.73	6.49	
62	Eastern Shore series	±0.72	±1.22	1.75	1.85	5.24	
63	Kent Island base net to Atlanta base net, II	±0.72	±1.31	1.80	2.05	4.64	+ 24
64	Dauphin Island base net to New Orleans	±0.78	±1.20	1.50	2.65	5.40	
65	Atlanta base net to Dauphin Island base net, I	±0.79	±0.97	1.35	2.19	3.44	+ 2
66	American Bottom base net	±0.82	±1.59	2.22	1.80	6.36	

[1] The fixed length Mount Helena-Snow Mountain West of the thirty-ninth parallel triangulation, Willamette base, and Tacoma base, are connected by this arc with discrepancies of +79 and −19, respectively.

Of the 66 sections of triangulation tabulated, the three sections of the one hundred and fourth meridian arc rank as numbers 29, 35, and 39. The mean value of d, 0″.38, for the whole arc comes between those for the sections numbered 34 and 35. The average accuracy as shown by this value of d is only slightly lower than the average accuracy for all the 66 sections done in the United States.

THE NORTH AMERICAN DATUM.

Early in the year 1913 the Superintendent of the United States Coast and Geodetic Survey was notified by the director of the Comisión Geodésica Mexicana and by the chief astronomer of the Dominion of Canada Astronomical Observatory that the so-called United States Standard Datum had been adopted as the datum for the triangulation of those organizations. They also reported that the Clarke Spheroid of 1866, now used in the United States, would be used by them.

Owing to the international character of the datum now adopted by the three countries, the Superintendent of the United States Coast and Geodetic Survey has changed its designation from the "United States Standard Datum" to the "North American Datum."

EXPLANATION OF POSITIONS, LENGTHS, AND AZIMUTHS, AND OF THE NORTH AMERICAN DATUM.

The lengths, as already fully explained in connection with the adjustments, all depend upon the Salina, El Paso, Salt Lake, Cheyenne, Provo, and Ambrose bases. The lengths as given are all reduced to sea level. If the actual length of a line simply reduced to the horizontal is desired, it may be obtained with all the accuracy ordinarily needed by adding to the sea level length as given a correction = (length of line as given) $\left[\frac{\text{mean elevation of the two ends of the line in meters}}{6\,370\,000}\right]$. The maximum value of this correction does not exceed $\frac{1}{1450}$ of the length for any portion of the triangulation here published. The maximum error made in the use of the above approximate formula for the correction does not exceed $\frac{1}{450000}$ of the length for any portion of this triangulation.

The positions—that is, the latitudes, longitudes, and azimuths—need special explanation.

All of the positions and azimuths have been computed upon the Clarke spheroid of 1866, as expressed in meters, which has been in use in the Coast and Geodetic Survey for many years.

After a spheroid has been adopted and all the angles and lengths in a triangulation have been fully fixed, it is still necessary, before the computation of latitudes, longitudes, and azimuths can be made, to adopt a standard latitude and longitude for a specified station and a standard azimuth of a line from that station. For convenience, the adopted standard position (latitude and longitude) of a given station, together with the adopted standard azimuth of a line from that station, is called the geodetic datum.

The primary triangulation in the United States was commenced at various points and existed at first as a number of detached portions in each of which the geodetic datum was necessarily dependent only upon the astronomic stations connected with that particular portion. As examples of such detached portions of triangulation there may be mentioned the early triangulation in New England and along the Atlantic coast, a detached portion of the transcontinental triangulation centering on St. Louis and another portion of the same triangulation in the Rocky Mountain region, and three separate portions of triangulation in California, in the latitude of San Francisco, in the vicinity of Santa Barbara Channel, and in the vicinity of San Diego. With the lapse of time these separate pieces expanded until they touched or overlapped.

The transcontinental triangulation, of which the office computation was completed in 1899, joined all of the detached portions mentioned and made them one continuous triangulation. As soon as this took place the logical necessity existed of discarding the old geodetic data used in these various pieces and substituting one for the whole country, or at least for as much of the country as is covered by continuous triangulation. To do this was a very heavy piece of work, and involved much preliminary study to determine the best datum to be adopted. On March 13, 1901, the Superintendent adopted what was known from that time until 1913 as the United States Standard Datum, but is now known as the North American Datum (see p. 80), and it was decided to reduce the positions to that datum as rapidly as possible. The datum adopted was that formerly in use in New England, and therefore its adoption did not affect the positions which had been used for geographic purposes in New England and along the Atlantic coast to North Carolina, nor those in the States of New York, Pennsylvania, New Jersey, and Delaware. The adopted datum does not agree, however, with that used in The Transcontinental Triangulation and in The Eastern Oblique Arc of the United States, publications which deal primarily with the purely scientific problem of the determination of the figure of the earth and which were prepared for publication before the adoption of the new datum.

As the adoption of such a standard datum was a matter of considerable importance, it is in order here to explain the desirability of this step more fully.

The main objects to be attained by the geodetic operations of the Coast and Geodetic Survey are, first, the control of the charts published by the Survey; second, the furnishing of geographic positions (latitudes and longitudes), of accurately determined elevations, and of distances and azimuths, to officers connected with the Coast and Geodetic Survey and to other organizations; third, the determination of the figure of the earth. For the first and second objects it is not necessary that the reference spheroid should be accurately that which most closely fits the geoid within the area covered, nor that the adopted geodetic datum should be absolutely the best that can be derived from the astronomic observations at hand. It is simply desirable that the reference spheroid and the geodetic datum adopted shall be, if possible, such a close approximation to the truth that any correction which may hereafter be derived from the observations which are now or may become available shall not greatly exceed the probable errors of such corrections. It is, however, very desirable that one spheroid and one geodetic datum be used for the whole country. In fact, this is absolutely necessary if a geodetic survey is to perform fully the function of accurately coordinating all surveys within the area which it covers. This is the most important function of a geodetic survey. To perform this function, it is also highly desirable that when a certain spheroid and geodetic datum have been adopted for a country they be rigidly adhered to, without change, for all time, unless shown to be largely in error.

In striving to attain the third object, the determination of the figure of the earth, the conditions are decidedly different. This problem concerns itself primarily with astronomic observations of latitude, longitude, and azimuth, and with the geodetic positions of the points at which the astronomic observations were made, but is not concerned with the geodetic positions of other points fixed by the triangulations. The geodetic positions (latitudes and longitudes) of comparatively few points are therefore concerned in this problem. However, in marked contrast to the statements made in preceding paragraphs, it is desirable in dealing with this problem that, with each new important accession of data, a new spheroid fitting the geoid with the greatest possible accuracy, and new values of the geodetic latitudes, longitudes, and azimuths of the highest degree of accuracy, should be derived.

The United States Standard (now the North American) Datum was adopted with reference to positions furnished for geographic purposes, but has no reference to the problem of the determination of the figure of the earth. It is adopted with reference to the engineer's problem of furnishing standard positions and does not affect the scientist's problem of the determination of the figure of the earth.

The principles which guided in the selection of the datum to be adopted were: First, that the adopted datum should not differ widely from the ideal datum for which the sum of the station errors in latitude, longitude, and azimuth should each be zero; second, it was desirable that the adopted datum should produce minimum changes in the publications of the Survey, including its charts; and, third, it was desirable, other things being equal, to adopt that datum which allowed the maximum number of positions already in the office registers to remain unchanged, and therefore necessitated a minimum amount of new computation. These considerations led to the adoption, as the standard, of that datum which had been in use for many years in the northeastern group of States and along the Atlantic coast as far south as North Carolina.

An examination of the station errors available in 1903 on the United States Standard Datum at 246 latitude stations, 76 longitude stations, and 152 azimuth stations, scattered widely over the United States from Maine to Louisiana and to California, indicated that this datum approaches closely the ideal with which the algebraic sum of the station errors of each class would be zero.[1]

The North American Datum, upon which the positions and azimuths given in this publication depend, may be defined in terms of the position of the station Meades Ranch as follows:

	°	′	″
ϕ =	39	13	26.686
λ =	98	32	30.506
α to Waldo =	75	28	14.52

Points are then said to be upon the North American Datum when they are connected with the station Meades Ranch by a continuous triangulation, through which the corresponding latitudes, longitudes, and azimuths have been computed on the Clarke spheroid of 1866, as expressed in meters, starting from the above data.

[1] This is further borne out in the reduction of 765 astronomic stations in connection with the "Supplementary investigation in 1909 of the figure of the earth and isostasy," by J. F. Hayford, published by the Coast and Geodetic Survey.

The principal lists of geographic positions published on the adopted datum throughout the whole United States are contained in the following publications of the Coast and Geodetic Survey and of other organizations:

Appendix 8 of the Report for 1885, positions in Massachusetts and Rhode Island.
Appendix 8 of the Report for 1888, positions in Connecticut.
Appendix 8 of the Report for 1893, positions in Pennsylvania, Delaware, and Maryland.
Appendix 10 of the Report for 1894, positions in Massachusetts.
Appendix 6 of the Report for 1901, positions in Kansas and Nebraska.
Appendix 3 of the Report for 1902, positions in Kansas, Missouri, Nebraska, and Colorado.
Appendix 4 of the Report for 1903, positions in Kansas, Oklahoma, and Texas.
Appendix 9 of the Report for 1904, positions in California.
Appendix 5 of the Report for 1905, positions in Texas.
Appendix 3 of the Report for 1907, positions in California.
Appendix 5 of the Report for 1910, positions in California.
Appendix 4 of the Report for 1911, positions in Nebraska, Minnesota, North Dakota, and South Dakota.
Appendix 5 of the Report for 1911, positions in Texas.
Appendix 6 of the Report for 1911, positions in Florida.
Special Publication No. 11, positions in Texas, New Mexico, Arizona, and California.
Special Publication No. 13, positions in California, Oregon, and Washington.
Special Publication No. 16, positions in Florida.
Special Publication No. 17, positions in Texas.
Special Publication No. 19, positions in Colorado, Utah, Nevada, Wyoming, Montana, South Dakota, and North Dakota.
Appendix EEE, pages 2905–3031, Annual Report of the Chief of Engineers, 1902, positions of points on and near the Great Lakes.
Publications of the Massachusetts Harbor and Land Commission.
Various bulletins of the United States Geological Survey.

EXPLANATION OF TABLES OF POSITIONS.

In the tables of positions, the latitude and longitude of each point are given on the North American datum (see p. 80), also the length and azimuth of each line observed over, whether in one or both ways. Along with the latitude and longitude of each point the lengths and azimuths are given of lines from that point to other points of the triangulation. No lengths or azimuths are repeated, and for a given line the length and azimuth will generally be found opposite the position of the last mentioned of the two stations involved.

For the convenience of the draftsman a column of "seconds in meters" is given, in which is placed the length (in meters) of each small arc of a meridian or parallel corresponding to the seconds of the given latitude or longitude. To facilitate further the use of the tables, a column is given of the logarithms of the lengths. It must be remembered that it is the logarithm which is derived first from the computation, the lengths given in this table being then derived from the corresponding logarithms.

The rule followed in recent publications of this office has been to give latitudes and longitudes to thousandths of seconds for all points the positions of which are fixed by fully adjusted triangulation. Points, the positions of which are given to hundredths of seconds only, are marked by footnotes as being without check (observed from only two stations) or checked by verticals only.

In the columns giving azimuths, distances, and logarithms of distances, the accuracy is indicated to a certain extent by the number of decimal places given, it being understood that in each case two doubtful figures are given. In some cases there is very little doubt of the correctness of the second figure from the right, while in a few cases some doubt may be cast on the third figure from the right.

These tables may be conveniently consulted by using as finders the 11 sketches and the index at the end of this publication. In the third column of the index will be found for each point a reference to the page on which its description is given, in the fourth column the page on which its elevation above sea level will be found, and in the fifth column the number of the sketch on which it appears.

The following conversion tables are inserted for the convenience of those who may wish to convert the distances or elevations given in this publication from meters to feet or from feet to meters.

Lengths—Feet to meters (from 1 to 1,000 units).

[Reduction factor: 1 foot = 0.3048006096 meter.]

Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.
0		**100**	30.48006	**200**	60.96012	**300**	91.44018	**400**	121.92024	**500**	152.40030	**600**	182.88037	**700**	213.36043	**800**	243.84049	**900**	274.32055
1	.30480	1	30.78486	1	61.26492	1	91.74498	1	122.22504	1	152.70511	1	183.18517	1	213.66523	1	244.14529	1	274.62535
2	.60960	2	31.08966	2	61.56972	2	92.04978	2	122.52985	2	153.00991	2	183.48997	2	213.97003	2	244.45009	2	274.93015
3	.91440	3	31.39446	3	61.87452	3	92.35458	3	122.83465	3	153.31471	3	183.79477	3	214.27483	3	244.75489	3	275.23495
4	1.21920	4	31.69926	4	62.17932	4	92.65939	4	123.13945	4	153.61951	4	184.09957	4	214.57963	4	245.05969	4	275.53975
5	1.52400	5	32.00406	5	62.48412	5	92.96419	5	123.44425	5	153.92431	5	184.40437	5	214.88443	5	245.36449	5	275.84455
6	1.82880	6	32.30886	6	62.78893	6	93.26899	6	123.74905	6	154.22911	6	184.70917	6	215.18923	6	245.66929	6	276.14935
7	2.13360	7	32.61367	7	63.09373	7	93.57379	7	124.05385	7	154.53391	7	185.01397	7	215.49403	7	245.97409	7	276.45415
8	2.43840	8	32.91847	8	63.39853	8	93.87859	8	124.35865	8	154.83871	8	185.31877	8	215.79883	8	246.27889	8	276.75895
9	2.74321	9	33.22327	9	63.70333	9	94.18339	9	124.66345	9	155.14351	9	185.62357	9	216.10363	9	246.58369	9	277.06375
10	3.04801	**110**	33.52807	**210**	64.00813	**310**	94.48819	**410**	124.96825	**510**	155.44831	**610**	185.92837	**710**	216.40843	**810**	246.88849	**910**	277.36855
1	3.35281	1	33.83287	1	64.31293	1	94.79299	1	125.27305	1	155.75311	1	186.23317	1	216.71323	1	247.19329	1	277.67336
2	3.65761	2	34.13767	2	64.61773	2	95.09779	2	125.57785	2	156.05791	2	186.53797	2	217.01803	2	247.49810	2	277.97816
3	3.96241	3	34.44247	3	64.92253	3	95.40259	3	125.88265	3	156.36271	3	186.84277	3	217.32283	3	247.80290	3	278.28296
4	4.26721	4	34.74727	4	65.22733	4	95.70739	4	126.18745	4	156.66751	4	187.14757	4	217.62764	4	248.10770	4	278.58776
5	4.57201	5	35.05207	5	65.53213	5	96.01219	5	126.49225	5	156.97231	5	187.45237	5	217.93244	5	248.41250	5	278.89256
6	4.87681	6	35.35687	6	65.83693	6	96.31699	6	126.79705	6	157.27711	6	187.75718	6	218.23724	6	248.71730	6	279.19736
7	5.18161	7	35.66167	7	66.14173	7	96.62179	7	127.10185	7	157.58192	7	188.06198	7	218.54204	7	249.02210	7	279.50216
8	5.48641	8	35.96647	8	66.44653	8	96.92659	8	127.40665	8	157.88672	8	188.36678	8	218.84684	8	249.32690	8	279.80696
9	5.79121	9	36.27127	9	66.75133	9	97.23139	9	127.71146	9	158.19152	9	188.67158	9	219.15164	9	249.63170	9	280.11176
20	6.09601	**120**	36.57607	**220**	67.05613	**320**	97.53620	**420**	128.01626	**520**	158.49632	**620**	188.97638	**720**	219.45644	**820**	249.93650	**920**	280.41656
1	6.40081	1	36.88087	1	67.36093	1	97.84100	1	128.32106	1	158.80112	1	189.28118	1	219.76124	1	250.24130	1	280.72136
2	6.70561	2	37.18567	2	67.66574	2	98.14580	2	128.62586	2	159.10592	2	189.58598	2	220.06604	2	250.54610	2	281.02616
3	7.01041	3	37.49047	3	67.97054	3	98.45060	3	128.93066	3	159.41072	3	189.89078	3	220.37084	3	250.85090	3	281.33096
4	7.31521	4	37.79528	4	68.27534	4	98.75540	4	129.23546	4	159.71552	4	190.19558	4	220.67564	4	251.15570	4	281.63576
5	7.62002	5	38.10008	5	68.58014	5	99.06020	5	129.54026	5	160.02032	5	190.50038	5	220.98044	5	251.46050	5	281.94056
6	7.92482	6	38.40488	6	68.88494	6	99.36500	6	129.84506	6	160.32512	6	190.80518	6	221.28524	6	251.76530	6	282.24536
7	8.22962	7	38.70968	7	69.18974	7	99.66980	7	130.14986	7	160.62992	7	191.10998	7	221.59004	7	252.07010	7	282.55017
8	8.53442	8	39.01448	8	69.49454	8	99.97460	8	130.45466	8	160.93472	8	191.41478	8	221.89484	8	252.37490	8	282.85497
9	8.83922	9	39.31928	9	69.79934	9	100.27940	9	130.75946	9	161.23952	9	191.71958	9	222.19964	9	252.67971	9	283.15977
30	9.14402	**130**	39.62408	**230**	70.10414	**330**	100.58420	**430**	131.06426	**530**	161.54432	**630**	192.02438	**730**	222.50445	**830**	252.98451	**930**	283.46457
1	9.44882	1	39.92888	1	70.40894	1	100.88900	1	131.36906	1	161.84912	1	192.32918	1	222.80925	1	253.28931	1	283.76937
2	9.75362	2	40.23368	2	70.71374	2	101.19380	2	131.67386	2	162.15392	2	192.63399	2	223.11405	2	253.59411	2	284.07417
3	10.05842	3	40.53848	3	71.01854	3	101.49860	3	131.97866	3	162.45872	3	192.93879	3	223.41885	3	253.89891	3	284.37897
4	10.36322	4	40.84328	4	71.32334	4	101.80340	4	132.28346	4	162.76353	4	193.24359	4	223.72365	4	254.20371	4	284.68377
5	10.66802	5	41.14808	5	71.62814	5	102.10820	5	132.58827	5	163.06833	5	193.54839	5	224.02845	5	254.50851	5	284.98857
6	10.97282	6	41.45288	6	71.93294	6	102.41300	6	132.89307	6	163.37313	6	193.85319	6	224.33325	6	254.81331	6	285.29337
7	11.27762	7	41.75768	7	72.23774	7	102.71781	7	133.19787	7	163.67793	7	194.15799	7	224.63805	7	255.11811	7	285.59817
8	11.58242	8	42.06248	8	72.54255	8	103.02261	8	133.50267	8	163.98273	8	194.46279	8	224.94285	8	255.42291	8	285.90297
9	11.88722	9	42.36728	9	72.84735	9	103.32741	9	133.80747	9	164.28753	9	194.76759	9	225.24765	9	255.72771	9	286.20777
40	12.19202	**140**	42.67209	**240**	73.15215	**340**	103.63221	**440**	134.11227	**540**	164.59233	**640**	195.07239	**740**	225.55245	**840**	256.03251	**940**	286.51257
1	12.49682	1	42.97689	1	73.45695	1	103.93701	1	134.41707	1	164.89713	1	195.37719	1	225.85725	1	256.33731	1	286.81737
2	12.80163	2	43.28169	2	73.76175	2	104.24181	2	134.72187	2	165.20193	2	195.68199	2	226.16205	2	256.64211	2	287.12217
3	13.10643	3	43.58649	3	74.06655	3	104.54661	3	135.02667	3	165.50673	3	195.98679	3	226.46685	3	256.94691	3	287.42697
4	13.41123	4	43.89129	4	74.37135	4	104.85141	4	135.33147	4	165.81153	4	196.29159	4	226.77165	4	257.25171	4	287.73178
5	13.71603	5	44.19609	5	74.67615	5	105.15621	5	135.63627	5	166.11633	5	196.59639	5	227.07645	5	257.55652	5	288.03658
6	14.02083	6	44.50089	6	74.98095	6	105.46101	6	135.94107	6	166.42113	6	196.90119	6	227.38125	6	257.86132	6	288.34138
7	14.32563	7	44.80569	7	75.28575	7	105.76581	7	136.24587	7	166.72593	7	197.20599	7	227.68606	7	258.16612	7	288.64618
8	14.63043	8	45.11049	8	75.59055	8	106.07061	8	136.55067	8	167.03073	8	197.51080	8	227.99086	8	258.47092	8	288.95098
9	14.93523	9	45.41529	9	75.89535	9	106.37541	9	136.85547	9	167.33553	9	197.81560	9	228.29566	9	258.77572	9	289.25578

50	15.24003	**150**	45.72009	**250**	76.20015	**350**	106.68021	**450**	137.16027	**550**	167.64034	**650**	198.12040	**750**	228.60046	**850**	259.08052	**950**	289.56058
1	15.54483	1	46.02489	1	76.50495	1	106.98501	1	137.46507	1	167.94514	1	198.42520	1	228.90526	1	259.38532	1	289.86538
2	15.84963	2	46.32969	2	76.80975	2	107.28981	2	137.76988	2	168.24994	2	198.73000	2	229.21006	2	259.69012	2	290.17018
3	16.15443	3	46.63449	3	77.11455	3	107.59462	3	138.07468	3	168.55474	3	199.03480	3	229.51486	3	259.99492	3	290.47498
4	16.45923	4	46.93929	4	77.41935	4	107.89942	4	138.37948	4	168.85954	4	199.33960	4	229.81966	4	260.29972	4	290.77978
5	16.76403	5	47.24409	5	77.72416	5	108.20422	5	138.68428	5	169.16434	5	199.64440	5	230. 2446	5	260.60452	5	291.08458
6	17.06883	6	47.54890	6	78.02896	6	108.50902	6	138.98908	6	169.46914	6	199.94920	6	230.42926	6	260.90932	6	291.38938
7	17.37363	7	47.85370	7	78.33376	7	108.81382	7	139.29388	7	169.77394	7	200.25400	7	230.73406	7	261.21412	7	291.69418
8	17.67844	8	48.15850	8	78.63856	8	109.11862	8	139.59868	8	170.07874	8	200.55880	8	231.03886	8	261.51892	8	291.99898
9	17.98324	9	48.46330	9	78.94336	9	109.42342	9	139.90348	9	170.38354	9	200.86360	9	231.34366	9	261.82372	9	292.30378
60	18.28804	**160**	48.76810	**260**	79.24816	**360**	109.72822	**460**	140.20828	**560**	170.68834	**660**	201.16840	**760**	231.64846	**860**	262.12852	**960**	292.60859
1	18.59284	1	49.07290	1	79.55296	1	110.03302	1	140.51308	1	170.99314	1	201.47320	1	231.95326	1	262.43332	1	292.91339
2	18.89764	2	49.37770	2	79.85776	2	110.33782	2	140.81788	2	171.29794	2	201.77800	2	232.25806	2	262.73813	2	293.21819
3	19.20244	3	49.68250	3	80.16256	3	110.64262	3	141.12268	3	171.60274	3	202.08280	3	232.56287	3	263.04293	3	293.52299
4	19.50724	4	49.98730	4	80.46736	4	110.94742	4	141.42748	4	171.90754	4	202.38760	4	232.86767	4	263.34773	4	293.82779
5	19.81204	5	50.29210	5	80.77216	5	111.25222	5	141.73228	5	172.21234	5	202.69241	5	233.17247	5	263.65253	5	294.13259
6	20.11684	6	50.59690	6	81.07696	6	111.55702	6	142.03708	6	172.51714	6	202.99721	6	233.47727	6	263.95733	6	294.43739
7	20.42164	7	50.90170	7	81.38176	7	111.86182	7	142.34188	7	172.82195	7	203.30201	7	233.78207	7	264.26213	7	294.74219
8	20.72644	8	51.20650	8	81.68656	8	112.16662	8	142.64669	8	173.12675	8	203.60681	8	234.08687	8	264.56693	8	295.04699
9	21.03124	9	51.51130	9	81.99136	9	112.47142	9	142.95149	9	173.43155	9	203.91161	9	234.39167	9	264.87173	9	295.35179
70	21.33604	**170**	51.81610	**270**	82.29616	**370**	112.77623	**470**	143.25629	**570**	173 73635	**670**	204.21641	**770**	234.69647	**870**	265.17653	**970**	295.65659
1	21.64084	1	52.12090	1	82.60097	1	113.08103	1	143.56109	1	174.04115	1	204.52121	1	235.00127	1	265.48133	1	295.96139
2	21.94564	2	52.42570	2	82.90577	2	113.38583	2	143.86589	2	174.34595	2	204.82601	2	235.30607	2	265.78613	2	296.26619
3	22.25044	3	52.73051	3	83.21057	3	113.69063	3	144.17069	3	174.65075	3	205.13081	3	235.61087	3	266.09093	3	296.57099
4	22.55525	4	53.03531	4	83.51537	4	113.99543	4	144.47549	4	174.95555	4	205.43561	4	235.91567	4	266.39573	4	296.87579
5	22.86005	5	53.34011	5	83.82017	5	114.30023	5	144.78029	5	175.26035	5	205.74041	5	236.22047	5	266.70053	5	297.18059
6	23.16485	6	53.64491	6	84.12497	6	114.60503	6	145.08509	6	175.56515	6	206.04521	6	236.52527	6	267.00533	6	297.48539
7	23.46965	7	53.94971	7	84.42977	7	114.90983	7	145.38989	7	175.86995	7	206.35001	7	236.83007	7	267.31013	7	297.79020
8	23.77445	8	54.25451	8	84.73457	8	115.21463	8	145.69469	8	176.17475	8	206.65481	8	237.13487	8	267.61494	8	298.09500
9	24.07925	9	54.55931	9	85.03937	9	115.51943	9	145.99949	9	176.47955	9	206.95961	9	237.43967	9	267.91974	9	298.39980
80	24.38405	**180**	54.86411	**280**	85.34417	**380**	115.82423	**480**	146.30429	**580**	176.78435	**680**	207.26441	**780**	237.74448	**880**	268.22454	**980**	298.70460
1	24.68885	1	55.16891	1	85.64897	1	116.12903	1	146.60909	1	177.08915	1	207.56922	1	238.04928	1	268.52934	1	299.00940
2	24.99365	2	55.47371	2	85.95377	2	116.43383	2	146.91389	2	177.39395	2	207.87402	2	238.35408	2	268.83414	2	299.31420
3	25.29845	3	55.77851	3	86.25857	3	116.73863	3	147.21869	3	177.69876	3	208.17882	3	238.65888	3	269.13894	3	299.61900
4	25.60325	4	56.08331	4	86.56337	4	117.04343	4	147.52350	4	178.00356	4	208.48362	4	238.96368	4	269.44374	4	299.92380
5	25.90805	5	56.38811	5	86.86817	5	117.34823	5	147.82830	5	178.30836	5	208.78842	5	239.26848	5	269.74854	5	300.22860
6	26.21285	6	56.69291	6	87.17297	6	117.65304	6	148.13310	6	178.61316	6	209.09322	6	239.57328	6	270.05334	6	300.53340
7	26.51765	7	56.99771	7	87.47777	7	117.95784	7	148.43790	7	178.91796	7	209.39802	7	239.87808	7	270.35814	7	300.83820
8	26.82245	8	57.30251	8	87.78258	8	118.26264	8	148.74270	8	179.22276	8	209.70282	8	240.18288	8	270.66294	8	301.14300
9	27.12725	9	57.60732	9	88.08738	9	118.56744	9	149.04750	9	179.52756	9	210.00762	9	240.48768	9	270.96774	9	301.44780
90	27.43205	**190**	57.91212	**290**	88.39218	**390**	118.87224	**490**	149.35230	**590**	179.83236	**690**	210.31242	**790**	240.79248	**890**	271.27254	**990**	301.75260
1	27.73686	1	58.21692	1	88.69698	1	119.17704	1	149.65710	1	180.13716	1	210.61722	1	241.09728	1	271.57734	1	302.05740
2	28.04166	2	58.52172	2	89.00178	2	119.48184	2	149.96190	2	180.44196	2	210.92202	2	241.40208	2	271.88214	2	302.36220
3	28.34646	3	58.82652	3	89.30658	3	119.78664	3	150.26670	3	180.74676	3	211.22682	3	241.70688	3	272.18694	3	302.66701
4	28.65126	4	59.13132	4	89.61138	4	120.09144	4	150.57150	4	181.05156	4	211.53162	4	242.01168	4	272.49174	4	302.97181
5	28.95606	5	59.43612	5	89.91618	5	120.39624	5	150.87630	5	181.35636	5	211.83642	5	242.31648	5	272.79655	5	303.27661
6	29.26086	6	59.74092	6	90.22098	6	120.70104	6	151.18110	6	181.66116	6	212.14122	6	242.62129	6	273.10135	6	303.58141
7	29.56566	7	60.04572	7	90.52578	7	121.00584	7	151.48590	7	181.96596	7	212.44602	7	242.92609	7	273.40615	7	303.88621
8	29.87046	8	60.35052	8	90.83058	8	121.31064	8	151.79070	8	182.27076	8	212.75083	8	243.23089	8	273.71095	8	304.19101
9	30.17526	9	60.65532	9	91.13538	9	121.61544	9	152.09550	9	182.57557	9	213.05563	9	243.53569	9	274.01575	9	304.49581

1 inch = .02540 meter.	4 inches = .10160 meter.	7 inches = .17780 meter.	10 inches = .25400 meter.
2 inches = .05080 meter.	5 inches = .12700 meter.	8 inches = .20320 meter.	11 inches = .27940 meter.
3 inches = .07620 meter.	6 inches = .15240 meter.	9 inches = .22860 meter.	12 inches = .30480 meter.

Lengths—Meters to feet (from 1 to 1,000 units).

[Reduction factor: 1 meter = 3.280833333 feet.]

Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.	Meters.	Feet.
0		100	328.08333	200	656.16667	300	984.25000	400	1,312.33333	500	1,640.41667	600	1,968.50000	700	2,296.58333	800	2,624.66667	900	2,952.75000
1	3.28083	1	331.36417	1	659.44750	1	987.53083	1	1,315.61417	1	1,643.69750	1	1,971.78083	1	2,299.86417	1	2,627.94750	1	2,956.03083
2	6.56167	2	334.64500	2	662.72833	2	990.81167	2	1,318.89500	2	1,646.97833	2	1,975.06167	2	2,303.14500	2	2,631.22833	2	2,959.31167
3	9.84250	3	337.92583	3	666.00917	3	994.09250	3	1,322.17583	3	1,650.25917	3	1,978.34250	3	2,306.42583	3	2,634.50917	3	2,962.59250
4	13.12333	4	341.20667	4	669.29000	4	997.37333	4	1,325.45667	4	1,653.54000	4	1,981.62333	4	2,309.70667	4	2,637.79000	4	2,965.87333
5	16.40417	5	344.48750	5	672.57083	5	1,000.65417	5	1,328.73750	5	1,656.82083	5	1,984.90417	5	2,312.98750	5	2,641.07083	5	2,969.15417
6	19.68500	6	347.76833	6	675.85167	6	1,003.93500	6	1,332.01833	6	1,660.10167	6	1,988.18500	6	2,316.26833	6	2,644.35167	6	2,972.43500
7	22.96583	7	351.04917	7	679.13250	7	1,007.21583	7	1,335.29917	7	1,663.38250	7	1,991.46583	7	2,319.54917	7	2,647.63250	7	2,975.71583
8	26.24667	8	354.33000	8	682.41333	8	1,010.49667	8	1,338.58000	8	1,666.66333	8	1,994.74667	8	2,322.83000	8	2,650.91333	8	2,978.99667
9	29.52750	9	357.61083	9	685.69417	9	1,013.77750	9	1,341.86083	9	1,669.94417	9	1,998.02750	9	2,326.11083	9	2,654.19417	9	2,982.27750
10	32.80833	110	360.89167	210	688.97500	310	1,017.05833	410	1,345.14167	510	1,673.22500	610	2,001.30833	710	2,329.39167	810	2,657.47500	910	2,985.55833
1	36.08917	1	364.17250	1	692.25583	1	1,020.33917	1	1,348.42250	1	1,676.50583	1	2,004.58917	1	2,332.67250	1	2,660.75583	1	2,988.83917
2	39.37000	2	367.45333	2	695.53667	2	1,023.62000	2	1,351.70333	2	1,679.78667	2	2,007.87000	2	2,335.95333	2	2,664.03667	2	2,992.12000
3	42.65083	3	370.73417	3	698.81750	3	1,026.90083	3	1,354.98417	3	1,683.06750	3	2,011.15083	3	2,339.23417	3	2,667.31750	3	2,995.40083
4	45.93167	4	374.01500	4	702.09833	4	1,030.18167	4	1,358.26500	4	1,686.34833	4	2,014.43167	4	2,342.51500	4	2,670.59833	4	2,998.68167
5	49.21250	5	377.29583	5	705.37917	5	1,033.46250	5	1,361.54583	5	1,689.62917	5	2,017.71250	5	2,345.79583	5	2,673.87917	5	3,001.96250
6	52.49333	6	380.57667	6	708.66000	6	1,036.74333	6	1,364.82667	6	1,692.91000	6	2,020.99333	6	2,349.07667	6	2,677.16000	6	3,005.24333
7	55.77417	7	383.85750	7	711.94083	7	1,040.02417	7	1,368.10750	7	1,696.19083	7	2,024.27417	7	2,352.35750	7	2,680.44083	7	3,008.52417
8	59.05500	8	387.13833	8	715.22167	8	1,043.30500	8	1,371.38833	8	1,699.47167	8	2,027.55500	8	2,355.63833	8	2,683.72167	8	3,011.80500
9	62.33583	9	390.41917	9	718.50250	9	1,046.58583	9	1,374.66917	9	1,702.75250	9	2,030.83583	9	2,358.91917	9	2,687.00250	9	3,015.08583
20	65.61667	120	393.70000	220	721.78333	320	1,049.86667	420	1,377.95000	520	1,706.03333	620	2,034.11667	720	2,362.20000	820	2,690.28333	920	3,018.36667
1	68.89750	1	396.98083	1	725.06417	1	1,053.14750	1	1,381.23083	1	1,709.31417	1	2,037.39750	1	2,365.48083	1	2,693.56417	1	3,021.64750
2	72.17833	2	400.26167	2	728.34500	2	1,056.42833	2	1,384.51167	2	1,712.59500	2	2,040.67833	2	2,368.76167	2	2,696.84500	2	3,024.92833
3	75.45917	3	403.54250	3	731.62583	3	1,059.70917	3	1,387.79250	3	1,715.87583	3	2,043.95917	3	2,372.04250	3	2,700.12583	3	3,028.20917
4	78.74000	4	406.82333	4	734.90667	4	1,062.99000	4	1,391.07333	4	1,719.15667	4	2,047.24000	4	2,375.32333	4	2,703.40667	4	3,031.49000
5	82.02083	5	410.10417	5	738.18750	5	1,066.27083	5	1,394.35417	5	1,722.43750	5	2,050.52083	5	2,378.60417	5	2,706.68750	5	3,034.77083
6	85.30167	6	413.38500	6	741.46833	6	1,069.55167	6	1,397.63500	6	1,725.71833	6	2,053.80167	6	2,381.88500	6	2,709.96833	6	3,038.05167
7	88.58250	7	416.66583	7	744.74917	7	1,072.83250	7	1,400.91583	7	1,728.99917	7	2,057.08250	7	2,385.16583	7	2,713.24917	7	3,041.33250
8	91.86333	8	419.94667	8	748.03000	8	1,076.11333	8	1,404.19667	8	1,732.28000	8	2,060.36333	8	2,388.44667	8	2,716.53000	8	3,044.61333
9	95.14417	9	423.22750	9	751.31083	9	1,079.39417	9	1,407.47750	9	1,735.56083	9	2,063.64417	9	2,391.72750	9	2,719.81083	9	3,047.89417
30	98.42500	130	426.50833	230	754.59167	330	1,082.67500	430	1,410.75833	530	1,738.84167	630	2,066.92500	730	2,395.00833	830	2,723.09167	930	3,051.17500
1	101.70583	1	429.78917	1	757.87250	1	1,085.95583	1	1,414.03917	1	1,742.12250	1	2,070.20583	1	2,398.28917	1	2,726.37250	1	3,054.45583
2	104.98667	2	433.07000	2	761.15333	2	1,089.23667	2	1,417.32000	2	1,745.40333	2	2,073.48667	2	2,401.57000	2	2,729.65333	2	3,057.73667
3	108.26750	3	436.35083	3	764.43417	3	1,092.51750	3	1,420.60083	3	1,748.68417	3	2,076.76750	3	2,404.85083	3	2,732.93417	3	3,061.01750
4	111.54833	4	439.63167	4	767.71500	4	1,095.79833	4	1,423.88167	4	1,751.96500	4	2,080.04833	4	2,408.13167	4	2,736.21500	4	3,064.29833
5	114.82917	5	442.91250	5	770.99583	5	1,099.07917	5	1,427.16250	5	1,755.24583	5	2,083.32917	5	2,411.41250	5	2,739.49583	5	3,067.57917
6	118.11000	6	446.19333	6	774.27667	6	1,102.36000	6	1,430.44333	6	1,758.52667	6	2,086.61000	6	2,414.69333	6	2,742.77667	6	3,070.86000
7	121.39083	7	449.47417	7	777.55750	7	1,105.64083	7	1,433.72417	7	1,761.80750	7	2,089.89083	7	2,417.97417	7	2,746.05750	7	3,074.14083
8	124.67167	8	452.75500	8	780.83833	8	1,108.92167	8	1,437.00500	8	1,765.08833	8	2,093.17167	8	2,421.25500	8	2,749.33833	8	3,077.42167
9	127.95250	9	456.03583	9	784.11917	9	1,112.20250	9	1,440.28583	9	1,768.36917	9	2,096.45250	9	2,424.53583	9	2,752.61917	9	3,080.70250
40	131.23333	140	459.31667	240	787.40000	340	1,115.48333	440	1,443.56667	540	1,771.65000	640	2,099.73333	740	2,427.81667	840	2,755.90000	940	3,083.98333
1	134.51417	1	462.59750	1	790.68083	1	1,118.76417	1	1,446.84750	1	1,774.93083	1	2,103.01417	1	2,431.09750	1	2,759.18083	1	3,087.26417
2	137.79500	2	465.87833	2	793.96167	2	1,122.04500	2	1,450.12833	2	1,778.21167	2	2,106.29500	2	2,434.37833	2	2,762.46167	2	3,090.54500
3	141.07583	3	469.15917	3	797.24250	3	1,125.32583	3	1,453.40917	3	1,781.49250	3	2,109.57583	3	2,437.65917	3	2,765.74250	3	3,093.82583
4	144.35667	4	472.44000	4	800.52333	4	1,128.60667	4	1,456.69000	4	1,784.77333	4	2,112.85667	4	2,440.94000	4	2,769.02333	4	3,097.10667
5	147.63750	5	475.72083	5	803.80417	5	1,131.88750	5	1,459.97083	5	1,788.05417	5	2,116.13750	5	2,444.22083	5	2,772.30417	5	3,100.38750
6	150.91833	6	479.00167	6	807.08500	6	1,135.16833	6	1,463.25167	6	1,791.33500	6	2,119.41833	6	2,447.50167	6	2,775.58500	6	3,103.66833
7	154.19917	7	482.28250	7	810.36583	7	1,138.44917	7	1,466.53250	7	1,794.61583	7	2,122.69917	7	2,450.78250	7	2,778.86583	7	3,106.94917
8	157.48000	8	485.56333	8	813.64667	8	1,141.73000	8	1,469.81333	8	1,797.89667	8	2,125.98000	8	2,454.06333	8	2,782.14667	8	3,110.23000
9	160.76083	9	488.84417	9	816.92750	9	1,145.01083	9	1,473.09417	9	1,801.17750	9	2,129.26083	9	2,457.34417	9	2,785.42750	9	3,113.51083

50	164.04167	150	492.12500	250	820.20833	350	1,148.29167	450	1,476.37600	550	1,604.45833	650	2,132.64167	750	2,460.62500	850	2,788.70833	950	3,116.79167
1	167.32250	1	495.40583	1	823.48917	1	1,161.57250	1	1,479.65583	1	1,807.73917	1	2,135.82250	1	2,463.90583	1	2,791.98917	1	3,120.07250
2	170.60833	2	498.68667	2	626.77000	2	1,154.85333	2	1,482.93667	2	1,811.02000	2	2,139.10333	2	2,467.18667	2	2,795.27000	2	3,123.35333
3	173.88417	3	501.96750	3	830.05083	3	1,158.13417	3	1,486.21750	3	1,814.30083	3	2,142.38417	3	2,470.46750	3	2,798.55083	3	3,126.63417
4	177.16500	4	505.24833	4	833.33167	4	1,161.41500	4	1,489.49833	4	1,817.58167	4	2,145.66500	4	2,473.74833	4	2.801.83167	4	3,129.91600
5	180.44583	5	508.52917	5	836.61250	5	1,164.69583	5	1,492.77917	5	1,820.86250	5	2,148.94583	5	2,477.02917	5	2,805.11250	5	3,133.19683
6	183.72667	6	511.81000	6	639.89333	6	1,167.97667	6	1,496.06000	6	1,824.14333	6	2,152.22667	6	2,480.31000	6	2,808.39333	6	3,136.47667
7	187.00750	7	515.09083	7	843.17417	7	1,171.25750	7	1,499.34083	7	1,827.42417	7	2,155.50760	7	2,483.69083	7	2,811.67417	7	3,139.75750
8	190.28833	8	518.37167	8	846.45500	8	1,174.53833	8	1,502.62167	8	1,830.70500	8	2,158.78833	8	2,486.87167	8	2,814.95500	8	3,143.03833
9	193.56917	9	521.65250	9	849.73583	9	1,177.81917	9	1,505.90250	9	1,833.98583	9	2,162.06917	9	2,490.15250	9	2,818.23583	9	3,146.31917
60	196.85000	160	624.93333	260	853.01667	360	1,181.10000	460	1,509.18333	560	1,837.26667	660	2,165.35000	760	2,493.43333	860	2,821.51667	960	3,149.60000
1	200.13083	1	528.21417	1	856.29750	1	1,184.38083	1	1,612.46417	1	1,840.54760	1	2,168.63083	1	2,496.71417	1	2,824.79750	1	3,152.88083
2	203.41167	2	531.49500	2	859.57833	2	1,187.66167	2	1,515.74600	2	1,843.82833	2	2,171.91167	2	2,499.99500	2	2,828.07833	2	3,156.16167
3	206.69250	3	534.77583	3	862.85917	3	1,190.94260	3	1,519.02583	3	1,847.10917	3	2,175.19250	3	2,503.27583	3	2,831.35917	3	3,159.44250
4	209.97333	4	538.05667	4	866.14000	4	1,194.22333	4	1,522.30667	4	1,850.39000	4	2,178.47333	4	2,506.55667	4	2,834.64000	4	3,162.72333
5	213.25417	5	641.33750	5	869.42083	5	1,197.50417	5	1,525.58750	5	1,853.67083	5	2,181.75417	5	2,509.83750	5	2,837.92083	5	3,166.00417
6	216.53500	6	544.61633	6	672.70167	6	1,200.78500	6	1,628.86833	6	1,856.95167	6	2,185.03500	6	2,513.11833	6	2,841.20167	6	3,169.28500
7	219.81563	7	547.89917	7	875.98250	7	1,204.06583	7	1,532.14917	7	1,660.23250	7	2,188.31563	7	2,516.39917	7	2,844.48250	7	3,172.56583
8	223.09667	8	551.18000	8	879.26333	8	1,207.34667	8	1,535.43000	8	1,863.51333	8	2,191.59667	8	2,519.68000	8	2,847.76333	8	3,175.84667
9	226.37750	9	554.46083	9	882.54417	9	1,210.62750	9	1,533.71083	9	1,866.79417	9	2,194.87750	9	2,522.96083	9	2,851.04417	9	3,179.12750
70	229.65833	170	557.74167	270	885.82500	370	1,213.90833	470	1,541.99167	570	1,870.07500	670	2,198.16833	770	2,526.24167	870	2,854.32500	970	3,182.40833
1	232.93917	1	561.02250	1	889.10583	1	1,217.18917	1	1,545.27250	1	1,873.35583	1	2,201.43917	1	2,529.62250	1	2,857.60583	1	3,185.68917
2	236.22000	2	564.30333	2	892.38667	2	1,220.47000	2	1,548.55333	2	1,876.63667	2	2,204.72000	2	2,532.80333	2	2,860.88667	2	3,188.97000
3	239.50083	3	567.58417	3	895.66760	3	1,223.75083	3	1,551.83417	3	1,879.91750	3	2,208.00083	3	2,536.08417	3	2,864.16750	3	3,192.25083
4	242.78167	4	570.66500	4	898.94833	4	1,227.03167	4	1,555.11500	4	1,883.19833	4	2,211.28167	4	2,539.36500	4	2,867.44833	4	3,195.53167
5	246.06250	5	674.14583	5	902.22917	5	1,230.31250	5	1,558.39583	5	1,886.47917	5	2,214.56250	5	2.542.64683	5	2,870.72917	5	3,198.81250
6	249.34333	6	577.42667	6	905.51000	6	1,233.59333	6	1,561.67667	6	1,889.76000	6	2,217.84333	6	2,545.92667	6	2,874.01000	6	3,202.09333
7	252.62417	7	580 70750	7	908.79083	7	1,236.87417	7	1,564.95750	7	1,893.04083	7	2,221.12417	7	2,649.20760	7	2,877.29083	7	3,205.37417
8	255.90500	8	583.98833	8	912.07167	8	1,240.15500	8	1,568.23833	8	1,896.32167	8	2,224.40500	8	2,552.48833	8	2,880.57167	8	3,208.65500
9	259.18583	9	587.26917	9	915.35250	9	1,243.43583	9	1,571.51917	9	1,899.60250	9	2,227.68583	9	2,555.76917	9	2,883.85250	9	3,211.93583
80	[illegible]	180	690.55000	280	918.63333	380	1,246.71667	480	1,674.80000	580	1,902.88333	680	2,230.96667	780	2,559.05000	880	2,887.13333	980	3,215.21667
1	[illegible]	1	593.83083	1	921.91417	1	1,249.99750	1	1,578.08083	1	1,906.16417	1	2,234.24750	1	2,562.33083	1	2,890.41417	1	3,218.49750
2	269.02833	2	597.11167	2	925.19500	2	1,253.27833	2	1,581.36167	2	1,909.44500	2	2,237.62833	2	2,565.61167	2	2,893.69500	2	3,221.77833
3	272.30917	3	600.39250	3	928.47683	3	1,256.55917	3	1,584.64250	3	1,912.72583	3	2,240.80917	3	2,568.89250	3	2,896.97583	3	3,225.05917
4	275.59000	4	603.67333	4	931.76667	4	1,259.84000	4	1,587.92333	4	1,916.00667	4	2,244.09000	4	2,572.17333	4	2,900.25667	4	3,228.34000
5	278.87083	5	606.95417	5	935.03750	5	1,263.12083	5	1,591.20417	5	1,919.28760	5	2,247.37083	5	2,575.46417	5	2.903.53750	5	3,231.62083
6	262.16167	6	610.23500	6	938.31633	6	1,266.40167	6	1,594.48500	6	1,922.56833	6	2,250.65167	6	2,678.73500	6	2,906.81833	6	3,234.90167
7	285.43250	7	613.51583	7	941.69917	7	1,269.68250	7	1,597.76583	7	1,925.84917	7	2,253.93250	7	2,682.01583	7	2,910.09917	7	3,238.18250
8	288.71333	8	616.79667	8	944.88000	8	1,272.96333	8	1,601.04667	8	1,929.13000	8	2,257 21333	8	2,685.29667	8	2,913.38000	8	3,241.46333
9	291.99417	9	620.07750	9	948.16083	9	1,276.24417	9	1,604.32750	9	1,932.41083	9	2,260.49417	9	2,588.57750	9	2,916.66083	9	3,244.74417
90	295.27500	190	623.35833	290	951.44167	390	1,279.52500	490	1,607.60833	590	1,935.69167	690	2,263.77500	790	2,691.85833	890	2,919.94167	990	3,248.02500
1	298.65583	1	626.63917	1	954.72250	1	1,282.80583	1	1,610.86917	1	1,938.97250	1	2,267.05583	1	2,595.13917	1	2,923.22250	1	3,251.30583
2	301.83667	2	629.92000	2	958.00333	2	1,266.08667	2	1,614.17000	2	1,942.25333	2	2,270.33667	2	2,598.42000	2	2,926.50333	2	3,254.58667
3	305.11750	3	633.20083	3	961.28417	3	1,289.36760	3	1,617.45083	3	1,945.53417	3	2,273.61750	3	2,601.70083	3	2,929.78417	3	3,257.86750
4	308.39833	4	636.48167	4	964.56500	4	1,292.64833	4	1,620.73167	4	1,948.81600	4	2,276.89333	4	2,604.98167	4	2,933.06500	4	3,261.14833
5	311.67917	5	639.76250	5	967.84583	5	1,295.92917	5	1,624.01250	5	1,952.09583	5	2,280.17917	5	2,608.26250	5	2,936.34583	5	3,264.42917
6	314.96000	6	643.04333	6	971.12667	6	1,299.21000	6	1,627.29333	6	1,955.37667	6	2,283.46000	6	2,611.64333	6	2,939.62667	6	3,267.71000
7	318.21083	7	646.32417	7	974.40750	7	1,302.49083	7	1,630.57417	7	1,958.65750	7	2,286.74088	7	2,614.82417	7	2,942.90750	7	3,270.99083
8	321.62167	8	649.60500	8	977.68833	8	1,305.77167	8	1,633.85500	8	1,961.93833	8	2,290.02167	8	2,618.10500	8	2,946.18833	8	3,274.27167
9	324.80250	9	652.88583	9	980.96917	9	1,309.05250	9	1,637.13583	9	1,965.21917	9	2,293.30250	9	2,621.38583	9	2,949.46917	9	3,277.55250

GEOGRAPHIC POSITIONS.

One hundred and fourth meridian.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Principal points.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Elbert, 1912	39 14 02.936	90.5	343 07 56.47	163 10 20.77	Divide	18933.89	4.2772398
	104 34 33.167	795.5	42 59 00.56	222 41 19.86	Pikes Peak	59573.16	4.7750507
Hilltop, 1912	39 27 19.099	589.0	344 49 56.55	164 55 01.05	Divide	44205.34	4.6454747
	104 38 45.755	1093.9	346 08 18.69	166 10 58.83	Elbert	25286.81	4.4028941
			26 51 45.60	206 36 41.84	Pikes Peak	76407.25	4.8831345
Morrison[1] (U. S. G. S.), 1912	39 40 09.669	298.2	295 34 22.98	115 56 17.17	Hilltop	54688.99	4.7378999
	105 13 09.104	217.0	310 54 07.84	131 18 39.47	Elbert	73489.54	4.8662255
			350 35 37.49	170 42 17.31	Pikes Peak	93241.38	4.9696087
Douglas, 1912	39 31 17.498	539.6	346 31 08.07	166 31 54.95	Hilltop	7560.25	3.8785359
	104 39 59.472	1420.5	109 14 48.94	288 53 40.82	Morrison	50230.47	4.7009672
Indian[1] (U. S. G. S.), 1912	39 39 18.826	580.6	13 19 47.36	193 17 27.29	Hilltop	22809.08	4.3581077
	104 35 05.801		23 47 37.97	203 30 13.10	Pikes Peak	98724.61	4.9944254
		138.3	25 17 51.63	205 14 44.49	Douglas	16415.27	4.2152479
			59 47 09.64	239 12 22.83	Bison	91149.94	4.9597564
			91 51 09.32	271 26 51.98	Morrison	54450.86	4.7360048
Watkins astronomic, 1912	39 44 43.813	1351.2	350 08 03.53	170 08 50.23	Indian	10173.11	4.0074536
	104 36 18.915	450.4	81 04 24.38	260 40 52.36	Morrison	53325.64	4.7269361
Brighton[1] (U. S. G. S.), 1912	40 01 37.866	1167.9	340 19 54.87	160 26 31.41	Indian	43841.69	4.6418873
	104 45 24.750	586.9	45 01 51.47	224 44 05.02	Morrison	56071.86	4.7487449
Boulder[1] (U. S. G. S.), 1912	39 57 37.355	1152.1	260 39 07.01	80 59 51.20	Brighton	46520.13	4.6676409
	105 17 40.611	963.9	291 47 49.68	112 14 20.01	Watkins astronomic	63635.83	4.8037017
			298 54 42.35	119 21 57.99	Indian	69578.17	4.8424730
			348 40 25.56	168 43 19.41	Morrison	32951.10	4.5178699
Horsetooth[1] (U. S. G. S.), 1912	40 32 22.856	705.0	326 34 17.88	146 51 20.48	Brighton	68074.92	4.8329872
	105 11 46.319	1090.0	7 26 54.96	187 23 06.04	Boulder	64867.40	4.8120265
Dewey[1] (U. S. G. S.), 1912	40 30 25.868	797.9	17 58 02.72	197 50 11.75	Brighton	56009.99	4.7482655
	104 33 16.100	379.1	46 17 31.88	225 48 50.82	Boulder	87486.98	4.9419434
			94 00 17.52	273 35 16.43	Horsetooth	54499.80	4.7363949
Warren, 1912	41 01 11.747	362.4	334 54 07.47	155 06 26.45	Dewey	62822.61	4.7981160
	104 52 07.859	183.7	27 29 54.69	207 17 04.97	Horsetooth	60064.56	4.7786183
Twin, 1912	41 02 54.064	1667.9	275 14 57.94	95 30 39.81	Warren	33661.38	4.5271319
	105 16 02.530	59.1	314 43 30.82	135 11 27.05	Dewey	85048.51	4.9296667
			353 54 24.76	173 57 12.15	Horsetooth	56805.20	4.7543881
Wadill, 1912	41 15 12.609	389.0	344 22 09.52	164 25 33.83	Warren	26931.76	4.4302648
	104 57 18.432	429.2	49 06 21.40	228 54 01.69	Twin	34729.35	4.5406967
Russell, 1912	41 14 12.177	375.7	266 22 19.71	86 36 40.68	Wadill	30465.35	4.4838061
	105 19 04.365	101.7	302 24 34.82	122 42 18.07	Warren	44737.06	4.6506675
			348 31 26.00	168 33 25.63	Twin	21344.32	4.3292824
Greentop, 1912	41 21 01.198	37.0	288 46 15.42	109 01 06.78	Wadill	33207.90	4.5212413
	105 19 48.921	1137.3	351 02 25.01	171 04 54.13	Twin	33949.22	4.5308298
			355 17 56.36	175 18 25.77	Russell	12660.57	4.1024531
Whitaker, 1912	41 23 56.362	1738.8	348 33 54.26	168 35 26.95	Wadill	16484.04	4.2170637
	104 59 38.801	901.3	79 14 01.89	259 00 42.02	Greentop	28636.04	4.4569130
Ragged, 1912	41 26 20.835	642.8	278 32 31.95	98 46 25.78	Whitaker	29607.27	4.4713984
	105 20 39.192	909.8	302 12 20.11	122 27 45.47	Wadill	38542.13	4.5859357
			353 14 27.24	173 15 00.48	Greentop	9929.70	3.9969363
Cheyenne west base, 1913	41 17 56.459	1741.8	198 18 18.15	18 20 02.62	Whitaker	11695.67	4.0680250
	105 02 16.930	393.9	306 00 42.90	126 03 59.82	Wadill	8591.41	3.9340644
Cheyenne east base, 1913	41 16 49.077	1514.0	108 14 19.23	288 11 20.08	Cheyenne west base	6650.437	3.8228501
	104 57 45.442	1057.5	168 42 10.42	348 40 55.54	Whitaker	13442.53	4.1284810
			348 04 07.26	168 04 25.07	Wadill	3041.67	3.4831115
Chugwater, 1912	41 48 06.161	190.1	356 10 17.77	176 11 43.32	Whitaker	44827.29	4.6515425
	105 01 47.644	1100.0	33 08 55.52	212 56 23.95	Ragged	48041.56	4.6816171
Notch, 1912	42 02 21.540	664.6	316 36 59.15	136 48 59.78	Chugwater	36252.52	4.5593383
	105 19 46.264	1064.0	338 27 36.65	158 41 00.22	Whitaker	76399.49	4.8830905
			1 03 21.67	181 02 46.44	Ragged	66672.95	4.8239497
Coleman, 1912	42 22 03.568	110.1	353 10 06.76	173 13 45.38	Chugwater	63307.03	4.8014519
	105 07 13.823	316.3	25 23 50.13	205 15 30.66	Notch	40349.54	4.6058386
Haystack, 1912	42 20 29.575	912.6	28 44 34.16	208 28 40.87	Chugwater	68300.94	4.8344267
	104 38 04.961	113.6	59 54 36.24	239 26 36.36	Notch	66491.43	4.8227657
			94 18 28.48	273 58 50.24	Coleman	40130.24	4.6034718
Hobbs, 1912	42 34 50.753	1566.1	8 44 32.82	188 42 32.32	Haystack	26883.46	4.4294852
	104 35 06.461	147.3	61 54 54.49	241 33 13.02	Coleman	49987.22	4.6988590

[1] Identical with a tertiary station of the U. S. Geological Survey.

GEOGRAPHIC POSITIONS—Continued.

One hundred and fourth meridian—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Principal points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Willow, 1912	42 41 10.995	339.3	331 07 55.45	151 11 07.52	Hobbs	13394.48	4.1269258
	104 39 50.037	1139.2	356 24 24.71	176 25 35.72	Haystack	38380.37	4.5841092
			46 48 49.49	226 30 18.39	Coleman	51585.62	4.7125287
Rawhide, 1912	42 35 12.227	377.3	23 22 31.80	203 16 44.75	Haystack	29659.32	4.4721611
	104 29 30.902	704.6	85 04 56.68	265 01 09.62	Hobbs	7680.46	3.8853872
			128 10 56.81	308 03 57.44	Willow	17931.62	4.2536195
Manville, 1912	42 50 58.350	1800.5	346 16 00.17	166 19 32.41	Rawhide	30050.12	4.4778463
	104 34 43.766	993.7	21 02 44.64	200 59 16.67	Willow	19415.93	4.2881582
Kirtley, 1912	42 51 44.682	1378.7	46 27 45.37	226 11 48.73	Rawhide	44350.40	4.6468975
	104 06 00.914	20.8	67 13 10.90	246 50 12.89	Willow	50102.43	4.6998588
			88 04 10.11	267 44 38.30	Manville	39141.23	4.5926345
Alkali, 1912	43 38 12.937	399.3	339 50 18.69	160 06 11.43	Kirtley	91584.60	4.9618224
	104 29 11.373	255.0	4 55 53.83	184 52 06.11	Manville	87796.36	4.9434765
Parker, 1912	43 23 56.397	1740.5	29 21 10.66	209 04 22.43	Kirtley	68298.02	4.8344081
	103 41 26.178	589.1	50 07 24.95	229 30 59.10	Manville	94607.37	4.9759250
			112 36 19.63	292 03 26.69	Alkali	69568.86	4.8424149
Cottonwood, 1912	43 15 14.290	441.0	143 50 57.64	323 35 02.45	Alkali	52780.57	4.7224741
	104 06 02.351	53.0	244 00 41.00	64 17 33.88	Parker	36956.39	4.5676896
Sullivan, 1912	43 35 33.573	1036.1	310 23 59.88	130 36 51.44	Parker	33124.53	4.5201497
	104 00 07.127	159.9	12 01 23.05	191 57 18.88	Cottonwood	38467.43	4.5850932
			97 20 03.30	277 00 00.11	Alkali	39420.55	4.5957226
Elk, 1912	43 43 41.793	1289.8	321 29 23.15	141 44 13.11	Parker	46672.02	4.6690566
	104 02 57.536	1287.8	345 45 48.64	165 47 46.28	Sullivan	15543.90	4.1915599
			74 05 21.92	253 47 14.93	Alkali	36683.60	4.5644719
Provo west base, 1912	43 10 23.438	723.3	121 01 36.87	300 54 03.09	Cottonwood	17445.44	4.2416820
	103 54 59.622	1346.7	216 05 22.40	36 14 40.13	Parker	31076.54	4.4924327
Provo east base, 1912	43 12 14.546	449.0	76 26 17.66	256 19 08.81	Provo west base	14559.251	4.1631390
	103 44 33.014	745.3	100 54 57.71	280 40 14.63	Cottonwood	29619.95	4.4715843
			190 59 06.10	11 01 14.24	Parker	22064.98	4.3437035
Provo astronomic, 1912	43 11 44.159	1362.7	70 55 53.73	250 52 15.72	Provo west base	7613.22	3.8815683
	103 49 41.058	927.4	106 24 50.46	286 13 38.41	Cottonwood	23075.86	4.3631578
			206 13 35.66	26 19 15.04	Parker	25200.59	4.4014107
			262 17 29.81	82 21 00.68	Provo east base	7017.74	3.8461975
Cambria, 1912	44 02 43.952	1356.7	341 44 39.20	161 50 39.26	Elk	37108.73	4.5694761
	104 11 36.919	821.9	27 31 26.43	207 19 16.05	Alkali	51147.53	4.7088247
Crow, 1912	44 03 19.230	593.6	10 58 38.10	190 54 59.78	Elk	37013.47	4.5683598
	103 57 42.632	949.0	86 43 31.02	266 33 50.95	Cambria	18604.16	4.2696101
Laird, 1912	44 12 34.829	1075.1	347 52 24.18	167 54 19.44	Crow	17538.85	4.2440010
	104 00 28.154	625.1	39 15 13.37	219 07 27.74	Cambria	23530.07	4.3716232
Inyankara, 1912	44 12 47.667	1471.2	270 42 42.55	90 57 00.58	Laird	27320.84	4.4364940
	104 20 58.646	1302.0	326 06 57.19	146 13 28.31	Cambria	22431.32	4.3508548
			9 47 15.91	189 41 34.10	Alkali	64970.54	4.8127165
Sundance, 1912	44 28 44.696	1379.6	310 07 33.02	130 26 07.65	Laird	46302.10	4.6656007
	104 27 02.821	62.4	344 41 27.56	164 45 42.12	Inyankara	30621.32	4.4860240
Terry, 1912	44 19 39.971	1233.7	46 30 02.25	226 22 47.96	Laird	19042.37	4.2797210
	103 50 05.990	132.7	72 58 16.08	252 36 42.84	Inyankara	43014.97	4.6336196
			109 08 03.66	288 42 12.52	Sundance	51856.71	4.7148050
Wymonkota [1] (U. S. G. S.), 1912	45 00 35.551	1097.6	345 13 31.72	165 24 05.75	Terry	78358.54	4.8940863
	104 05 07.832	171.5	26 15 16.33	205 59 50.65	Sundance	65696.98	4.8175454
Castle, 1912	45 00 36.830	1137.0	21 51 23.00	201 35 18.76	Terry	81634.76	4.9118751
	103 27 14.399	315.3	53 34 01.58	232 51 55.47	Sundance	98568.51	4.9937382
			90 10 40.31	269 43 52.46	Wymonkota	49785.14	4.6970997
Harding, 1912	45 22 14.317	442.0	319 33 43.52	139 52 06.88	Castle	52506.52	4.7202132
	103 53 09.605	209.1	21 25 44.27	201 17 14.73	Wymonkota	43050.45	4.6339777
Moreau, 1912	45 20 42.313	1306.4	331 05 41.20	151 16 46.16	Castle	42472.10	4.6281037
	103 42 51.869	1129.3	38 11 36.99	217 55 49.41	Wymonkota	47315.27	4.6750013
			101 59 21.11	281 52 01.59	Harding	13742.23	4.1380573
Reva, 1912	45 34 51.060	1576.3	16 43 58.75	196 33 40.23	Castle	66190.86	4.8207980
	103 12 44.169	957.6	56 28 05.74	236 06 37.20	Moreau	47211.66	4.6740493
			66 19 29.87	245 50 40.63	Harding	57629.33	4.7606436
Table, 1912	45 53 50.506	1559.2	315 16 27.88	135 35 35.72	Reva	49377.81	4.6935318
	103 39 26.917	580.2	17 00 40.54	196 50 52.40	Harding	61193.14	4.7867027

[1] Identical with a tertiary station of the U. S. Geological Survey.

GEOGRAPAIC POSITIONS—Continued.

One hundred and fourth meridian—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Principal points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Lodge, 1912	45 51 15.997	493.9	19 10 59.87	199 05 10.62	Reva	32186.90	4.5076792
	103 04 36.336	784.0	49 51 52.44	229 17 10.50	Harding	82920.96	4.9186643
			96 14 53.36	275 49 52.66	Table	45337.63	4.6564588
Butte, 1912	46 12 27.224	840.6	328 18 13.75	148 31 41.32	Lodge	46074.28	4.6634585
	103 23 18.398	394.4	31 13 25.17	211 01 47.85	Table	40278.12	4.6050692
Whetstone, 1912	46 13 24.329	751.2	12 42 44.28	192 37 35.65	Lodge	42036.25	4.6236240
	102 57 27.579	591.1	56 27 33.86	235 57 19.73	Table	65161.12	4.8139885
			87 07 09.24	266 48 29.63	Butte	33287.78	4.5222849
Rainy, 1912	46 29 41.772	1289.8	348 48 51.35	168 52 12.86	Whetstone	30762.09	4.4880158
	103 02 06.026	128.5	40 32 52.31	220 17 31.64	Butte	41958.75	4.6228225
Black, 1912	46 23 54.639	1687.1	251 10 37.89	71 28 34.77	Rainy	33477.75	4.5247562
	103 26 51.919	1109.1	297 05 40.50	117 26 56.40	Whetstone	42473.41	4.6281171
			347 49 44.89	167 52 19.27	Butte	21711.48	4.3366893
Badland, 1912	46 42 00.620	19.1	314 51 31.91	135 04 31.54	Rainy	32282.90	4.5089726
	103 19 59.087	1255.3	14 44 17.60	194 39 17.90	Black	34667.28	4.5399198
Sentinel, 1912	46 52 16.945	523.2	296 14 20.12	116 36 16.14	Badland	42770.06	4.6311399
	103 50 04.820	102.1	304 04 48.83	124 39 43.39	Rainy	74121.36	4.8699434
			330 27 05.33	150 43 57.97	Black	60339.54	4.7806020
Saddle, 1912	46 58 57.890	1787.7	344 40 28.36	164 48 55.66	Rainy	56207.90	4.7497973
	103 13 42.639	901.2	14 17 10.76	194 12 36.15	Badland	32409.96	4.5106785
			75 12 31.53	254 45 57.47	Sentinel	47797.60	4.6794061
Hump, 1912	46 57 09.936	306.8	265 23 39.72	85 48 38.65	Saddle	43477.43	4.6382639
	103 47 53.230	1125.6	17 07 14.69	197 05 38.59	Sentinel	9466.45	3.9761872
Cook, 1912	47 09 19.652	606.9	296 20 00.98	116 42 16.19	Saddle	43002.68	4.6334956
	103 44 06.248	131.6	12 01 30.72	191 58 44.57	Hump	23037.92	4.3624433
			13 31 19.42	193 26 57.12	Sentinel	32477.36	4.5115807
Blue, 1912	47 15 22.033	680.4	288 43 41.25	109 02 41.76	Cook	34572.39	4.5387294
	104 10 00.510	10.7	320 10 37.18	140 26 49.54	Hump	43825.42	4.6417261
			329 20 31.25	149 35 06.63	Sentinel	49660.30	4.6960093
Trotter, 1912	47 18 52.318	1615.7	331 29 58.68	151 35 33.17	Cook	26114.92	4.3035182
	103 51 41.870	879.4	74 24 06.58	254 10 39.37	Blue	23983.39	4.3799106
Flat, 1912	47 26 03.601	111.2	342 39 26.02	162 45 03.68	Cook	32472.54	4.5115163
	103 51 45.739	958.5	359 39 01.47	179 39 04.32	Trotter	13319.41	4.1244849
			49 20 39.71	229 07 14.56	Blue	30342.22	4.4820474
Lovering, 1912	47 42 43.969	1357.9	309 33 15.48	129 55 08.05	Flat	48329.26	4.6842101
	104 21 23.935	499.0	344 10 22.55	164 18 46.30	Blue	52688.29	4.7217141
Sheep, 1912	47 37 50.103	1547.4	13 18 21.80	193 15 20.17	Flat	22418.88	4.3506139
	103 47 39.515	825.0	34 09 05.19	213 52 37.39	Blue	50226.13	4.7009297
			102 20 11.28	281 55 14.63	Lovering	43195.98	4.6354433
Jackson [1] (U. S. G. S.), 1912	47 55 37.687	1163.9	309 16 03.61	129 39 48.19	Sheep	51874.17	4.7149511
	104 19 43.166	896.1	5 01 24.78	185 00 10.11	Lovering	23988.15	4.3799968
Buford, 1912	48 02 48.713	1504.5	342 56 25.62	163 04 49.72	Sheep	48397.04	4.6848188
	103 58 59.573	1233.8	37 02 04.70	216 45 27.54	Lovering	46527.14	4.6677064
			62 49 19.93	242 33 55.95	Jackson	29019.77	4.4626940
Montana [2] (Mo. River Com. and U. S. G. S.), 1912.	48 01 51.167	1580.3	251 06 16.65	71 09 23.33	Buford	5495.79	3.7400299
	104 03 10.628	220.2	336 23 25.85	156 34 55.96	Sheep	48537.78	4.6860799
			60 50 08.29	240 37 50.93	Jackson	23595.47	4.3728287
Cutoff [2] (Mo. River Com. and U. S. G. S.), 1912.	47 59 50.607	1562.9	57 22 34.21	237 15 18.32	Jackson	14465.74	4.1603406
	104 09 56.269	1166.5	246 04 03.14	66 09 04.66	Montana	9194.39	3.9635227
Lanark [2] (Mo. River Com. and U. S. G. S.), 1912.	48 06 20.308	627.3	301 52 27.07	122 00 26.22	Montana	15712.96	4.1962579
	104 13 54.701	1131.6	337 40 13.38	157 43 10.71	Cutoff	13009.91	4.1142743
			20 01 44.44	199 57 25.41	Jackson	21121.00	4.3247144
Mondak, 1912	48 00 10.435	322.3	86 05 24.18	266 00 06.56	Cutoff	8881.14	3.9484687
	104 02 48.867	1012.9	171 45 17.45	351 45 01.28	Montana	3143.75	3.4974476
Ferry [3] (Mo. River Com.), 1912	47 58 36.762	1135.3	108 28 59.04	288 24 54.06	Cutoff	7207.17	3.8577646
	104 04 26.550	550.7	194 40 43.63	14 41 40.06	Montana	6207.25	3.7928989
			214 59 00.63	35 00 13.21	Mondak	3531.67	3.5479803
Bainville, 1912	48 11 40.535	1252.1	319 06 06.03	139 14 36.97	Buford	21708.24	4.3366246
	104 10 25.812	533.0	21 15 59.47	201 09 04.88	Jackson	31899.61	4.5037854
Snake, 1912	48 15 46.468	1435.4	330 18 02.17	150 26 14.67	Buford	27636.58	4.4414843
	104 10 00.691	14.2	3 54 25.23	183 54 06.49	Bainville	7613.90	3.8816071
			17 57 04.49	197 49 50.98	Jackson	39232.37	4.5936445

[1] Identical with a tertiary station of the U. S. Geological Survey.
[2] Identical with a tertiary station of the Missouri River Commission and the U. S. Geological Survey.
[3] Identical with a tertiary station of the Missouri River Commission.

GEOGRAPHIC POSITIONS—Continued.

One hundred and fourth meridian—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Principal points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Bull, 1912	48 20 13.441	415.2	353 41 04.07	173 43 12.60	Buford	32464.61	4.5114102
	104 01 52.003	1071.0	50 44 29.58	230 38 24.71	Snake	13016.79	4.1145040
Williston, 1912	48 15 12.182	376.3	37 10 24.51	216 59 58.94	Buford	28786.18	4.4591840
	103 44 59.761	1232.8	92 06 52.93	271 48 13.01	Snake	30976.71	4.4910353
			114 08 30.39	293 55 54.67	Bull	22844.69	4.3587853
Bonetraill, 1912	48 25 00.000	0.0	342 05 14.19	162 08 46.69	Williston	19078.27	4.2805390
	103 49 44.219	909.2	59 29 32.36	239 20 28.32	Bull	17396.74	4.2404680
Gladys, 1912	48 26 45.434	1403.4	308 25 37.52	128 28 06.81	Bonetraill	5237.51	3.7191251
	103 53 03.761	77.3	334 59 36.19	155 05 37.84	Williston	23618.45	4.3732514
			41 57 50.02	221 51 15.05	Bull	16269.66	4.2113784
Marmon, 1912	48 27 27.934	862.8	30 47 32.53	210 39 22.26	Williston	26436.68	4.4222069
	103 34 03.685	75.7	76 47 56.17	256 36 12.44	Bonetraill	19864.58	4.2980793
			86 54 40.27	266 40 27.04	Gladys	23463.31	4.3703892
Howard, 1912	48 38 19.918	615.2	317 00 12.70	137 11 36.66	Marmon	27492.80	4.4392190
	103 49 16.219	332.0	12 17 53.32	192 15 02.79	Gladys	21953.82	4.3415101
Muddy, 1912	48 40 27.449	847.9	1 02 17.03	181 02 01.11	Marmon	24082.56	4.3817027
	103 33 42.450	868.4	43 16 57.63	223 02 27.05	Gladys	34809.99	4.5417039
			78 26 57.96	258 15 16.92	Howard	19511.88	4.2902991
Stady, 1912	48 47 20.723	640.1	334 04 39.51	154 08 27.42	Muddy	14190.38	4.1519940
	103 38 45.669	932.2	37 43 10.09	217 35 16.28	Howard	21100.27	4.3242881
Crosby, 1912	48 51 34.335	1060.6	0 47 59.49	180 47 48.92	Muddy	20602.30	4.3139157
	103 33 28.392	578.7	38 22 22.94	218 10 30.34	Howard	31258.44	4.4949673
			39 35 32.98	219 31 34.17	Stady	10161.57	4.0069608
Norge, 1912	48 53 38.866	1200.5	282 41 42.89	102 52 09.75	Crosby	17387.23	4.2402305
	103 47 20.556	418.7	317 59 50.72	138 06 18.37	Stady	15705.83	4.1960608
			4 46 06.79	184 44 39.81	Howard	28484.69	4.4546115
Ambrose southwest base, 1912	48 57 07.378	227.9	337 07 55.21	157 10 35.61	Crosby	11163.82	4.0478126
	103 37 01.232	25.1	63 00 10.86	242 52 24.00	Norge	14157.90	4.1509988
Bowie, 1912	48 59 56.626	1749.1	301 29 07.06	121 34 23.21	Ambrose southwest base	9998.09	3.9999169
	103 44 00.295	6.0	320 16 36.31	140 24 32.70	Crosby	20154.33	4.3043684
			19 16 10.92	199 13 39.91	Norge	12360.50	4.0920359
Ambrose, 1912	48 54 48.459	1497.0	27 42 29.31	207 40 32.92	Crosby	6772.40	3.8307427
	103 30 53.905	1097.6	119 53 37.91	299 49 00.97	Ambrose southwest base	8620.45	3.9355299
			120 50 12.95	300 40 19.85	Bowie	18616.36	4.2698948
School, or Ambrose northeast base, 1912.	48 59 24.331	751.6	13 57 50.17	193 56 31.68	Ambrose	8781.15	3.9435513
	103 29 09.836	200.0	66 14 17.96	246 08 22.35	Ambrose southwest base	10479.177	4.0203272
			93 14 52.63	273 03 40.65	Bowie	18129.03	4.2583746
Supplementary points.							
Denver University, observatory dome, 1895.	39 40 34.185	1054.3	4 52 58.9	184 49 31.0	Pikes Peak	93092.5	4.9689146
	104 57 08.710	207.6	88 11 35.8	268 01 22.7	Morrison	22902.5	4.3598826
			137 13 59.1	317 00 50.2	Boulder	43060.8	4.6340818
Denver, Loretto Heights school, belfry, 1912.	39 39 41.908	1292.4	93 02 05.8	272 54 44.4	Morrison	16504.1	4.2175931
	105 01 37.646	897.4	145 27 26.0	325 17 09.4	Boulder	40308.7	4.6053987
			209 35 34.0	29 45 57.3	Brighton	46714.6	4.6694524
Denver, county courthouse, dome, 1895.	39 44 32.976	1017.0	2 42 16.8	182 40 12.6	Pikes Peak	100233.4	5.0010123
	104 59 21.160	503.8	67 41 44.4	247 32 55.5	Morrison	21330.0	4.3289915
			132 53 03.9	312 41 19.4	Boulder	35613.9	4.5516194
			212 05 04.2	32 14 00.6	Brighton	37338.0	4.5721507
Denver, State Capitol, dome, 1895	39 44 21.662	668.0	2 57 24.3	182 55 09.0	Pikes Peak	99899.4	4.9995629
	104 59 03.598	85.7	68 58 36.5	248 49 36.4	Morrison	21589.9	4.3342500
			132 50 30.2	312 38 34.4	Boulder	36157.8	4.5582017
			211 15 40.5	31 24 25.5	Brighton	37415.4	4.5730500
			285 07 22.7	105 22 41.1	Indian	35506.6	4.5503095
Denver, Grant smelter, chimney, 1912.	39 46 35.932	1108.1	60 38 50.6	240 29 24.0	Morrison	24243.3	4.3845924
	104 58 22.557	536.8	126 38 52.9	306 26 30.5	Boulder	34258.5	4.5347687
			213 31 25.3	33 39 44.2	Brighton	33394.5	4.5236753
			291 56 01.4	112 10 53.8	Indian	35896.9	4.5550570
Denver, Daniels & Fisher's tower, gilded dome, 1912.	39 44 53.583	1652.5	65 34 21.7	245 25 46.4	Morrison	21115.6	4.3246033
	104 59 42.502	1011.9	132 40 59.8	312 29 28.9	Boulder	34809.3	4.5416954
			213 16 03.7	33 25 13.8	Brighton	37077.3	4.5691086
			286 13 25.4	106 29 08.8	Indian	36664.5	4.5642459
Westminster schoolhouse belfry, 1912.	39 50 50.209	1548.4	39 13 26.9	219 06 14.6	Morrison	25479.1	4.4061833
	105 01 53.135	1263.2	119 14 34.1	299 04 26.3	Boulder	25772.7	4.4111601
			229 30 27.4	49 41 02.0	Brighton	30817.3	4.4887947
			298 59 06.5	119 16 14.4	Indian	43805.6	4.6415299
Section 36, T. 4 S., R. 65 W., southeast corner stone.	39 39 22.420	691.4	34 58 06	214 58 04	Indian	135.251	2.131140
	104 35 02.550	60.8					

GEOGRAPHIC POSITIONS—Continued.

One hundred and fourth meridian—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Bench mark G_2	39 44 47.559	1466.7	64 15 43.6	244 15 37.2	Watkins astronomic	266.017	2.424909
	104 36 08.850	210.7					
Brighton bench mark eccentric, 1912	40 00 01.626	50.1	43 18 44.08	223 03 14.63	Morrison	50415.64	4.7025653
	104 48 58.148	1379.4	83 56 25.13	263 37 58.40	Boulder	41111.89	4.6139674
			239 35 22.18	59 37 39.39	Brighton	5867.25	3.7684346
Brighton bench mark R_2 (U. S. G. S.)	40 00 01.640	50.5	89 22	269 22	Brighton bench mark eccentric	39.832	1.60023
	104 48 56.469	1339.4					
Greeley tall tank,[1] 1912	40 25 07.923	244.4	107 06 14.1	286 45 59.8	Horsetooth	46055.0	4.663277
	104 40 35.853	845.3	226 31 58.3	46 36 43.7	Dewey	14266.1	4.154304
Greeley sugar factory chimney,[1] 1912	40 25 06.241	192.5	107 09 04.0	286 48 48.6	Horsetooth	46108.7	4.663783
	104 40 34.144	805.0	226 16 15.1	46 20 59.3	Dewey	14272.6	4.154504
La Salle tank near coal chute,[1] 1912	40 20 46.859	1445.4	117 25 47.6	297 06 41.3	Horsetooth	46852.8	4.670736
	104 42 19.228	453.8	215 35 13.9	35 41 06.1	Dewey	21974.4	4.341917
Loveland red brick chimney	40 24 10.606	327.1	22 09 46.9	202 00 43.0	Boulder	53033.2	4.724548
	105 03 37.705	889.2	142 52 42.9	322 47 25.7	Horsetooth	19053.2	4.279969
Loveland tall white chimney, 1912	40 24 10.770	332.2	22 12 20.9	202 03 15.8	Boulder	53054.7	4.724724
	105 03 35.817	844.7	83 31 06.9	263 31 05.7	Loveland red brick chimney	44.82	1.651486
			142 45 47.5	322 40 29.1	Horsetooth	19076.1	4.280490
Eaton, sugar factory chimney, 1912	40 31 35.067	1081.6	92 11 42.8	271 52 37.9	Horsetooth	41486.5	4.6179069
	104 42 24.722	581.9	162 31 11.7	342 27 05.8	Dover bench mark eccentric	29460.3	4.4692378
			279 20 05.5	99 26 01.7	Dewey	13090.5	4.1169546
Nunn schoolhouse, belfry, 1912	40 42 23.296	718.6	62 07 32.9	241 51 28.4	Horsetooth	39440.1	4.5959378
	104 47 04.840	113.6	164 16 30.2	344 15 26.9	Dover bench mark eccentric	8414.8	3.9250455
			318 33 48.0	138 42 47.4	Dewey	29484.3	4.4695911
Dover bench mark eccentric, 1912	40 46 45.871	1414.9	50 49 10.70	230 34 08.79	Horsetooth	42024.1	4.6234982
	104 48 42.095	987.1	128 01 52.69	307 43 58.33	Twin	48638.6	4.6869813
Dover bench mark E_3, 1912	40 46 45.705	1409.8	240 38 03.8	60 38 04.1	Dover bench mark eccentric	10.44	1.01870
	104 48 42.483	996.2					
Dover bench mark reference mark, 1912.	40 46 47.346	1460.5	330 42 36	150 42 37	Dover bench mark eccentric	52.180	1.717504
	104 48 43.183	1012.6	342 01 16	162 01 16	Dover bench mark E_3	53.21	1.726027
Terry[2] (U. S. G. S.), 1912	41 01 33.472	1032.6	94 24 44.23	274 09 11.10	Twin	33291.34	4.5223313
	104 52 21.266	496.8	164 41 23.84	344 38 08.34	Wadill	26202.40	4.4183411
			334 56 47.95	154 56 56.75	Warren	739.75	2.8690837
Colorado-Wyoming boundary monument, milepost 44, 1912.	40 59 54.156	1670.6	208 52 14.81	28 53 02.26	Terry	3498.70	3.543907
	104 53 33.575	784.7	219 55 00.85	39 55 57.09	Warren	3121.06	3.494302
Otto, Union Pacific Railway black water tank, 1912.	41 05 27.677	853.8	292 56 50.6	113 04 49.0	Terry	18479.9	4.2666994
	105 04 29.681	692.7	294 26 00.4	114 34 07.6	Warren	19037.2	4.2796026
			73 44 07.6	253 36 32.4	Twin	16855.7	4.2267459
Fort D. A. Russell, water tank, 1912	41 09 23.623	728.8	359 33 42.5	179 33 45.8	Warren	15174.0	4.1810997
	104 52 12.826	299.1	70 19 17.3	250 03 37.4	Twin	35460.8	4.5497491
			103 28 58.7	283 11 17.3	Russell	38592.5	4.5865029
			119 19 07.0	299 00 55.0	Greentop	44155.5	4.6449852
Cheyenne, State capitol dome, 1912	41 08 25.342	781.8	17 11 19.8	197 09 23.5	Warren	13999.8	4.1461203
	104 49 10.786	251.5	74 56 52.2	254 39 12.8	Twin	38978.6	4.5908259
			104 31 18.9	284 11 37.8	Russell	43146.6	4.6349462
			118 44 58.6	298 24 46.8	Greentop	48739.7	4.6878830
East Twin[2] (U. S. G. S.)	41 02 54.074	1668.2	276 08 40	96 08 40	Twin	2.764	0.44154
	105 16 02.648	61.8					
Kipp's, William, square house, chimney, 1912.	41 16 40.626	1253.3	17 23 13.7	197 22 49.6	Wadill	2845.2	3.454117
	104 56 41.913	975.4	104 07 05.6	283 51 49.9	Greentop	33248.4	4.521771
			163 00 13.5	342 58 16.7	Whitaker	14057.4	4.147906
Hollingswood's, Glen, new barn, west gable, 1912.	41 17 03.586	110.6	104 15 20.7	284 01 34.8	Greentop	30003.7	4.477175
	104 58 58.032	1350.5	175 44 47.6	355 44 20.7	Whitaker	12769.2	4.106165
			325 53 11.4	145 54 17.1	Wadill	4134.7	3.616439
Ritzke's windmill, center, 1912	41 15 23.872	736.5	69 00 17.2	248 59 51.5	Wadill	969.6	2.986584
	104 56 39.551	920.8	107 58 24.9	287 43 07.8	Greentop	33956.1	4.530918
			165 14 45.4	345 12 47.0	Whitaker	16350.4	4.213529
Tall new house, west gable, 1912	41 15 46.185	1424.8	112 05 35.6	291 54 13.0	Greentop	25943.6	4.414030
	105 02 34.880	812.0	195 08 05.1	15 10 01.4	Whitaker	15666.4	4.194968
			277 58 27.8	98 01 56.5	Wadill	7439.4	3.871538
Section 33, T. 17 N., R. 68 W., stone post, southwest corner, 1912.	41 23 38.222	1179.2	225 37 06	45 37 22	Whitaker	800.12	2.903155
	105 00 03.418	79.4					
Bench mark "Denver" 6702 (U. S. G. S.).	41 23 38.315	1182.0	239 55 02	59 55 29	Whitaker	1110.82	3.045644
	105 00 20.178	468.8					

[1] Checked by vertical angles only.

[2] Identical with a tertiary station of the U. S. Geological Survey.

GEOGRAPHIC POSITIONS—Continued.

One hundred and fourth meridian—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters*	
Wheatland standpipe, 1912	42 02 43.815	1351.9	12 32 04.16	192 29 09.95	Chugwater	27736.64	4.4430538
	104 57 26.898	618.6	88 50 47.50	268 35 50.55	Notch	30812.33	4.4887246
			159 26 06.16	339 19 31.86	Coleman	38232.68	4.5824348
			218 55 31.77	39 08 32.17	Haystack	42333.06	4.6266796
Nebraska-Wyoming boundary monument eccentric, 1912.	42 46 48.822	1506.5	59 18 47.09	239 00 54.90	Rawhide	41934.33	4.6225697
	104 03 09.368	212.9	78 26 41.82	258 01 48.48	Willow	51135.87	4.7087257
			156 54 04.68	336 52 08.09	Kirtley	9926.49	3.9967957
Nebraska-Wyoming boundary monument 123, 1912.	42 46 48.332	1491.3	142 35 50	322 35 50	Nebraska-Wyoming boundary monument eccentric.	19.052	1.27994
	104 03 08.859	201.4					
Bluff, 1912	43 01 44.498	1373.3	161 39 06.12	341 27 40.02	Alkali	71193.08	4.8524378
	104 12 31.590	715.2	225 30 51.08	45 52 08.38	Parker	58841.43	4.7696832
			334 23 28.75	154 27 54.92	Kirtley	20519.31	4.3121628
South Dakota-Nebraska boundary monument eccentric, 1912.	43 00 06.456	199.2	27 43 49.60	207 39 45.45	Kirtley	17487.61	4.2427305
	104 00 02 469	55.9	100 10 59.03	280 02 27.98	Bluff	17231.71	4.2363285
South Dakota-Nebraska boundary monument, 1912.	43 00 06.539	201.8	5 56 44	185 56 44	South Dakota-Nebraska boundary monument eccentric.	2.572	0.41027
	104 00 02.457	55.6					
South Dakota-Wyoming boundary monument, 1912.	43 03 30.992	956.5	10 06 12.02	190 04 15.44	Kirtley	22137.84	4.3451353
	104 03 09.845	222.8	75 33 42.76	255 27 19.34	Bluff	13132.82	4.1183579
Jireh College, cupola,[1] 1912	42 46 29.82	920.1	232 10 53	52 16 13	Manville	13527.2	4.131208
	104 42 34.38	781.6	339 10 34	159 12 26	Willow	10524.7	4.022208
Manville, C. & N. W. Ry. water tank,[2] 1912.	42 46 54.90	1694.0	201 12 03	21 13 30	Manville	8058.3	3.906245
	104 36 52.11	1184.5	20 53 39	200 51 38	Willow	11357.6	4.055288
Manville Congregational Church steeple,[2] 1912.	42 46 45.09	1391.3	21 24 59	201 22 58	Willow	11072.8	4.044256
	104 36 52.44	1192.0	200 29 51	20 31 18	Manville	8343.8	3.921363
Sullivan (U. S. G. S.)	43 35 33.447	1032.2	210 29 32	30 29 32	Sullivan	4.53	0.65610
	104 00 07.229	162.2					
Alkali (U. S. G. S.)	43 38 12.066	372.4	200 14 01	20 14 01	Alkali	28.64	1.45697
	104 29 11.815	264.9					
Elk (U. S. G. S.)	43 43 41.826	1290.8	10 20 15	190 20 15	Elk	1.035	0.01494
	104 02 57.528	1287.6					
Crows Nest (U. S. G. S.)	44 03 19.216	593.1	257 56	77 56	Crow	2.016	0.30449
	103 57 42.721	951.0					
Bear Lodge Mountain, highest peak, 1912.	44 28 34.364	1060.7	118 16 24.4	298 16 05.6	Sundance	673.5	2.828328
	104 26 35.982	795.2	205 24 57.6	25 40 04.4	Wymonkota	65727.0	4.817744
			232 30 49.3	53 12 36.5	Castle	98290.2	4.992510
Peak, south of Terry,[2] 1912	44 14 39.77	1227.6	139 08 30.4	319 04 17.8	Terry	12257.6	4.088407
	103 44 04.08	90.5	194 33 29.2	14 45 18.5	Castle	87966.2	4.944316
Castle Rock (U. S. G. S.)	45 00 36.784	1135.6	111 10	291 10	Castle	3.92	0.59329
	103 27 14.232	311.7					
Haystack Butte, highest point, 1912	45 03 46.269	1428.4	2 00 01.5	181 59 54.9	Castle	5851.6	3.767272
	103 27 05.071	111.0	83 30 15.5	263 03 20.4	Wymonkota	50312.2	4.701673
			146 43 00.7	326 31 48.8	Moreau	37560.8	4.574735
East Deer Ear Butte,[2] 1912	45 00 01.63	50.3	92 58 32.2	272 46 54.5	Castle	21635.8	4.335173
	103 10 47.73	1045.4	132 32 25.3	312 09 40.6	Moreau	56853.5	4.754757
West Deer Ear Butte,[2] 1912	44 59 55.20	1703.8	93 33 39.1	273 22 13.9	Castle	21260.4	4.327571
	103 11 05.42	118.7	132 56 57.7	312 34 25.6	Moreau	56703.8	4.753612
Montana, southeast corner eccentric, 1912.	44 59 49.837	1538.3	347 28 17.6	167 37 01.9	Terry	76180.3	4.8818425
	104 02 31.798	696.5	29 29 12.9	209 11 57.5	Sundance	66047.1	4.8198540
Montana, southeast corner monument, 1912.	44 59 53.739	1658.8	63 40 49.9	243 40 42.0	Montana, southeast corner eccentric.	271.66	2.434026
	104 02 20.681	453.0					
Wyoming, northeast corner eccentric, 1912.	44 59 59.117	1824.8	346 45 45.3	166 55 02.4	Terry	76687.7	4.8847255
	104 03 18.515	405.5	28 34 45.8	208 18 03.2	Sundance	65801.0	4.8182325
Wyoming, northeast corner monument, 1912.	44 59 51.995	1605.0	215 18 11.2	35 18 16.2	Wyoming, northeast corner eccentric.	269.41	2.430414
	104 03 25.623	561.3					
North Dakota-South Dakota, milepost 333 eccentric, 1912.	45 56 49.625	1532.1	193 08 21.6	13 12 08.7	Butte	29731.01	4.4732096
	103 28 33.658	724.9	68 37 01.3	248 29 12.0	Table	15124.01	4.1796671
North Dakota-South Dakota, milepost 333, 1912.	45 56 43.386	1339.4	126 12 35.5	306 12 26.7	North Dakota-South Dakota milepost 333 eccentric.	326.07	2.513315
	103 28 21.443	461.9					
Eagles Nest Butte, cairn,[2] 1912	45 55 26.182	808.3	77 18 32.6	257 11 17.6	Table	13383.3	4.126562
	103 29 21.280	458.5	201 42 31.6	21 43 05.8	North Dakota-South Dakota milepost 333 eccentric	2773.0	3.442956

[1] No check on this position.

[2] Checked by vertical angles only.

GEOGRAPHIC POSITIONS—Continued.

One hundred and fourth meridian—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Bowman water tank, 1912	46 10 57.262 103 24 10.452	1768.1 224.2	171 49 20.59 201 53 12.72 262 18 43.05 325 10 48.82 31 57 28.41	351 47 23.88 21 53 50.29 82 38 00.01 145 24 53.68 211 46 28.71	Black Butte Whetstone Lodge Table	24250.44 2993.58 34663.33 44363.02 37327.27	4.3847197 3.4761909 4.5398702 4.6470211 4.5720262
Bowman longitude, 1912	46 10 57.528 103 24 11.012	1776.3 236.2					
Buffalo Springs, 1912	46 10 20.683 103 14 00.696	638.6 14.9	108 08 51.6 254 59 20.9	288 02 09.2 75 11 17.7	Butte Whetstone	12581.71 22035.78	4.0997397 4.3431284
Sentinel Butte schoolhouse flagpole,[1] 1912.	46 55 04.277 103 50 19.054	132.1 403.2	218 28 00.6 356 39 40.9	38 29 47.1 176 39 51.3	Hump Sentinel	4957.0 5176.0	3.695219 3.713994
Beach Catholic church, cross,[1] 1912	46 54 49.726 104 00 05.435	1535.4 115.0	254 18 28.8 290 17 48.3	74 27 23.7 110 25 07.0	Hump Sentinel	16082.5 13561.9	4.206354 4.132320
Schoolhouse north of Hump, chimney,[1] 1912.	47 01 23.379 103 47 25.308	721.9 534.5	4 18 51.5 11 19 16.9	184 18 31.1 191 17 20.4	Hump Sentinel	7848.7 17208.0	3.894797 4.235730
North Dakota-Montana boundary monument eccentric, 1912.	47 12 42.065 104 02 39.376	1299.1 828.5	326 54 36.05 118 04 30.63	147 05 25.00 297 59 06.78	Hump Blue	34322.2 10512.3	4.5355757 4.0216980
North Dakota-Montana boundary monument, 1912.	47 12 41.959 104 02 39.375	1295.8 828.5	179 39 41	359 39 41	North Dakota-Montana boundary monument eccentric.	3.28	0.51587
Section 7, T. 143 N., R. 105 W., southwest corner.	47 12 40.981 104 02 39.380	1265.6 828.7	180 07 38	0 07 38	North Dakota-Montana boundary monument eccentric.	33.48	1.52479
Section 22, T. 17 N., R. 60 E., southeast corner.	47 12 33.603 104 02 39.408	1037.8 829.3	180 08 56	0 08 56	North Dakota-Montana boundary monument eccentric.	261.31	2.417156
Lovering (U. S. G. S.)	47 42 43.961 104 21 24.073	1357.7 501.8	265 14	85 14	Lovering	2.88	0.45939
Bench mark $1\frac{3}{3}2$ (Mo. River Com.)	48 01 49.033 104 05 18.270	1514.6 378.6	349 45 40.22 57 37 05.53	169 46 18.66 237 33 38.89	Ferry Cutoff	6034.53 6824.39	3.7806436 3.8340636
Bench mark $1\frac{3}{2}1$ (Mo. River Com.)	48 03 39.440 104 07 53.275	1218.3 1103.1	19 50 19.99 123 37 51.17	199 48 48.55 303 33 22.23	Cutoff Lanark	7513.15 8980.07	3.8758223 3.9532796
Bench mark $1\frac{3}{2}1$ (Mo. River Com.)	48 00 11.187 104 02 44.329	345.6 918.9	76 08 04	256 08 01	Mondak	96.89	1.98628
Steihl's house, chimney, 1912	48 01 02.300 104 04 00.418	71.0 8.7	214 20 55.0 6 52 29.0 73 19 33.6	34 21 32.0 186 52 09.6 253 15 09.1	Montana Ferry Cutoff	1828.2 4527.7 7700.9	3.262027 3.655873 3.886544
Snowden water tank,[1] 1912	48 02 17.694 104 05 47.337	546.5 980.6	346 12 16.3 126 39 11.6	166 13 16.3 306 33 09.0	Ferry Lanark	7026.2 12567.4	3.846720 4.099246
Bainville Catholic Church, highest spire,[1] 1912.	48 08 12.190 104 13 16.423	376.5 339.5	196 02 56.6 208 41 52.5	16 05 22.5 28 43 59.6	Snake Bainville	14601.9 7337.6	4.164410 3.865551
Section 13, T. 155 N., R. 102 W., northwest corner.	48 15 21.313 103 45 16.617	658.3 342.8	309 02 47	129 03 00	Williston	447.70	2.650987
Section 4, T. 157 N., R. 102 W., southwest corner.	48 26 44.321 103 53 04.372	1369.0 89.8	200 03 24	20 03 25	Gladys	36.61	1.56360
Bonetraill schoolhouse, belfry, 1912	48 24 53.802 103 50 26.702	1661.9 549.0	136 53 56.7 257 38 03.5 339 25 09.5	316 51 59.2 77 38 35.3 159 29 13.9	Gladys Bonetraill Williston	4723.8 894.3 19185.5	3.674287 2.951476 4.282973
Bilby (U. S. and Canada boundary survey), 1912.	48 54 47.587 103 32 50.957	1469.9 1037.5	125 06 13.4 130 18 54.6 207 43 56.3 269 20 23.4	304 57 48.6 310 15 46.0 27 46 43.1 89 21 51.7	Bowie Ambrose southwest base School Ambroso	16630.1 6678.1 9660.5 2383.5	4.220895 3.824650 3.984999 3.377214
Jasper (U. S. and Canada boundary survey), 1912.	48 53 27.806 103 39 27.787	858.9 566.0	155 14 51.3 228 43 25.6 252 59 58.6	335 11 25.8 48 51 11.6 73 04 57.6	Bowie School Bilby	13229.4 16716.5 8449.2	4.121539 4.223145 3.926818
Ambrose Presbyterian Church steeple. 1812.	48 57 11.468 103 28 52.441	354.2 1066.9	29 14 38.8 89 19 23.0 105 32 35.3 175 04 31.6	209 13 07.2 269 13 14.4 285 21 10.4 355 04 18.6	Ambrose Ambrose southwest base Bowie School	5062.4 9945.5 19154.0 4119.5	3.704360 3.997625 4.282259 3.614845

[1] Checked by vertical angles only.

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Principal points.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Arapahoe, 1891	38 46 01.519	46.8	201 13 23.16	21 18 21.15	McLane	31530.12	4.4987257
	102 05 43.882	1059.4	225 59 04.46	46 11 49.31	Turtle	40747.11	4.6100968
			253 12 17.04	73 24 03.41	Curlew	28396.26	4.4532612
Monotony, 1892	39 01 44.752	1380.1	269 13 17.61	89 24 05.78	McLane	24759.27	4.3937378
	102 14 58.626	1410.2	297 10 24.65	117 28 01.65	Curlew	45596.54	4.6589319
			335 16 03.18	155 21 51.53	Arapahoe	32010.98	4.5052989
Cheyenne Wells, 1892	38 57 03.559	109.7	236 23 24.28	56 29 05.96	Monotony	15684.55	4.1954719
	102 24 01.683	40.5	307 32 45.61	127 44 14.39	Arapahoe	33427.32	4.5241016
First View, 1892	38 47 42.811	1320.2	216 36 11.70	36 41 46.63	Cheyenne Wells	21552.31	4.3334939
	102 32 55.360	1336.0	224 53 00.40	45 04 16.73	Monotony	36702.02	4.5646899
			274 23 34.75	94 40 36.62	Arapahoe	39503.36	4.5966341
Landsman, 1892	38 56 52.445	1617.3	252 46 51.94	72 59 37.29	Monotony	30633.15	4.4861917
	102 35 15.085	363.2	268 43 49.68	88 50 53.00	Cheyenne Wells	16219.55	4.2100388
			348 44 50.91	168 46 18.60	First View	17280.17	4.2375479
Kit Carson, 1881	38 42 07.623	235.1	220 49 17.49	40 59 31.89	Landsman	36101.18	4.5575214
	102 51 35.083	847.7	248 59 00.89	69 10 41.73	First View	28947.57	4.4616121
Eureka, 1881	38 58 40.110	1237.0	277 50 07.94	98 00 31.08	Landsman	24088.66	4.3818126
	102 51 46.059	1108.7	306 32 29.34	126 44 19.16	First View	33963.08	4.5310070
			359 30 12.57	179 30 19.45	Kit Carson	30605.63	4.4858014
Aroya, 1881	38 48 10.006	308.5	234 51 24.77	55 03 26.50	Eureka	33839.18	4.5294198
	103 10 55.610	1341.9	291 38 19.34	111 50 25.78	Kit Carson	30169.10	4.4795624
Overland, 1881	39 02 20.344	627.4	284 10 31.14	104 22 09.55	Eureka	27547.64	4.4400844
	103 10 15.645	376.3	324 03 32.14	144 15 15.36	Kit Carson	46132.24	4.6640046
			2 06 22.47	182 05 57.36	Aroya	26239.18	4.4189503
Hugo, 1880	39 04 33.113	1021.2	277 45 10.33	97 58 07.46	Overland	29936.01	4.4761939
	103 30 48.995	1177.7	316 25 21.51	136 37 51.55	Aroya	41774.60	4.6209123
Adobe, 1881	38 40 40.853	1259.8	184 35 08.04	4 36 40.53	Hugo	44308.31	4.6464851
	103 33 16.360	395.5	219 35 57.43	39 50 23.69	Overland	52095.98	4.7168042
			246 43 34.10	66 57 33.13	Aroya	35218.28	4.5467681
Square Bluffs, 1880	38 51 08.351	257.5	227 38 51.91	47 50 45.42	Hugo	36906.45	4.5671023
	103 49 43.645	1052.4	308 58 58.77	129 09 16.94	Adobe	30700.94	4.4871516
Holt, 1880	39 02 20.996	647.5	263 59 12.25	84 16 30.89	Hugo	39842.50	4.6003466
	103 58 17.376	417.9	329 08 28.63	149 13 51.55	Square Bluffs	24151.46	4.3829433
Cramer Gulch, 1880	38 35 36.137	1114.3	197 16 18.69	17 20 10.59	Square Bluffs	30108.03	4.4786823
	103 55 54.360	1315.6	253 55 05.62	74 09 13.51	Adobe	34162.64	4.5335514
Big Springs, 1880	38 45 06.471	199.5	253 00 32.12	73 16 28.40	Square Bluffs	38478.04	4.5852130
	104 15 09.707	234.4	302 05 50.30	122 17 52.24	Cramer Gulch	33004.99	4.5185796
Holcolm Hills, 1880	39 00 08.200	252.9	262 05 24.21	82 18 26.48	Holt	30168.27	4.4795504
	104 18 59.830	1439.7	291 19 38.13	111 38 01.61	Square Bluffs	45460.73	4.6576364
			348 41 52.39	168 44 16.83	Big Springs	28353.95	4.4526136
Divide, 1879	39 04 15.307	472.0	294 08 37.34	114 16 01.23	Holcolm Hills	18585.24	4.2691681
	104 30 44.631	1072.9	327 28 05.73	147 37 52.97	Big Springs	41981.08	4.6230536
Corral Bluffs, 1879	38 52 11.680	360.2	197 19 46.26	17 22 48.45	Divide	23378.69	4.3688201
	104 35 34.310	827.2	238 23 05.31	58 33 30.29	Holcolm Hills	28100.32	4.4487113
			293 49 24.17	114 02 11.69	Big Springs	32325.13	4.5095403
El Paso east base, 1879	38 57 22.331	688.6	49 57 08.67	229 52 11.96	Corral Bluffs	14875.45	4.1724701
	104 27 41.954	1010.2	160 58 32.80	340 56 37.80	Divide	13472.04	4.1294334
			247 48 32.32	67 54 00.75	Holcolm Hills	13568.80	4.1325413
			321 17 46.63	141 25 38.54	Big Springs	29050.07	4.4631471
El Paso west base, 1879	38 58 43.188	1331.9	212 48 09.30	32 51 02.24	Divide	12187.82	4.0859261
	104 35 19.292	464.4	263 34 07.03	83 44 23.29	Holcolm Hills	23717.78	4.3750740
			282 43 12.26	102 47 59.87	El Paso east base	11288.98	4.0526549
			1 43 03.62	181 42 54.18	Corral Bluffs	12078.20	4.0820023
Plateau, 1894	38 23 32.404	999.2	176 25 59.15	356 24 33.57	Corral Bluffs	53117.55	4.7252380
	104 33 17.232	418.2	213 19 18.60	33 30 36.67	Big Springs	47804.45	4.6794683
Pikes Peak, 1895	38 50 26.293	810.8	240 47 55.04	61 07 57.56	Divide	52672.80	4.7215864
	105 02 37.268	898.8	277 55 08.54	98 24 52.70	Big Springs	69422.24	4.8414986
			319 17 43.98	139 36 02.44	Plateau	65494.52	4.8162049
Bison, 1894	39 14 18.521	571.2	282 00 51.85	102 38 10.61	Divide	87140.73	4.9402212
	105 29 50.196	1203.8	318 12 49.14	138 29 57.66	Pikes Peak	59100.81	4.7715934
Mount Ouray, 1894	38 25 22.175	683.8	214 39 19.73	35 06 40.72	Bison	110376.78	5.0428777
	106 13 27.238	660.8	245 20 54.82	66 05 08.20	Pikes Peak	112774.26	5.0522100
			270 48 39.57	91 50 53.46	Plateau	145857.21	5.1639279

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Colorado Springs public schoolhouse, flagstaff on clock tower, 1879.	38 50 11.423	352.2	26 52 25.0	206 52 13.8	Colorado Springs United States Engineers astronomic station.	951.4	2.978388
	104 49 27.609	665.9	35 37 28.6	215 37 23.9	Colorado Springs Coast and Geodetic Survey latitude and longitude.	310.8	2.492500
			67 53 25.6	247 50 59.3	Bear Creek	6077.6	3.783730
			134 10 27.4	314 07 19.0	Glen Eyrie	10090.4	4.003908
Monte Rosa, 1895	38 45 15.218	469.3	138 57 09.00	318 53 31.90	Pikes Peak	12724.92	4.1046552
	104 56 50.785	1226.3	226 53 18.30	47 09 42.06	Divide	51573.01	4.7124225
			270 02 18.43	90 28 24.02	Big Springs	60393.83	4.7809926
Table, 1895	39 14 02.700	83.3	343 07 19.5	163 09 43.8	Divide	18927.3	4.2770884
	104 34 33.222	796.8	42 59 14.4	222 41 33.7	Pikes Peak	59566.9	4.7750052
			131 18 57.3	310 54 25.7	Morrison	73493.4	4.8662481
Arapahoe Peak, summit, 1895	40 01 19.800	610.7	313 19 25.4	133 00 17.1	Table	126723.7	5.1028578
	105 38 37.018	877.9	317 00 08.9	137 43 21.9	Divide	143555.2	5.1570188
			338 29 55.4	157 52 47.1	Pikes Peak	140042.0	5.1462523
			351 44 12.1	171 49 48.1	Bison	87911.8	4.9440471
Longs Peak, 1895	40 15 22.539	695.2	321 31 08.6	142 11 02.7	Table	144308.4	5.1592916
	105 36 57.124	1350.0	323 54 37.3	144 36 53.1	Divide	162127.0	5.2098553
			342 26 27.0	162 48 18.7	Pikes Peak	164682.3	5.2166469
			354 49 19.8	174 53 52.7	Bison	113458.0	5.0548352
Camerons Cone,[1] 1895	38 50 34.31	1057.9	134 48 43.3	314 29 18.9	Bison	62493	4.795829
	104 59 01.61	38.8	238 04 10.3	58 21 57.3	Divide	48068	4.681852
Greenhorn Mountain, cairn, 1895	37 52 53.319	1643.8	164 29 33.0	344 11 25.9	Bison	156438.3	5.194343
	105 00 46.325	1132.1	178 33 37.2	358 32 28.4	Pikes Peak	106501.8	5.027357
			198 08 51.5	18 27 32.5	Divide	139066.6	5.143223
			215 10 01.1	35 26 59.5	Plateau	69484.8	4.841890
East Spanish Peak, 1879	37 23 36.421	1122.8	176 09 46.0	356 05 10.2	Pikes Peak	161000.6	5.2068274
	104 55 10.560	259.8	190 42 51.7	10 57 58.9	Divide	189578.7	5.2777895
			196 01 51.0	16 15 17.6	Plateau	115418.6	5.0622758
			201 00 29.0	21 25 09.6	Big Springs	161727.4	5.2087837
West Spanish Peak, 1879	37 22 41.316	1273.7	178 25 51.8	358 23 58.0	Pikes Peak	162393.3	5.2105682
	104 59 32.927	810.0	192 27 48.2	12 45 37.6	Divide	192539.8	5.2845206
			198 44 58.5	19 01 06.1	Plateau	118969.8	5.0754366
			202 50 13.1	23 17 35.2	Big Springs	165713.6	5.2193581
Platte Peak, 1895	39 15 37.709	1162.9	167 22 54.8	347 18 23.8	Morrison	46524.9	4.667685
	105 06 02.702	64.8	273 32 02.1	93 51 57.5	Table	45403.4	4.657088
			292 17 46.3	112 40 04.0	Divide	55031.5	4.740611
			353 55 54.6	173 58 04.0	Pikes Peak	46869.0	4.670886
Sierra Blanca Peak,[1] 1894	37 34 39.19	1208.2	145 32 48.3	325 05 30.3	Mount Ouray	114088	5.057241
	105 29 06.57	161.2	195 16 56.3	15 33 19.6	Pikes Peak	145434	5.162665
Crestone Peak, 1894	37 57 58.955	1817.5	132 17 47.0	311 54 02.1	Mount Ouray	75572.5	4.878364
	105 35 02.866	70.0	183 02 23.5	3 05 38.6	Bison	141412.9	5.150489
			205 46 25.1	26 06 33.8	Pikes Peak	107917.3	5.033091
Hunts Peak, 1894	38 22 59.973	1849.2	100 19 02.8	280 08 40.9	Mount Ouray	24685.4	4.392441
	105 56 46.061	1117.9	202 11 13.2	22 28 06.0	Bison	102623.5	5.011247
			269 05 48.2	89 57 38.7	Plateau	121564.8	5.084807
			236 51 47.7	57 25 35.3	Pikes Peak	93569.2	4.971133
Rito Alto, cairn, 1894	38 13 10.209	314.8	119 00 26.3	298 43 01.1	Mount Ouray	46755.2	4.669830
	105 45 21.582	525.1	191 10 05.3	11 19 48.0	Bison	115329.9	5.061942
			221 47 34.1	42 14 11.5	Pikes Peak	92799.4	4.967545
			259 16 49.6	80 01 30.1	Plateau	106804.1	5.028588
Grays Peak, summit, 1894	39 38 01.563	48.1	298 39 04.8	119 28 42.2	Divide	128621.4	5.1093133
	105 49 00.008	0.2	322 35 41.1	143 05 01.2	Pikes Peak	110484.5	5.0433016
			327 49 40.9	148 01 51.2	Bison	51788.8	4.7142355
Mount Evans, 1894	39 35 18.780	579.2	53 09 27.0	232 38 57.0	Mount Elbert	86630.0	4.9376684
	105 38 35.495	847.0	256 01 15.1	76 17 28.6	Morrison	37492.0	4.5739391
			292 50 14.7	113 30 54.2	Table	99997.9	4.9999909
			300 09 19.6	120 52 19.7	Divide	113176.9	5.0537579
			327 51 46.7	148 14 31.1	Pikes Peak	97851.8	4.9905690
			342 02 08.6	162 07 42.1	Bison	40846.6	4.6111559
Buffalo Peak, 1894	38 59 30.76	948.5	116 52 06	296 39 59	Mount Elbert	31061	4.492217
	106 07 28.01	674.1	243 01 21	63 25 05	Bison	60760	4.783616
			7 51 18	187 47 33	Mount Ouray	63762	4.804565
Antero, cairn, 1894	38 19 30.234	932.2	75 54 53.6	255 08 44.8	Uncompahgre	112513.3	5.051204
	106 13 04.362	106.0	135 13 48.1	314 40 47.1	Treasury Mountain	108303.9	5.034644
			177 04 21.5	357 04 07.3	Mount Ouray	10865.8	4.036063
Mount Shavano, 1893	38 37 09.150	282.1	222 51 10.7	43 19 08.1	Bison	94129.1	4.973724
	106 14 19.575	473.5	356 40 00.9	176 40 33.5	Mount Ouray	21836.0	4.339174
			60 45 53.4	240 00 22.3	Uncompahgre	122961.4	5.089769
			120 42 19.3	300 09 59.2	Treasury Mountain	86605.2	4.937544

[1] No check on this position.

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Mount Harvard, cairn, 1894	38 55 28.365	874.6	46 48 10.9	226 05 33.1	Uncompahgre	137380.1	5.1379237
	106 19 12.944	311.8	153 21 19.1	333 16 36.7	Mount Elbert	24022.1	4.3806105
			274 24 21.1	95 12 26.0	Pikes Peak	111160.6	5.0459510
			351 26 10.9	171 29 46.9	Mount Ouray	56317.8	4.7506458
Mount Princeton, cairn, 1894	38 44 57.560	1774.9	55 09 26.2	234 23 58.2	Uncompahgre	130397.9	5.1152705
	106 14 31.029	749.2	156 47 56.3	336 40 17.3	Mount Elbert	44536.5	4.6487164
			264 03 47.9	84 48 50.7	Pikes Peak	104594.7	5.0195096
			357 33 18.4	177 33 58.2	Mount Ouray	36275.6	4.5596151
Mount Yale, 1894	38 50 39.561	1219.9	49 48 30.5	229 05 39.4	Uncompahgre	131906.6	5.1202666
	106 18 47.823	1153.3	159 28 08.6	339 23 10.8	Mount Elbert	32437.9	4.5110530
			269 48 52.1	90 36 38.8	Pikes Peak	110226.9	5.0422876
			350 33 44.5	170 37 04.7	Mount Ouray	47426.8	4.6760239
Leadville, Ninth Street schoolhouse, cupola,[1] 1894.	39 15 05.26	162.2	4 10 50	184 09 41	Mount Harvard	36389.0	4.560970
	106 17 22.82	547.2	42 09 48	222 03 55	Mount Elbert	19990.2	4.300818
Mount Massive, cairn, 1894	39 11 15.376	474.2	341 16 22.6	161 17 31.6	Mount Elbert	8171.8	3.912320
	106 28 30.586	734.0	70 34 26.9	250 10 51.6	Treasury Mountain	57248.6	4.757765
			265 51 54.8	86 29 00.6	Bison	84646.5	4.927609
Mount of the Holy Cross, cairn,[1] 1893	39 28 01.17	36.1	355 22 00.1	175 23 22.9	Mount Elhert	38884	4.589766
	106 28 52.12	1246.0	46 53 14.4	226 29 48.4	Treasury Mountain	73248	4.864797
La Garita, king summit, 1893	37 55 20.52	632.8	101 51 48.1	281 17 46.1	Uncompahgre	82612.6	4.917046
	106 32 24.77	605.0	158 16 31.4	337 55 41.0	Treasury Mountain	130647.2	5.116100
			206 23 47.3	26 35 30.3	Mount Ouray	62068.0	4.792868
La Garita, range peak, 1893	38 01 23.690	730.4	96 39 51.4	276 19 56.2	Uncompahgre	47591.8	4.677532
	106 55 22.370	545.6	172 07 42.7	352 01 08.9	Treasury Mountain	111085.9	5.045659
			233 50 36.9	54 16 33.1	Mount Ouray	75564.3	4.878317
Gunnison azimuth, 1894	38 32 46.597	1436.8	282 25 50.09	102 51 57.92	Mount Ouray	62581.67	4.7964471
	106 55 26.644	645.2	41 55 09.28	221 35 09.72	Uncompahgre	70599.94	4.8488043
West Elk Peak, cairn, 1894	38 43 05.077	156.5	17 49 15.2	197 39 27.8	Uncompahgre	75322.0	4.876922
	107 11 55.992	1352.8	84 13 23.1	262 57 24.0	Mount Waas	177741.6	5.249789
			194 47 55.8	14 51 42.4	Treasury Mountain	34031.6	4.531882
			290 47 41.0	111 24 08.6	Mount Ouray	91044.1	4.959252
Gunnison Peak, cairn, 1893	38 48 44.035	1357.8	4 49 53.7	184 46 56.5	Uncompahgre	82482.9	4.916364
	107 22 56.680	1367.6	79 53 25.0	258 44 14.3	Mount Waas	163378.2	5.213194
			227 33 32.2	47 44 14.2	Treasury Mountain	33318.1	4.522680
Leon Peak, low cairn, 1893	39 04 46.496	1433.9	63 55 06.5	243 03 03.9	Mount Waas	134339.8	5.1282046
	107 50 36.104	867.8	117 23 23.4	296 39 13.3	Tavaputs	112498.9	5.0511484
			276 09 57.0	96 38 06.2	Treasury Mountain	64885.8	4.8121500
North Mann, cairn,[1] 1891	39 23 12.25	377.8	51 52 13.2	231 00 50.7	Mount Waas	150924.2	5.178759
	107 51 56.34	1348.3	100 12 10.6	279 28 42.9	Tavaputs	99544.9	4.998019
South Mann, cairn,[1] 1891	39 21 08.58	264.6	52 23 00.4	231 32 48.6	Mount Waas	146490.0	5.165808
	107 53 47.10	1127.8	102 39 37.8	281 57 21.4	Tavaputs	97701.4	4.989901
Mount Sneffels, cairn, 1895	38 00 14.236	438.9	115 45 32.0	294 52 11.0	Mount Waas	138962.6	5.1428980
	107 47 30.523	744.7	148 38 30.5	327 52 54.5	Tavaputs	200485.9	5.3020839
			161 21 48.0	341 07 21.4	Mesa	105090.0	5.0215613
			208 06 53.5	28 32 47.6	Treasury Mountain	127427.3	5.1052625
			255 20 34.2	75 32 46.8	Uncompahgre	29952.1	4.4764271
Wetterhorn, cigar peak, 1895	38 03 38.972	1201.7	110 00 16.2	288 56 25.0	Mount Waas	159305.1	5.2022298
	107 30 37.123	905.0	142 07 26.8	321 11 14.0	Tavaputs	209346.3	5.3208653
			148 09 38.4	327 44 40.6	Mesa	109951.0	5.0411992
			198 36 28.5	18 51 52.2	Treasury Mountain	111776.6	5.0483509
			254 07 18.4	74 09 06.5	Uncompahgre	4445.6	3.6479338
Lone Cone, 1893	37 53 17.100	527.2	130 37 30.1	310 01 24.6	Mount Waas	111697.3	5.0480428
	108 15 17.852	436.2	183 21 34.3	3 24 24.3	Mesa	112566.2	5.0514081
			218 33 36.0	39 16 45.1	Treasury Mountain	160690.6	5.2059905
Mount Wilson, 1893	37 50 21.321	657.3	126 02 21.2	305 16 29.6	Mount Waas	133289.3	5.1247952
	107 59 28.028	685.4	155 15 52.1	334 37 49.5	Tavaputs	208393.2	5.3188835
			172 07 32.9	352 00 33.2	Mesa	118927.3	5.0752817
			210 34 57.6	31 08 14.8	Treasury Mountain	151956.9	5.1817205
			240 49 39.1	61 09 11.6	Uncompahgre	53216.5	4.7260459
Mesa, 1893	38 54 01.482	45.7	325 32 33.86	145 59 21.02	Uncompahgre	111255.70	5.0463223
	108 10 44.122	1063.2	66 35 42.47	245 56 21.62	Mount Waas	99599.56	4.9982574
			135 06 52.01	314 35 30.84	Tavaputs	100670.85	5.0029038
Chiquita, 1895	38 54 38.264	1179.9	156 30 45.38	336 17 20.66	Tavaputs	76245.93	4.8822167
	108 39 06.632	159.8	271 26 06.85	91 43 56.10	Mesa	41038.42	4.6131906
			311 30 37.10	132 15 04.15	Uncompahgre	139476.30	5.1445004
Grand Junction stand pipe, 1895	39 04 18.567	572.6	143 40 52.71	323 23 57.38	Tavaputs	64622.87	4.8103862
	108 33 36.340	873.6	23 58 47.80	203 55 19.98	Chiquita	19580.84	4.2918314
			299 49 45.10	120 04 08.41	Mesa	38116.54	4.5811135

[1] No check on this position.

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
La Salle, northwest peak, cairn, 1893	38 32 48.012	1480.5	328 57 57.8	148 58 10.5	Mount Waas	956.0	2.980469
	109 13 58.653	1420.3	358 12 44.0	178 12 53.7	Mount Peale	11998.5	4.079129
			10 57 49.2	190 56 50.2	Mount Waas azimuth mark	12099.3	4.082761
La Salle, north peak, cairn, 1893	38 33 02.190	67.5	356 32 08.6	176 32 10.6	Mount Waas	1258.7	3.099912
	109 13 41.442	1003.5	12 26 52.1	192 25 42.4	Mount Waas azimuth mark	12612.0	4.100784
			43 37 56.4	223 37 45.7	La Salle northwest peak	604.0	2.781035
C. V. South, cairn, 1893	38 31 38.608	1190.4	357 42 40.3	177 42 50.5	Mount Peale	9860.6	3.993901
	109 13 59.456	1440.1	13 11 10.1	193 10 11.6	Mount Waas azimuth mark	10002.2	4.000095
			180 31 14.1	0 31 14.6	La Salle northwest peak	2140.1	3.330435
			189 36 22.9	9 36 34.1	La Salle north peak	2613.9	3.417282
			201 12 00.2	21 12 13.4	Mount Waas	1416.7	3.151283
C. V. North, cairn, 1893	38 32 04.699	144.9	350 44 08.9	170 44 12.3	C. V. South	815.2	2.911237
	109 14 04.874	118.1	357 10 43.5	177 10 57.1	Mount Peale	10670.1	4.028169
			11 31 38.8	191 30 43.7	Mount Waas azimuth mark	10760.1	4.031815
			186 26 07.6	6 26 11.5	La Salle northwest peak	1344.0	3.128390
			197 44 53.4	17 45 08.0	La Salle north peak	1861.3	3.269812
			231 15 30.0	51 15 46.6	Mount Waas	825.1	2.916486
North boundary, flag, Colorado-Utah, 1893.	38 33 57.976	1787.7	74 12 35.0	254 06 05.3	C. V. South	15739.7	4.196996
	109 03 34.184	827.6	78 33 03.2	258 26 46.7	Mount Waas	14928.0	4.174001
			81 56 02.4	261 49 33.2	La Salle northwest peak	15273.4	4.183935
			83 22 47.1	263 16 28.6	La Salle north peak	14803.4	4.170361
North boundary, stone, Colorado-Utah, 1893.	38 33 56.987	1757.2	180	0	North boundary, flag	30.48	1.48402
	109 03 34.184	827.6					
Middle boundary, monument,[1] Colorado-Utah, 1893.	38 30 44.20	1362.7	101 38 04.2	281 31 48.0	Mount Waas	14935.2	4.174211
	109 03 34.29	830.9	106 11 22.5	286 05 04.3	La Salle, north peak	15309.2	4.184953
South boundary, Colorado-Utah, 1893	38 27 46.723	1440.7	120 06 12.2	299 59 56.0	Mount Waas	16915.6	4.228287
	109 03 34.058	825.7	121 35 51.4	301 29 22.5	La Salle northwest peak	17758.0	4.249394
			123 30 57.0	303 24 38.8	La Salle north peak	17640.8	4.246520
Mount Peale, 1893	38 26 19.073	588.1	76 15 00.2	255 16 04.3	Mount Ellen	143118.4	5.1556954
	109 13 43.219	1048.2	141 44 57.6	321 03 55.4	Patmos Head	151081.5	5.1792112
			180 36 38.1	0 36 41.1	Mount Waas	11174.1	4.0482135
			188 55 25.9	9 03 51.8	Tavaputs	123786.6	5.0926735
			240 22 35.7	61 01 57.0	Mesa	104757.2	5.0201837
			284 12 05.2	105 17 44.2	Uncompahgre	159939.9	5.2039567
Middle La Salle peak, 1893	38 27 48.256	1487.9	75 08 25.9	254 09 39.6	Mount Ellen	143395.5	5.1565357
	109 14 00.343	8.3	141 12 57.5	320 32 05.5	Patmos Head	148671.4	5.1722274
			183 37 33.9	3 37 47.6	Mount Waas	8440.5	3.9263693
			241 48 23.6	62 27 56.2	Mesa	103791.3	5.0161608
			285 06 38.1	106 12 28.8	Uncompahgre	161037.4	5.2069268
Mount Waas azimuth mark, cairn, 1893.	38 26 22.765	701.9	119 33 25.5	299 23 06.6	Moab	27669.6	4.4420026
	109 15 33.537	813.4	146 15 45.4	325 58 38.9	Thompsons Springs, west tank	71153.1	4.8521938
			194 09 43.3	14 10 55.0	Mount Waas	11406.8	4.0571630
Thompsons Springs, west tank, 1893	38 58 18.490	570.1	318 23 10.3	138 41 30.1	Mount Waas	64067.1	4.8066349
	109 42 55.086	1326.2	323 15 05.5	143 33 10.6	Middle La Salle peak	70295.1	4.8469252
			45 45 47.6	225 04 42.6	Mount Ellen	134482.8	5.1286669
Moab (Warner's ranch), 1893	38 33 44.255	1364.6	275 20 01.8	95 31 33.2	Mount Waas	26984.1	4.4311080
	109 32 07.662	185.5	297 03 30.2	117 14 57.8	Mount Peale	30077.6	4.4782438
Moab ditch mark, 1893	38 33 45.268	1395.8	5 21 03.8	185 21 03.9	Moab (Warner's ranch)	31.387	1.49675
	109 32 07.541	182.6					
Valley Knob, 1890	38 59 05.726	176.6	159 55 09.07	339 45 52.74	Patmos Head	61195.29	4.7867180
	110 04 18.539	446.2	303 42 45.63	124 14 29.12	Mount Waas	88516.10	4.9470223
Hartman, 1898	39 01 49.899	1538.7	301 59 43.3	122 03 15.0	Valley Knob	9546.9	3.979864
	110 09 54.939	1321.4					
Mica, 1898	38 59 06.040	186.3	182 40 57.3	2 41 03.5	Hartman	5058.5	3.704018
	110 10 04.782	115.1	270 02 11.0	90 05 48.8	Valley Knob	8333.6	3.920831
Reservoir, 1898	38 59 30.031	926.1	181 22 38.5	1 22 41.2	Hartman	4314.4	3.634918
	110 09 59.250	1425.9	275 11 33.0	95 15 07.3	Valley Knob	8234.2	3.915623
			10 12 06.3	190 12 02.8	Mica	751.7	2.876024
Wash, 1898	39 00 10.767	332.0	216 05 38.9	36 06 37.2	Hartman	3783.5	3.577892
	110 11 27.605	664.4	300 34 04.0	120 34 59.6	Reservoir	2469.6	3.392620
			315 01 58.9	135 02 51.0	Mica	2820.8	3.450366
Green River east base, 1898	38 59 37.589	1159.1	120 28 31.6	300 27 46.1	Wash	2017.7	3.304849
	110 10 15.338	369.1	186 51 26.4	6 51 39.2	Hartman	4109.4	3.613783
			345 21 49.9	165 21 56.5	Mica	1005.5	3.002381
			301 02 56.6	121 03 06.7	Reservoir	451.9	2.655053
Green River west base, 1898	38 59 36.264	1118.3	151 20 28.0	331 20 12.8	Wash	1212.5	3.083697
	110 11 03.438	82.7	267 58 25.6	87 58 55.9	Green River east base	1158.3	3.063808
			277 05 16.3	97 05 56.7	Reservoir	1556.6	3.192187
			303 25 41.9	123 26 18.8	Mica	1691.6	3.228293

[1] No check on this position.

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Green River north meridian, 1898	38 59 50.639	1561.6	7 44 53.3	187 44 51.0	Reservoir	641.4	2.807099
	110 09 55.658	1339.4	9 04 20.8	189 04 15.0	Mica	1392.7	3.143858
			105 40 43.1	285 39 45.2	Wash	2298.0	3.361345
			180 16 09.6	0 16 10.0	Hartman	3677.7	3.565572
Green River south meridian,[1] 1898	38 59 30.690	946.4	76 46 03.3	256 46 01.0	Reservoir	88.8	1.948533
	110 09 55.658	1339.5	180 00 00.3	0 00 00.3	Green River north meridian	615.2	2.788994
Green River longitude, 1898	38 59 30.288	934.0	180 00 00.3	0 00 00.3	Green River south meridian	12.40	1.09342
	110 09 55.658	1339.5					
Green River latitude, 1898	38 59 30.288	934.0	270 00 00.0	90 00 00.0	Green River longitude	1.30	0.1139
	110 09 55.712	1340.8					
Cliff, 1898	39 03 51.601	1591.2	316 39 53	136 41 26	Hartman	5158.7	3.712538
	110 12 22.122	531.8	338 42 59	158 44 19	Green River east base	8405.7	3.924574
			339 25 23	159 26 50	Mica	9405.2	3.973368
			349 05 46	169 06 21	Wash	6935.0	3.841045
Green River schoolhouse, 1898	38 59 39.11	1206.0	29 24 02	209 23 47	Mica	1170	3.06836
	110 09 40.91	984.5	57 37 02	237 36 50	Reservoir	523	2.71826
			110 49 38	290 48 31	Wash	2747	3.43884
			175 13 01	355 12 52	Hartman	4047	3.60716
Green River hotel, 1898	38 59 28.88	890.6	22 39 31	202 39 23	Mica	763	2.88274
	110 09 52.56	1265.0	102 22 30	282 22 25	Reservoir	165	2.21686
			119 27 40	299 26 40	Wash	2627	3.41939
San Rafael Knob, 1890	38 48 47.802	1473.9	123 00 33.3	302 37 56.4	Wasatch	61817.2	4.7911092
	110 51 14.159	341.6	211 07 00.8	31 27 23.5	Patmos Head	89518.6	4.9519133
			357 23 37.9	177 25 07.2	Mount Ellen	76877.0	4.8857965
Mount Hilgard, cairn, 1884	38 40 06.364	196.2	67 54 21.3	247 25 30.9	Tushar	72705.0	4.8615643
	111 38 25.973	627.9	148 49 00.7	328 27 37.3	Scipio	94182.8	4.9739716
			198 04 51.4	18 11 54.6	Wasatch	52178.2	4.7174887
			309 48 19.2	130 19 07.1	Mount Ellen	94339.1	4.9746916
Monroe, 1885	38 37 33.071	1019.7	56 34 34.7	236 19 46.7	Tushar	41443.3	4.617454
	112 00 57.117	1381.6	165 19 13.5	345 14 34.6	Lone Tree	42267.7	4.626009
			169 04 46.0	348 57 33.8	Scipio	86738.3	4.938211
			219 44 02.2	40 00 32.5	Mooseneah	59416.8	4.773909
			221 46 37.0	42 07 48.0	Wasatch	73029.6	4.863499
			261 39 04.9	81 53 08.9	Mount Hilgard	33014.1	4.518700
Mount Alice, cairn,[2] 1890	38 41 03.66	112.8	189 14 24.0	9 17 47.3	Wasatch	48450.8	4.6853010
	111 32 35.74	863.8	314 13 24.9	134 40 35.6	Mount Ellen	89227.7	4.9504999
Mooseneah, 1890	39 02 11.911	367.3	46 55 09.2	226 23 49.2	Tushar	99807.0	4.999161
	111 34 37.961	913.0	126 14 11.7	305 50 19.2	Scipio	67222.7	4.827516
			169 21 38.0	349 14 26.8	Mount Nebo	87476.0	4.941889
			201 43 34.0	21 50 08.8	Sanpete	40386.7	4.606238
			230 52 19.3	50 57 00.4	Wasatch	13814.0	4.140318
			326 33 15.0	147 01 48.3	Mount Ellen	121421.9	5.084297
Gunnison astronomic, 1890	39 09 31.032	957.0	234 56 09.2	55 11 13.7	West Sanpete	41790.6	4.621079
	111 49 13.671	328.2	302 41 03.1	122 50 15.3	Mooseneah	25024.1	4.398359
			16 03 21.8	195 56 00.0	Monroe	61524.9	4.789051
Sanpete, 1884	39 22 28.049	865.0	8 28 21.75	188 26 28.81	Wasatch	29109.9	4.4640406
	111 24 13.389	320.5	39 50 36.98	219 12 37.77	Tushar	137431.6	5.1380865
			91 56 53.72	271 26 19.72	Scipio	69205.8	4.8401427
			147 24 59.19	327 11 08.42	Mount Nebo	57576.4	4.7602447
			261 01 49.09	81 43 16.41	Patmos Head	94705.7	4.9763759
West Sanpete, 1884	39 22 27.122	836.4	269 01 59.9	89 02 45.1	Sanpete	1705.3	3.231795
	111 25 24.621	589.4	5 07 14.9	185 06 07.0	Wasatch	28879.7	4.460592
			19 33 25.1	199 27 35.3	Mooseneah	39757.2	4.599416
Salt Creek, cairn, 1884	39 39 54.642	1685.1	52 59 33.0	232 41 49.9	Scipio	50053.8	4.6994371
	111 44 33.450	797.4	139 47 17.7	319 13 11.5	Deseret	116021.0	5.0645366
			173 00 08.5	352 59 15.1	Mount Nebo	16296.8	4.2121034
			337 42 21.7	157 53 22.7	Wasatch	65960.5	4.8192841
Nephi Bench, 1887	39 42 16.447	507.2	208 42 31.3	28 45 25.2	Mount Nebo	13459.0	4.129013
	111 50 28.717	684.1	297 17 18.6	117 21 05.4	Salt Creek	9528.8	3.979039
Cedar, 1884	39 37 30.677	946.1	216 33 33.0	36 40 24.0	Mount Nebo	25683.8	4.409660
	111 56 40.083	956.0	225 05 35.4	45 09 32.4	Nephi Bench	12491.4	4.096610
			255 33 43.0	75 41 26.5	Salt Creek	17885.3	4.252497
			41 14 27.6	221 04 27.3	Scipio	34256.0	4.534737
Levan, 1884	39 31 07.576	233.6	67 47 50.6	247 32 46.1	Scipio	36788.8	4.565716
	111 48 40.403	965.1	135 56 34.4	315 51 28.8	Cedar	16452.3	4.216227
			186 50 15.4	6 51 59.7	Mount Nebo	32663.3	4.514060
South Juab base, 1884	39 32 14.201	438.0	57 20 06.5	237 09 04.1	Scipio	29628.7	4.471712
	111 55 01.457	34.8	166 27 00.6	346 25 57.8	Cedar	10040.0	4.001732
			203 05 13.4	23 11 01.1	Mount Nebo	33031.7	4.518931

[1] No check on this position.

[2] Checked by vertical angles only.

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Mount Bruin, summit, 1887	39 38 41.473	1279.0	350 21 27.5	170 22 39.1	Patmos Head	16044.3	4.2053214
	110 20 50.412	1202.0	58 40 11.4	237 58 05.2	Wasatch	111980.9	5.0491441
			99 04 16.4	278 09 52.5	Mount Nebo	122999.1	5.0899020
Spanish Fork, cairn, 1887	40 05 17.553	541.4	301 42 08.0	122 28 38.5	Patmos Head	122430.6	5.0878901
	111 31 37.650	892.0	33 35 49.3	213 26 37.5	Mount Nebo	36936.9	4.5674605
			114 10 48.2	293 28 11.5	Deseret	102142.4	5.0092063
Mount Bartles, summit, 1887	39 42 06.1	188.1	344 12 33	164 15 20	Patmos Head	22994	4.361613
	110 23 19.8	471.8	54 57 05	234 16 32	Wasatch	112456	5.050981
			96 18 17	275 25 27	Mount Nebo	118625	5.074175
Strawberry North, summit, 1887	40 02 50.77	1566.0	316 23 25	136 49 03	Patmos Head	83284	4.920561
	110 59 02.22	52.6	68 47 47	248 17 40	Mount Nebo	71813	4.856201
			108 40 43	287 37 04	Deseret	146991	5.167292
Indian Head, summit, 1884	39 52 35.50	1094.8	308 58 42	129 21 29	Patmos Head	65770	4.818026
	110 54 37.87	899.9	84 35 12	264 02 19	Mount Nebo	73566	4.866680
			151 04 58	330 27 06	Ogden Peak	168433	5.226427
Springville Peak, monument, 1884	40 14 40.528	1250.1	307 26 07.87	128 13 50.42	Patmos Head	134347.9	5.1282309
	111 33 22.854	540.2	355 56 05.08	176 00 01.94	Wasatch	125714.5	5.0993853
			20 26 10.71	200 18 05.73	Mount Nebo	51370.0	4.7107099
			30 41 47.90	210 16 48.81	Scipio	109736.5	5.0403511
Lone Tree, cairn, 1884	38 59 38.822	1197.1	20 28 01.3	200 17 48.0	Tushar	68043.3	4.8327851
	112 08 22.199	534.3	172 33 36.9	352 31 04.3	Scipio	44647.5	4.6497973
			199 25 31.0	19 39 45.0	Mount Nebo	96219.4	4.9832627
			257 02 33.8	77 28 30.3	Wasatch	60897.4	4.7845984
South Scipio, cairn, 1884	39 17 42.192	1301.2	175 31 48.5	355 31 26.0	Scipio	10894.0	4.0371862
	112 11 48.302	1157.5	212 45 25.2	33 01 53.0	Mount Nebo	68201.5	4.8337941
			287 02 44.6	107 30 56.3	Wasatch	67252.5	4.8277085
			10 56 46.0	190 48 39.9	Tushar	98970.5	4.9955060
Scipio, 1884	39 23 34.370	1060.0	9 25 28.85	189 17 44.59	Tushar	109510.83	5.0394571
	112 12 23.783	569.2	76 43 54.91	255 24 02.27	Wheeler Peak	187526.51	5.2730627
			108 44 47.91	287 39 17.01	Ibepah	154815.27	5.1898138
			163 18 23.66	343 02 15.28	Deseret	123760.97	5.0925837
			219 04 05.78	39 20 57.34	Mount Nebo	59890.96	4.7773613
			295 08 06.11	115 36 42.09	Wasatch	71965.13	4.8571221
Cervera, 1898	39 18 25.893	798.5	247 54 09.8	68 04 33.0	Scipio	25383.1	4.404544
	112 28 46.596	1116.5					
Camara, 1898	39 22 07.166	221.0	264 22 31.4	84 34 48.8	Scipio	27945.8	4.446317
	112 31 45.985	1100.8	327 47 26.0	147 49 19.7	Cervera	8063.6	3.906528
Manterola, 1898	39 20 01.292	39.8	223 12 16.2	43 13 52.8	Camara	5326.6	3.726454
	112 34 18.321	438.8	258 05 24.3	78 19 18.0	Scipio	32148.7	4.507163
			290 17 13.2	110 20 43.4	Cervera	8473.5	3.928062
Montijo, 1898	39 17 50.608	1560.7	150 33 08.8	330 32 08.6	Manterola	4628.4	3.665435
	112 32 43.312	1037.8	189 50 23.3	9 50 59.5	Camara	8030.2	3.904727
			249 56 27.2	70 09 20.4	Scipio	31067.8	4.492310
			259 07 08.7	79 09 38.6	Cervera	5775.4	3.761579
Augusti, 1898	39 17 47.732	1472.0	174 22 57.9	354 22 47.2	Manterola	4138.7	3.616866
	112 34 01.406	33.7	267 16 46.3	87 17 35.8	Montijo	1873.4	3.272639
Blanco, 1898	39 19 06.870	211.9	229 35 11.6	49 36 03.8	Manterola	2589.2	3.413164
	112 35 40.632	973.4	298 57 08.4	118 59 00.8	Montijo	4855.9	3.686271
			315 44 31.8	135 45 34.7	Augusti	3407.0	3.532378
Canovas, 1898	39 17 55.150	1700.8	189 25 19.1	9 25 28.8	Blanco	2242.0	3.350637
	112 35 55.954	1340.8	211 00 28.1	31 01 30.0	Manterola	4539.1	3.656968
			274 45 14.6	94 46 27.2	Augusti	2754.4	3.440021
Oasis northeast base, 1898	39 18 43.279	1334.7	247 56 14.2	67 57 01.7	Blanco	1937.4	3.287210
	112 36 55.584	1331.6	285 01 09.9	105 03 49.8	Montijo	6258.9	3.796497
			292 18 03.9	112 19 54.3	Augusti	4511.2	3.654295
			316 05 11.4	136 05 49.2	Canovas	2060.2	3.313902
Oasis southwest base, 1898	39 17 56.185	1732.7	209 31 23.7	29 31 45.4	Oasis northeast base	1669.1	3.222483
	112 37 29.916	716.8	230 12 41.0	50 13 50.2	Blanco	3406.9	3.532361
			270 48 13.8	90 49 13.3	Canovas	2251.7	3.352519
Oasis north meridian, 1898	39 18 16.544	510.2	234 46 41.1	54 47 12.0	Oasis northeast base	1429.7	3.155251
	112 37 44.336	1062.4	242 20 56.4	62 22 14.8	Blanco	3345.4	3.524452
			284 14 41.3	104 15 50.0	Canovas	2679.5	3.428046
			331 10 21.7	151 10 30.9	Oasis southwest base	716.6	2.855301
Oasis south meridian, 1898	39 17 38.149	1176.5	180 00 01.7	0 00 01.7	Oasis north meridian	1184.0	3.073370
	112 37 44.336	1062.4	210 10 38.0	30 11 08.8	Oasis northeast base	2323.5	3.366148
			211 51 03.0	31 51 12.1	Oasis southwest base	654.8	2.816120
			227 16 41.2	47 17 59.6	Blanco	4033.7	3.605701
Oasis astronomic, 1898	39 17 37.980	1171.3	180 00 01.7	0 00 01.7	Oasis south meridian	5.22	0.71767
	112 37 44.336	1062.4					
Sagasta, 1898	39 21 22.358	689.5	0 09 13.2	180 09 12.8	Cervera	5442.0	3.735759
	112 28 45.987	1101.0	41 03 39.0	221 01 08.6	Montijo	8657.7	3.937404
			72 35 22.9	252 31 52.1	Manterola	8341.6	3.921250
			107 47 43.6	287 45 49.3	Camara	4525.3	3.655652

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		Meters.	
Oasis schoolhouse tower, 1898	39 17 18.819	580.4	177 34 51	357 34 50	Oasis southwest base	1153.3	3.061957
	112 37 27.884	668.3	196 32 46	16 33 06	Oasis northeast base	2717.2	3.434123
			243 02 06	63 03 04	Canovas	2471.5	3.392967
			261 47 40	81 50 40	Montijo	6889.6	3.838194
Delano, cairn, 1885	38 22 09.985	307.9	74 24 47.9	253 22 28.3	Pioche	153261.1	5.1854318
	112 22 15.090	366.4	147 10 30.6	327 08 58.7	Tushar	6617.6	3.8207007
			187 05 56.0	7 12 07.2	Scipio	114503.5	5.0588188
Milford Needle, 1883	38 23 04.355	134.3	68 11 04.9	247 25 13.5	Pioche	116980.5	5.0681136
	112 48 54.330	1318.7	205 03 37.1	25 26 32.4	Scipio	123761.4	5.0925851
			209 29 40.3	30 09 22.7	Mount Nebo	182512.7	5.2612932
			263 34 54.0	83 49 55.6	Tushar	35430.5	4.5493771
Beaver, 1885	38 24 07.205	222.2	112 12 42.7	291 02 11.9	Wheeler Peak	175919.1	5.2453132
	112 26 00.733	17.8	224 06 39.6	44 07 27.9	Tushar	2710.4	3.433039
			303 24 17.3	123 26 37.5	Delano	6561.6	3.817007
Birch Creek, cairn, 1885	38 13 45.847	1413.7	119 44 39.4	299 31 47.1	Milford Needle	34824.1	4.541880
	112 28 08.541	207.7	189 11 40.6	9 12 59.8	Beaver	19408.5	4.287993
			193 17 40.3	13 19 47.8	Tushar	21687.2	4.336203
			208 53 28.1	28 57 07.2	Delano	17759.1	4.249420
Beaver flagstaff (U. S. Engineers astronomic station, 1872–1885), 1885.	38 16 25.616	789.8	128 58 03.2	308 51 34.3	Milford Needle	19572.7	4.291650
	112 38 27.323	664.2	231 48 20.9	51 56 04.0	Beaver	23050.5	4.362680
			288 04 33.7	108 10 56.8	Birch Creek	15831.5	4.199523
West Beaver, monument, 1885	38 24 07.621	235.0	226 58 41.9	46 59 34.9	Tushar	2833.6	3.452337
	112 26 08.359	202.8	273 57 53.7	93 57 58.4	Beaver	185.5	2.268374
			302 37 35.4	122 40 00.3	Delano	6723.7	3.827611
			8 40 10.2	188 38 55.7	Birch Creek	19392.5	4.287633
Beaver meetinghouse,[1] 1885	38 16 27.27	840.9	231 40 31.0	51 48 10.3	Beaver	22901.2	4.359859
	112 38 21.16	514.4	288 25 24.4	108 31 43.7	Birch Creek	15705.2	4.196043
Herriman, 1884	40 25 33.199	1024.0	96 03 56.8	275 47 18.3	Deseret	36471.8	4.5619574
	112 11 53.256	1255.4	197 09 38.6	17 22 03.8	Ogden Peak	90043.9	4.9544545
			331 30 20.3	151 47 03.2	Mount Nebo	77598.9	4.8898558
			0 21 53.7	180 21 34.2	Scipio	114698.1	5.0595561
Draper, 1887	40 30 51.924	1601.6	358 42 56.01	178 43 43.51	Mount Nebo	78139.6	4.8928711
	111 47 10.553	248.4	85 24 07.49	264 51 25.36	Deseret	71430.9	4.8538863
			144 03 13.62	323 46 25.34	Antelope	61546.9	4.7892065
			174 01 03.50	353 57 19.43	Ogden Peak	76577.7	4.8841024
Lone Peak, needle, 1884	40 31 37.936	1170.1	0 38 10.8	180 37 46.9	Mount Nebo	79544.3	4.9006090
	111 45 19.779	465.6	17 09 42.7	196 52 19.7	Scipio	131711.9	5.1196251
			84 29 24.3	263 55 30.0	Deseret	74153.6	4.8701319
			171 57 24.0	351 52 27.4	Ogden Peak	75487.2	4.8778734
Oquirrh, 1887	40 36 50.350	1553.1	65 25 07.30	245 08 00.46	Deseret	40934.1	4.6120854
	112 11 12.651	297.3	176 26 26.13	356 25 18.91	Antelope	38757.6	4.5883572
			201 28 10.19	21 40 10.24	Ogden Peak	70002.5	4.8451133
			337 58 00.24	158 14 18.86	Mount Nebo	96109.4	4.9827660
Onaqui, 1887	40 36 10.481	323.3	220 02 28.81	40 18 07.43	Antelope	52233.1	4.7179456
	112 36 52.528	1235.0	222 43 34.13	43 12 22.38	Ogden Peak	90643.9	4.9573386
			320 18 58.12	140 51 50.73	Mount Nebo	113825.4	5.0562391
			3 23 45.93	183 23 19.92	Deseret	15918.8	4.2019090
Lake Shore bench, 1887	40 40 28.680	884.6	35 04 22.1	214 56 40.2	Deseret	29124.9	4.464264
	112 25 42.249	992.3	63 14 13.6	243 06 57.1	Onaqui	17649.7	4.246738
			288 09 49.1	108 19 15.5	Oquirrh	21513.8	4.332718
Grantsville flagstaff, 1887	40 36 07.456	230.0	39 20 44.8	219 14 47.9	Deseret	20413.4	4.309915
	112 28 23.257	546.8	90 29 32.8	270 24 01.4	Onaqui	11974.0	4.078240
			266 46 52.1	86 58 02.9	Oquirrh	24265.0	4.384981
Deseret magnetic, 1887	40 27 26.715	824.0	180 14 07.7	0 14 09.5	Onaqui	16155.9	4.208330
	112 36 55.352	1304.3	213 13 22.9	33 20 40.6	Lake Shore bench	28853.0	4.460191
			244 16 25.0	64 33 07.6	Oquirrh	40254.7	4.604817
Hill, flag, 1887	40 27 36.847	1136.6	61 51 11.7	241 50 55.6	Deseret magnetic	662.38	2.821107
	112 36 30.564	720.1	178 07 59.4	358 07 45.1	Onaqui	15851.7	4.200075
			212 35 03.9	32 42 05.5	Lake Shore bench	28273.4	4.451378
Flag in flat,[1] 1887	40 27 50.04	1543.5	334 05 19	154 05 24	Hill, flag	452.43	2.65555
	112 36 38.96	917.9	28 14 10	208 13 59	Deseret magnetic	816.60	2.91201
City Creek, 1893	40 48 27.055	834.5	354 56 04.18	175 00 30.96	Mount Nebo	111094.2	5.0456914
	111 52 49.276	1155.0	121 26 25.00	301 13 15.44	Antelope	33062.5	4.5193355
			179 53 01.61	359 52 59.12	Ogden Peak	43609.9	4.6395852
Salt Lake City Temple east spire, 1893.	40 46 14.599	450.3	127 59 16.51	307 46 32.37	Antelope	34652.0	4.5397279
	111 53 27.668	648.9	192 25 14.51	12 25 39.59	City Creek	4183.8	3.6215713
Salt Lake City Temple west spire, 1893.	40 46 14.602	450.4	128 02 02.50	307 49 19.63	Antelope	34615.9	4.5392754
	111 53 29.618	694.6	143 01 49.03	222 41 01.90	Promontory	73491.7	4.8662386
			193 01 51.42	13 02 17.78	City Creek	4193.8	3.6226054

[1] No check on this position.

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
	° ′ ″		° ′ ″	° ′ ″		Meters.	
Supplementary points—Continued.							
Salt Lake City azimuth, 1893	40 46 11.574	357.0	150 15 21.49	330 15 20.00	Salt Lake City Temple west spire.	107.6	2.0317042
	111 53 27.343	611.3	175 19 17.39	355 19 16.88	Salt Lake City Temple east spire.	93.6	1.9713155
			192 03 06.51	12 03 31.38	City Creek	4273.4	3.6307699
Salt Lake City longitude, 1869	40 46 12.38	381.9					
	111 53 27.30	640.3					
Salt Lake City latitude, 1869	40 46 12.38	381.9					
	111 53 27.24	638.9					
Salt Lake City U. S. Land Survey, standard meridian.	40 46 11.36	350.4					
	111 53 27.96	655.8					
South Antelope 1, cairn, 1892	40 52 55.542	1713.3	38 17 30.5	217 50 34.5	Deseret	59495.3	4.774483
	112 11 33.591	786.5	167 51 38.5	347 50 44.8	Antelope	9113.8	3.959699
			220 12 31.8	40 19 24.1	Salt Lake southeast base	22760.9	4.357190
South Antelope 2,[1] 1892	40 52 30.536	941.9	38 54 44.2	218 37 36.5	Deseret	59155.3	4.771994
	112 11 15.510	363.2	166 24 57.3	346 23 51.8	Antelope	9960.1	3.998263
Bountiful Peak or Francis Peak, cairn, 1892.	40 57 52.798	1628.6	42 17 35.1	222 14 52.7	Waddoup	8620.7	3.9355445
	111 49 02.634	61.6	50 53 07.9	230 21 29.8	Deseret	88365.0	4.9462804
			89 41 10.1	269 25 30.7	Antelope	33508.8	4.5251588
			115 58 55.9	295 51 02.3	Salt Lake southeast base	18757.4	4.2731737
			123 23 42.1	303 12 08.2	Salt Lake northwest base	29534.7	4.4703332
			126 26 26.7	306 02 41.5	Promontory	62660.3	4.7969928
Farmington courthouse, spire,[1] 1892	40 58 49.65	1531.5	359 53 01.8	179 53 02.3	Waddoup	8133.0	3.910249
	111 53 11.20	261.9	85 56 55.8	265 43 59.2	Antelope	27765.0	4.443497
Francis Peak,[2] 1896	41 01 52.61	1623.0	16 08 50.6	196 06 58.9	Waddoup	14341.5	4.156596
	111 50 20.08	469.1	111 10 35.0	290 59 51.5	Salt Lake northwest base	24506.3	4.389277
Kaysville R. G. W. depot, chimney,[1] 1892.	41 01 31.21	962.8	332 49 34.4	152 52 43.0	Waddoup	14740.6	4.168516
	111 57 58.14	1358.3	71 38 00.2	251 28 11.5	Antelope	22112.2	4.344632
Kaysville meetinghouse spire,[1] 1892	41 02 11.37	350.8	337 09 42.5	157 12 31.8	Waddoup	15574.0	4.192399
	111 57 28.77	672.0	69 15 55.6	249 05 47.6	Antelope	23173.4	4.364989
Lake Park pavilion, flag,[1] 1892	40 58 39.76	1226.4	330 20 34.7	150 22 39.5	Waddoup	9006.3	3.954546
	111 56 20.91	488.8	85 53 20.2	265 42 28.1	Antelope	23319.4	4.367718
Fremont Island, cairn, 1888	41 10 27.922	861.4	154 59 33.34	334 56 31.56	Promontory	15177.2	4.1811907
	112 20 33.503	781.0	265 36 55.25	85 55 08.68	Ogden Peak	38802.5	4.5888598
			335 32 35.33	155 37 36.18	Antelope	25867.2	4.4127501
North Promontory, cairn, 1892	41 29 26.038	803.3	301 23 37.6	121 48 26.9	Ogden Peak	61538.8	4.789149
	112 30 27.523	638.5	337 14 06.5	157 25 39.8	Antelope	63575.5	4.803290
			340 52 37.2	160 56 07.7	Promontory	22602.4	4.354154
			5 00 01.2	184 55 22.6	Deseret	114898.1	5.060313
Middle Promontory, cairn, 1892	41 23 55.025	1697.5	293 20 26.9	113 44 21.7	Ogden Peak	55170.0	4.7417032
	112 29 07.065	164.1	333 35 58.2	153 38 35.3	Promontory	12442.7	4.0949131
			6 31 04.5	186 25 33.4	Deseret	104924.4	5.0208766
South Promontory, cairn, 1892	41 18 26.224	809.0	283 54 23.2	104 16 44.7	Ogden Peak	48835.4	4.6887347
	112 26 47.534	1105.8	293 41 37.3	113 42 42.2	Promontory	2496.7	3.3973642
			333 03 35.7	153 12 43.0	Antelope	42943.6	4.6328986
Ogden longitude, 1873	41 13 12.554	387.3	190 04 31.4	10 05 51.7	North Ogden Peak	16169.8	4.208704
	111 59 37.990	884.9	283 10 30.4	103 14 57.2	Ogden Peak	9689.9	3.986320
Weber bench, 1891	41 12 12.908	398.2	176 23 12.7	356 23 09.4	Ogden longitude	1843.7	3.265689
	111 59 33.002	768.8	188 41 05.0	8 42 21.9	North Ogden Peak	17966.4	4.254461
			272 15 57.3	92 20 20.7	Ogden Peak	9325.9	3.969692
Ogden azimuth, 1891	41 13 12.406	382.7	103 49 14.95	283 32 25.09	Promontory	36689.3	4.5645397
	111 59 37.959	884.2	190 04 12.26	10 05 32.56	North Ogden Peak	16174.1	4.2088211
			283 08 59.55	103 13 26.30	Ogden Peak	9688.2	3.9862423
Ogden union depot, 1891	41 13 15.870	489.6	285 45 36.2	105 49 27.8	Ogden Peak	8513.7	3.930116
	111 58 44.718	1041.6	30 04 50.1	210 04 18.3	Weber bench	2244.5	3.351123
			85 17 34.0	265 16 58.9	Ogden longitude	1245.1	3.095202
Ogden City Hall, 1891	41 13 13.158	405.9	286 36 42.2	106 40 13.5	Ogden Peak	7798.6	3.892016
	111 58 13.797	321.4	44 47 56.6	224 47 04.4	Weber bench	2619.0	3.418140
			89 27 49.4	269 26 53.9	Ogden longitude	1961.2	3.292530
Ogden courthouse flagstaff, 1888	41 13 24.096	743.3	289 21 14.9	109 24 41.5	Ogden Peak	7746.1	3.889084
	111 58 06.727	156.7	42 28 21.4	222 27 24.6	Weber bench	2977.0	3.473775
			80 29 58.9	260 28 58.8	Ogden longitude	2155.4	3.333530
Ogden Methodist Church,[1] 1891	41 13 23.740	732.4	43 03 35.8	223 02 38.1	Weber bench	2990.3	3.475714
	111 58 05.375	125.2	80 55 13.1	260 54 12.1	Ogden longitude	2184.7	3.339394
Ogden Reform School,[1] 1891	41 13 57.097	1761.4	43 06 55.6	223 05 30.5	Weber bench	4402.2	3.643668
	111 57 23.867	555.8	66 16 09.7	246 14 41.3	Ogden longitude	3412.7	3.533104

[1] No check on this position.

[2] Checked by vertical angles only.

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Cliff, flag, 1891	41 16 46.678	1440.0	339 16 02.3	159 17 36.7	Ogden Peak	9430.2	3.974519
	111 55 16.345	380.4	35 18 31.1	215 15 41.9	Weber bench	10316.3	4.014786
			42 42 26.8	222 39 34.3	Ogden longitude	8985.8	3.953556
Sandy, 1891	41 13 02.989	92.2	191 50 20.2	11 51 56.7	North Ogden	16568.2	4.219275
	112 00 02.529	58.9	242 41 39.9	62 41 56.1	Ogden longitude	643.3	2.808395
			280 49 17.7	100 54 00.7	Ogden Peak	10187.8	4.008080
			335 59 47.8	156 00 07.3	Weber bench	1691.2	3.228190
North Ogden public school,[1] 1891	41 18 25.65	791.3	13 05 49.8	193 04 34.1	Weber bench	11805.2	4.072074
	111 57 38.19	888.4	16 06 58.3	196 05 39.3	Ogden longitude	10053.1	4.002302
North Ogden Peak, 1891	41 21 48.605	1499.5	340 00 03.50	160 03 10.35	Ogden Peak	19295.1	4.2854472
	111 57 36.283	843.3	25 46 24.74	205 36 19.67	Antelope	49439.3	4.6940724
			29 24 54.31	208 58 44.94	Deseret	114960.5	5.0605486
			79 28 29.35	259 10 17.71	Promontory	39116.1	4.5923554
Box Elder Peak, or Willards Peak, cairn, 1888.	41 38 09.520	293.7	347 03 59.2	167 09 14.7	Ogden Peak	49647.4	4.6958965
	112 00 49.969	1156.6	42 12 39.8	221 56 33.5	Promontory	50533.9	4.7035830
Cache,[1] 1888	42 11 09.38	289.4	305 52 42.1	127 03 42.2	Ogden Peak	184167.7	5.2652134
	113 39 37.51	860.8	15 09 37.1	194 53 01.9	Pilot Peak	133907.6	5.1268052
Oxford,[1] 1888	42 16 11.72	361.6	351 20 04.6	171 28 41.8	Ogden Peak	120157.5	5.0797507
	112 05 49.97	1145.2	50 36 15.7	229 17 19.6	Pilot Peak	215451.6	5.3333497
Desert Peak, cairn, 1892	41 11 10.835	334.2	284 01 50.04	104 47 15.21	Antelope	99970.0	4.9998697
	113 22 03.116	72.6	321 57 26.35	142 26 32.26	Deseret	102082.8	5.0089526
			73 08 53.84	253 40 55.31	Pilot Peak	62328.0	4.7946831
Grassy, cairn, 1892	41 15 53.946	1664.2	281 56 33.15	103 07 33.86	Antelope	154859.3	5.1899373
	114 00 54.859	1276.9	306 53 43.77	127 48 16.72	Deseret	147374.0	5.1684209
			10 49 47.67	190 47 21.99	Pilot Peak	27533.7	4.4398647
Tecoma railroad signboard eccentric,[1] 1892.	41 19 13.659	421.4	318 06 15.4	138 08 52.1	Grassy	8274.1	3.917720
	114 04 52.221	1214.6	359 21 27.4	179 21 37.9	Pilot Peak	33208.3	4.521246
Nevada-Utah boundary monument,[1] 1892.	41 20 31.33	966.5	346 26 02.7	166 27 01.2	Grassy	8802.5	3.944606
	114 02 23.56	547.8	55 17 09.5	235 15 31.3	Tecoma railroad signboard eccentric.	4206.3	3.623896
Butte[1], 1892	41 09 41.07	1267.0	50 16 35.6	230 07 50.2	Pilot Peak	24282.4	4.385291
	113 51 16.91	394.2	130 33 43.6	310 27 22.8	Grassy	17708.6	4.248183
East Peninsula Peak, 1889	40 54 24.875	767.3	3 47 39.0	183 44 02.6	Ibepah	120009.3	5.079215
	113 49 35.012	819.4	121 11 44.9	301 01 54.0	Pilot Peak	24616.8	4.391232
			175 11 42.3	355 10 35.4	Butte	28362.8	4.452749
West Peninsula Peak, 1889	40 50 03.588	110.7	0 27 35.7	180 27 11.3	Ibepah	111694.0	5.048030
	113 54 31.231	731.7	145 47 26.9	325 40 50.5	Pilot Peak	25144.2	4.400438
			187 06 33.7	7 08 41.2	Butte	36605.5	4.563546
Pilot Peak azimuth mark, 1892	41 02 30.426	938.7	257 50 40.7	78 55 54.6	Promontory	141491.1	5.150729
	114 04 14.748	344.4	12 33 55.8	192 33 41.6	Pilot Peak	2313.0	3.364183
Willow Springs, 1892	40 59 23.485	724.4	113 42 29.1	293 38 44.4	Pilot Peak	8738.2	3.941424
	113 58 53.844	1258.6	127 35 32.9	307 32 02.3	Pilot Peak azimuth mark	9459.3	3.975860
			209 12 11.0	29 17 11.2	Butte	21834.3	4.339139
White boundary stake, 1892	40 56 07.791	240.3	162 49 07.7	342 47 44.9	Pilot Peak	9992.3	3.999665
	114 02 29.952	700.7	279 51 36.2	100 00 03.8	East Peninsula Peak	18408.9	4.265027
			315 01 29.4	135 06 42.8	West Peninsula Peak	15869.3	4.200557
Black boundary stake, 1892	40 55 25.283	779.9	164 48 25.6	344 47 02.9	Pilot Peak	11250.9	4.051186
	114 02 30.087	703.9	180 08 18.0	0 08 18.1	White boundary stake	1311.2	3.117685
			311 28 02.8	131 33 16.3	West Peninsula Peak	14972.8	4.175302
Camp stake, 1892	40 59 23.584	727.4	305 07 05.2	125 13 11.6	East Peninsula Peak	15997.5	4.204053
	113 58 54.116	1265.0	340 22 22.8	160 25 15.0	West Peninsula Peak	18337.2	4.263334
			113 42 23.6	293 38 39.1	Pilot Peak	8731.2	3.941074
Flag, 1892	40 59 01.495	46.1	119 01 26.3	298 57 54.2	Pilot Peak	8638.8	3.936453
	113 59 12.972	303.3	212 53 46.1	32 53 58.5	Camp stake	811.5	2.909302
			302 12 25.7	122 18 44.5	East Peninsula Peak	15986.7	4.203758
			338 18 08.6	158 21 13.2	West Peninsula Peak	17855.1	4.251763
Nevada-Utah boundary stake,[1] 1892	41 01 16.84	519.5	304 52 30.4	124 54 51.1	Camp stake	6107.2	3.785839
	114 02 28.46	665.0	312 24 17.6	132 26 25.9	Flag	6189.1	3.791624
Ibepah azimuth mark, 1889	39 51 14.729	454.2	237 55 24.2	58 44 55.6	Deseret	128115.6	5.107602
	113 54 20.077	477.3	22 12 30.2	202 11 58.9	Ibepah	3073.7	3.487661
Red Squaw, cairn, 1889	39 48 02.759	85.1	209 20 20.8	29 21 07.3	Ibepah	3527.5	3.547471
	113 56 21.615	514.2	236 24 38.7	57 15 26.8	Deseret	133755.0	5.126310
Red Chief, cairn, 1889	39 48 00.739	22.8	204 06 54.7	24 07 32.5	Ibepah	3437.3	3.536215
	113 56 07.989	190.0	236 18 50.2	57 09 29.5	Deseret	133519.6	5.125545

[1] No check on this position.

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel.—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Bench, 1889	39 52 33.668	1038.3	176 52 47.6	356 49 35.0	Pilot Peak	127382.9	5.105111
	113 59 39.547	939.8	287 44 56.7	107 48 21.5	Ibepah azimuth mark	7973.8	3.901667
			309 21 19.3	129 24 12.7	Ibepah	8322.7	3.920263
			330 34 28.3	150 37 35.1	Red Squaw	9589.5	3.981796
South boundary flag, 1889	39 53 47.060	1451.3	292 05 53.9	112 11 05.5	Ibepah azimuth mark	12465.3	4.095704
	114 02 25.938	616.2	299 46 42.1	119 48 28.8	Bench	4555.7	3.658552
			305 57 04.8	126 01 44.9	Ibepah	12837.5	4.108480
			320 45 54.6	140 49 48.2	Red Squaw	13703.1	4.136820
Middle boundary, 1889	39 58 58.301	1798.0	319 53 30.6	139 58 55.6	Ibepah azimuth mark	18681.2	4.271404
	114 02 46.356	1099.8	327 35 32.2	147 40 25.7	Ibepah	20296.5	4.307421
			335 38 14.2	155 42 21.0	Red Squaw	22188.3	4.346125
North boundary flag, 1889	40 00 19.318	595.9	324 26 56.2	144 32 20.1	Ibepah azimuth mark	20632.7	4.314556
	114 02 44.732	1060.9	331 05 56.4	151 10 48.9	Ibepah	22427.4	4.350779
			338 08 01.5	158 12 07.3	Red Squaw	24471.9	4.388668
North Peak, tree, east prong, 1889	40 02 49.589	1529.6	5 00 46.4	184 59 48.9	Ibepah	24369.6	4.386849
	113 53 39.388	933.7	24 15 33.9	204 11 42.6	Bench	20831.0	4.318710
			36 47 53.6	216 42 15.3	South boundary flag	20883.5	4.319804
			61 14 27.9	241 08 36.1	Middle boundary	14804.0	4.170378
			70 19 47.9	250 13 57.1	North boundary flag	13736.8	4.137886
South Peak, middle tree, 1889	40 02 20.264	625.0	6 21 40.9	186 20 30.6	Ibepah	23516.5	4.371373
	113 53 19.365	459.1	26 32 36.1	206 28 32.0	Bench	20217.5	4.305727
			39 23 01.8	219 17 10.7	South boundary flag	20464.4	4.311000
			65 11 48.0	245 05 43.4	Middle boundary	14820.2	4.170853
			74 30 06.9	254 24 03.3	North boundary flag	13916.2	4.143521
Ibepah telegraph office flag, 1889	40 03 25.137	775.4	283 18 48.5	103 22 27.4	South Peak	8669.7	3.938002
	113 59 15.179	359.8	342 42 04.2	162 45 13.7	Ibepah azimuth mark	23591.2	4.372751
			347 00 11.7	167 02 39.8	Ibepah	26038.0	4.415607
Ibepah post office eccentric, 1889	40 03 32.150	991.7	347 44 50.2	167 47 20.2	Ibepah	26183.9	4.418034
	113 59 02.607	61.8	54 01 32.7	234 01 24.6	Ibepah telegraph office flag	368.20	2.566084
Ibepah post office, southeast corner, 1889.	40 03 32.51	1002.8	318 41 35	138 41 35	Ibepah post office eccentric	14.844	1.17155
	113 59 03.02	71.6	51 43 07	231 42 59	Ibepah telegraph office flag	367.12	2.56481
Ibepah telegraph office chimney, 1889.	40 03 24.581	758.2	237 42 25.2	57 42 35.2	Ibepah post office eccentric	436.98	2.640462
	113 59 18.193	431.2	256 29 43.5	76 29 45.4	Ibepah telegraph office flag	73.46	1.866029
			346 50 27.9	166 53 07.9	Ibepah	26037.4	4.415598
Devine's granary, 1889	40 03 33.19	1023.7	347 46 00	167 48 30	Ibepah	26214.7	4.418545
	113 59 02.52	59.7	3 46 15	183 46 15	Ibepah post office eccentric	32.034	1.50561
Granite Peak, 1884	40 07 42.222	1302.3	59 12 19.2	238 47 18.7	Ibepah	64653.3	4.8105909
	113 16 13.481	319.1	145 42 52.0	325 11 23.9	Pilot Peak	120398.8	5.0806222
			235 55 06.2	56 20 07.2	Deseret	66024.1	4.8197025
Antelope Mountain or Swasey Peak, 1884.	39 23 18.44	568.7	133 29 44.2	313 06 39.0	Ibepah	71226	4.8526387
	113 18 56.17	1344.2	206 09 08.4	26 35 42.4	Deseret	132771	5.1231030
			269 21 12.5	90 03 26.2	Scipio	95541	4.9801894
			323 37 53.0	144 11 56.2	Tushar	133093	5.1241565
Sawtooth Peak or Sevier Mountain, 1884.	39 08 36.600	1128.7	77 42 03.2	257 07 51.0	Wheeler Peak	80212.3	4.9042407
	113 24 31.620	759.3	150 09 37.2	329 50 08.8	Ibepah	87811.6	4.9435518
			254 40 42.9	75 26 22.2	Scipio	107378.2	5.0309160
			312 32 32.0	133 09 59.7	Tushar	118159.3	5.0724679
Frisco Mount, tree, 1884	38 31 14.526	447.9	120 23 36.8	299 45 04.0	Wheeler Peak	103092.0	5.0132251
	113 17 13.176	319.2	223 42 25.1	44 23 10.6	Scipio	134700.5	5.1293691
			278 05 36.0	98 38 15.8	Tushar	77188.3	4.8875514
Indian Peak, 1881	38 16 02.302	71.0	26 27 06.8	206 20 34.4	Pioche	34813.9	4.5417522
	113 52 29.343	713.3	92 50 30.7	271 50 02.1	White Pine	142409.7	5.1535395
			154 33 44.1	334 17 18.6	Wheeler Peak	88453.5	4.9467150
			178 44 43.7	358 43 02.8	Ibepah	173352.8	5.2389308
			262 01 12.8	82 55 40.0	Tushar	129000.4	5.1105909
Butte, 1883	37 56 42.122	1298.6	148 31 11.4	328 30 00.6	Piocho	5379.3	3.7307228
	114 01 09.712	237.1	167 34 28.9	347 23 30.7	Wheeler Peak	118371.6	5.0732473
			249 00 02.0	69 59 39.4	Tushar	150361.0	5.1771352
East Ridge, 1883	37 59 06.29	193.9	356 53 13	176 53 19	Butte	4451.6	3.64852
	114 01 19.61	478.5	93 10 29	273 09 24	Pioche	2571.4	3.41017
Road summit, 1883	37 57 59.34	1829.4	164 23 32	344 23 17	Pioche	2290.7	3.35996
	114 02 39.57	965.9	223 23 05	43 23 54	East Ridge	2840.5	3.45340
			317 20 09	137 21 04	Butte	3237.4	3.51019
North boundary signal, 1883	38 00 51.70	1594.1	325 46 11	145 47 07	East Ridge	3930.2	3.59441
	114 02 50.21	1224.8	342 18 44	162 19 46	Butte	8076.3	3.90721
			6 32 49	186 32 40	Pioche	3128.1	3.49528
Canyon Peak, 1883	38 00 34.56	1065.6	206 55 30	26 55 37	North boundary signal	592.7	2.77283
	114 03 01.21	29.5	317 39 35	137 40 38	East Ridge	3681.0	3.56597
			339 11 51	159 13 00	Butte	7665.7	3.88455
			1 57 28	181 57 26	Pioche	2580.8	3.41175

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel.—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Boundary stake No. 1,[1] 1883	38 00 47.89	1476.6	242 07 42	62 07 48	North boundary signal	251.2	2.40009
	114 02 59.31	1446.7	6 25 36	186 25 35	Canyon Peak	413.6	2.61657
Pine Hill, 1883	37 58 13.34	411.3	67 08 06	247 07 40	Road summit	1110.1	3.04538
	114 01 57.66	1407.5	137 16 50	317 16 08	Pioche	2415.9	3.38307
			209 37 30	29 37 53	East Ridge	1878.3	3.27377
			337 23 51	157 24 20	Butte	3046.1	3.48375
Boundary stake No. 2,[1] 1883	37 58 48.70	1501.4	306 00 33	126 01 11	Pine Hill	1853.2	3.26792
	114 02 59.08	1441.8	342 36 50	162 37 02	Road summit	1593.9	3.20246
Mount Moriah, cairn, 1883	39 16 24.515	756.0	201 10 53.9	21 21 33.6	Ibepah	66120.7	4.8203371
	114 11 53.573	1284.1	225 06 24.7	46 06 53.8	Deseret	188281.7	5.2748081
			253 18 09.7	74 51 05.2	Mount Nebo	217435.3	5.3373301
			264 57 17.6	86 13 02.3	Scipio	172225.6	5.2360976
			300 52 28.0	121 59 41.8	Tushar	181750.3	5.2594750
			17 21 32.2	197 17 10.7	Wheeler Peak	33422.1	4.5240336
			47 19 29.5	226 30 29.9	White Pine	155005.7	5.1903477
Snake Creek, 1883	38 58 01.824	56.2	94 11 55.7	273 59 09.3	Wheeler Peak	29402.1	4.468378
	113 58 29.544	711.3	150 28 24.0	330 19 56.7	Mount Moriah	39107.1	4.592256
			248 02 46.9	68 24 11.0	Sawtooth Mountain	52766.2	4.722356
Wheeler Peak reference mark, 1882	39 01 13.696	422.3	281 00 43.7	101 13 50.7	Snake Creek	30674.2	4.486773
	114 19 20.216	486.3	348 28 49.5	168 29 09.8	Wheeler Peak	3896.9	3.590723
Nevada-Utah boundary monument, 1883.	39 09 45.918	1416.0	343 42 23.6	163 45 09.7	Snake Creek	22618.3	4.354460
	114 02 53.130	1275.6	49 33 56.2	229 23 54.3	Wheeler Peak	30190.1	4.479864
			56 25 41.9	236 15 19.3	Wheeler Peak reference mark	28499.8	4.454842
Cedar Spur, 1883	38 56 40.132	1237.6	108 22 20.8	288 16 16.6	Wheeler Peak	14688.4	4.166976
	114 09 08.704	209.6	200 24 24.8	20 28 21.4	Nevada-Utah boundary monument.	25859.7	4.412623
			260 38 53.4	80 45 35.3	Snake Creek	15594.8	4.192979
Transit Venus station, 1883	39 00 41.514	1280.2	215 07 12.8	35 12 23.1	Nevada-Utah boundary monument	20535.5	4.312506
	114 11 05.208	125.3	285 05 04.0	105 12 59.5	Snake Creek	18841.5	4.275116
			339 20 44.4	159 21 57.7	Cedar Spur	7954.2	3.900596
Shell Creek, south peak, 1881	39 20 12.047	371.5	35 02 06.8	214 28 10.7	White Pine	137408.5	5.1380137
	114 35 57.638	1380.4	105 07 41.1	284 21 12.6	Diamond Peak	108454.8	5.0352487
			226 43 42.8	47 09 42.1	Ibepah	79975.5	4.9029571
			327 29 11.8	147 40 02.1	Wheeler Peak	46111.0	4.6638042
Shell Creek, north peak, 1881	39 24 48.819	1505.5	33 05 55.7	212 31 57.4	White Pine	144491.4	5.1598420
	114 35 56.796	1358.7	100 41 28.7	279 54 57.4	Diamond Peak	106566.1	5.0276190
			231 30 40.9	51 56 41.9	Ibepah	74369.2	4.8713929
			269 52 43.7	91 23 51.4	Scipio	206084.6	5.3140456
			332 25 28.3	152 36 18.6	Wheeler Peak	53496.3	4.7283238
Ward, north summit, 1881	39 08 29.8	919.0	28 09 06	207 48 11	White Pine	103318	5.014178
	114 56 38.2	917.3	123 27 13	302 53 06	Diamond Peak	90004	4.954264
			287 21 20	107 45 11	Wheeler Peak	57248	4.757762
Ward, small cairn, 1881	39 06 01.912	59.0	283 24 29.8	103 47 25.6	Wheeler Peak	54038.5	4.7327033
	114 55 11.920	286.4	328 14 55.0	148 47 23.6	Pioche	145019.5	5.1614265
			30 26 20.7	210 04 31.8	White Pine	100354.4	5.0015364
			125 05 10.5	304 31 00.9	Diamond Peak	94286.0	4.9744470
Mount Grafton, summit, 1881	38 41 32.972	1016.7	58 14 31.3	237 46 09.0	White Pine	78112.0	4.892718
	114 44 30.698	741.9	137 08 46.9	316 28 01.3	Diamond Peak	135940.8	5.133350
			228 39 05.8	48 55 13.4	Wheeler Peak	49464.0	4.694289
			322 10 51.4	142 36 33.5	Pioche	98934.8	4.995349
White Rock, 1881	38 08 47.033	1450.2	100 56 24.2	280 12 43.4	White Pine	104769.9	5.0202364
	114 19 30.168	734.6	180 37 32.3	0 37 58.6	Wheeler Peak	93213.8	4.9694803
			306 24 00.4	126 34 07.9	Pioche	29874.0	4.4752941
Pioche Peak, monument, 1881	37 56 01.546	47.7	210 11 24.3	30 17 12.0	White Rock	27318.4	4.4364550
	114 28 54.342	1327.0	234 59 42.7	55 22 21.0	Indian Peak	64845.0	4.8118762
			261 05 38.1	81 21 31.2	Pioche	38274.3	4.5829070
White cairn, 1883	37 55 19.160	590.7	114 39 12.6	294 38 00.9	Pioche Peak	3134.0	3.4961040
	114 26 57.704	1409.4	203 37 24.6	23 42 00.4	White Rock	27194.4	4.4344797
			258 20 02.3	78 34 43.7	Pioche	35704.1	4.5527179
Highland Peak, summit, 1881	37 53 38.346	1182.2	120 32 44.2	299 58 32.9	White Pine	93753.0	4.9719854
	114 34 40.972	1001.2	190 42 47.0	10 52 39.6	Wheeler Peak	123408.4	5.0913446
			242 25 53.2	62 29 26.2	Pioche Peak	9549.1	3.9799610
			254 36 10.8	74 40 55.4	White cairn	11736.2	4.0695285
			257 21 06.2	77 40 32.1	Pioche	47422.3	4.6759828
White Pine, azimuth mark, 1883	38 18 43.768	1349.6	210 48 48.68	30 49 01.33	White Pine	967.8	2.9857973
	115 30 25.198	612.2	233 52 42.97	54 37 26.98	Wheeler Peak	128041.7	5.1073514
			285 22 22.07	106 16 19.23	Pioche	132621.5	5.1226139
White Pine, south summit, 1880	38 17 37.860	1167.4	80 48 01.7	259 34 55.7	Lone Mountain	175374	5.243964
	115 31 19.351	470.3	111 07 57.3	289 59 29.4	Tolyabe Dome	170384	5.231428
			169 56 36.3	349 45 26.5	Diamond Peak	145640	5.163281

[1] No check on this position.

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Mount Irish, 1881–83	37 38 41.93	1292.7	173 18 19.3	353 14 36.5	White Pine	75402.9	4.877388
	115 24 02.93	71.8	212 14 22.4	32 54 49.9	Wheeler Peak	176648	5.247109
			251 54 04.4	72 43 43.1	Pioche	124720	5.095936
Duckwater cairn, 1881	38 54 36.238	1117.4	5 53 30.8	185 50 37.0	White Pine	65885.2	4.8187880
	115 25 26.384	635.7	87 40 44.9	266 28 07.9	Toiyabe Dome	167571.7	5.2242008
			124 28 43.3	303 30 42.4	Mount Callahan	158768.0	5.2007629
			155 42 55.6	335 27 58.1	Diamond Peak	82315.1	4.9154796
			264 38 34.6	85 20 28.2	Wheeler Peak	96656.6	4.9852317
Mount Hamilton, 1880	39 13 58.012	1789.1	358 03 22.9	178 04 51.5	White Pine	101423.6	5.006139
	115 32 26.379	632.7	74 46 30.9	253 38 03.1	Toiyabe Dome	163029.1	5.212265
			114 01 52.7	293 08 06.9	Mount Callahan	132343.0	5.121701
			148 41 01.3	328 30 27.3	Diamond Peak	45847.9	4.661319
Bullwhacker, 1898	39 31 28.408	876.1	245 44 28.9	65 51 08.8	Diamond Peak	16436.7	4.215815
	115 59 32.906	786.0	3 34 51.9	183 34 38.1	Prospect Peak	8290.6	3.918585
Desert, 1898	39 34 37.016	1141.6	266 54 32.4	87 02 18.0	Diamond Peak	17462.8	4.242114
	116 01 15.657	373.7	337 07 21.2	157 08 26.7	Bullwhacker	6312.9	3.800226
			352 09 53.9	172 10 45.5	Prospect Peak	14223.6	4.153010
Richmond, 1898	39 30 30.354	936.1	29 52 08.6	209 50 29.6	Prospect Peak	7476.2	3.873683
	115 57 18.843	450.2	119 13 12.3	299 11 47.0	Bullwhacker	3668.9	3.564539
Leo, 1898	39 31 00.855	26.4	24 50 33.9	204 49 02.3	Prospect Peak	8181.0	3.912804
	115 57 30.815	736.1	106 15 20.2	286 14 02.5	Bullwhacker	3037.5	3.482521
			343 05 13.8	163 05 21.4	Richmond	983.2	2.992630
Tank, 1898	39 30 42.745	1318.2	225 45 09.6	45 45 24.9	Leo	800.5	2.903352
	115 57 54.820	1309.6	293 58 02.0	113 58 24.9	Richmond	940.6	2.973407
Eureka courthouse, 1898	39 30 45.430	1401.0	78 46 51.5	258 46 40.4	Tank	425.6	2.629007
	115 57 37.345	892.1	198 09 10.6	18 09 14.8	Leo	500.6	2.699511
			316 26 53.1	136 27 04.9	Richmond	641.5	2.807207
Eureka Catholic Church, 1898	39 30 46.190	1424.5	63 06 38.8	243 06 33.2	Tank	234.9	2.370889
	115 57 46.050	1100.1	218 49 15.7	38 49 25.4	Leo	580.5	2.763817
			306 55 05.8	126 55 23.1	Richmond	813.0	2.910091
Eureka longitude, 1889	39 30 48.342	1490.8	60 43 36.4	240 43 32.1	Eureka courthouse	183.6	2.263973
	115 57 30.639	731.9	73 21 54.0	253 21 38.6	Tank	602.9	2.780243
			79 46 53.1	259 46 43.3	Eureka Catholic Church	374.1	2.572973
			179 22 30.0	359 22 29.9	Leo	385.9	2.586507
Broken Back King summit monument, 1880.	39 22 37.265	1149.2	52 12 10.1	231 38 26.7	Toiyabe Dome	97923.1	4.990885
	116 27 40.611	972.0	131 28 05.9	311 09 25.4	Mount Callahan	55952.2	4.747817
			247 07 25.7	67 31 58.1	Diamond Peak	59977.9	4.777991
Prospect Peak, 1880	39 27 00.103	3.2	60 05 32.4	239 14 15.6	Toiyabe Dome	135620.7	5.132326
	115 59 54.563	1304.6	109 43 35.0	289 07 12.1	Mount Callahan	86700.4	4.938021
			225 53 19.6	46 00 13.0	Diamond Peak	21591.1	4.334275
Sharp Peak, 1880	39 08 48.770	1504.1	70 17 35.1	249 35 59.6	Toiyabe Dome	101613.9	5.006953
	116 15 02.447	58.8	136 16 32.8	315 49 53.5	Mount Callahan	86788.3	4.938461
			217 19 07.3	37 35 35.2	Diamond Peak	61308.5	4.787521
			324 24 25.7	144 52 33.6	White Pine	112596.8	5.051526
Smoky Valley, southwest summit, 1880.	39 00 55.958	1725.7	65 57 56.6	245 38 20.5	Toiyabe Dome	49438	4.694065
	116 49 56.631	1362.4	172 32 02.0	352 27 33.1	Mount Callahan	77733	4.890608
			233 49 06.3	54 27 39.3	Diamond Peak	107964	5.033279
			303 16 45.8	124 06 39.9	White Pine	139237	5.143756
Smoky Valley, northeast summit, 1880.	39 02 05.485	169.1	65 45 42.2	245 24 14.4	Toiyabe Dome	54207	4.734058
	116 46 59.331	1427.0	169 10 42.2	349 04 20.8	Mount Callahan	76294	4.882490
			233 24 48.0	54 01 29.2	Diamond Peak	103259	5.013927
			305 02 23.7	125 50 27.6	White Pine	136912	5.136441
Monitor, 1881	38 49 10.763	331.9	42 04 16.29	221 30 35.60	Lone Mountain	118356.1	5.0731906
	116 35 26.210	632.3	91 31 18.35	271 02 38.94	Toiyabe Dome	66169.6	4.8206587
			162 40 43.71	342 27 04.43	Mount Callahan	103571.7	5.0152410
			217 53 40.51	38 22 58.49	Diamond Peak	108062.2	5.0336738
			299 58 22.76	120 39 07.70	White Pine	109965.7	5.0412572
Hot Creek, north summit, 1881	38 37 51.249	1580.3	200 43 29.2	21 01 09.8	Diamond Peak	113387.7	5.054566
	116 17 06.318	152.8	256 25 10.4	77 39 19.4	Wheeler Peak	175748.3	5.244891
			296 33 25.5	117 02 41.0	White Pine	76625.6	4.884374
Mount Jefferson, north summit monument, 1879.	38 47 45.284	1396.3	81 49 07.9	260 39 14.0	Mount Grant	164086.7	5.2150733
	116 55 36.996	892.8	96 29 28.3	276 13 28.2	Toiyabe Dome	37181.2	4.5703230
			178 52 29.2	358 51 36.2	Mount Callahan	101469.4	5.0063350
			227 12 08.0	47 54 10.6	Diamond Peak	129834.3	5.1133894
Mount Jefferson, middle summit, 1880.	38 46 16.505	508.9	291 21 02.3	112 14 47.7	White Pine	134987.5	5.1302934
	116 56 20.398	492.4	30 29 32.3	210 08 51.7	Lone Mountain	96004.2	4.9822900
			100 56 10.8	280 40 38.2	Toiyabe Dome	36560.0	4.5630058
			129 15 01.6	308 25 54.7	Carson Sink	143753.9	5.1576198
Mount Jefferson, south summit, 1879.	38 45 06.8	209.7	103 48 25	283 32 24	Toiyabe Dome	38088	4.580792
	116 55 35.1	847.5	225 38 48	46 20 48	Diamond Peak	133170	5.124408
			290 40 08	111 33 24	White Pine	133197	5.124495
			31 43 44	211 22 36	Lone Mountain	94729	4.976484
			83 30 58	262 21 05	Mount Grant	163508	5.213538

GEOGRAPHIC POSITIONS—Continued

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Toquema, 1880	38 40 12.453	384.0	286 32 04.2	107 26 35.9	White Pine	133139.4	5.1243065
	116 57 39.072	944.6	33 11 58.1	212 52 07.7	Lone Mountain	85462.4	4.9317751
			118 05 59.6	297 51 17.3	Toiyabe Dome	38541.4	4.5859274
Lyon, south summit, 1880–81	38 17 21.887	674.8	72 58 19.0	252 18 33.4	Lone Mountain	98491.4	4.9933982
	116 25 16.472	400.3	126 55 10.2	306 20 20.6	Toiyabe Dome	101132.9	5.0048926
			267 19 36.3	87 53 48.9	White Pine	80534.4	4.9059814
Kawich Peak, 1880–81	37 57 43.052	1327.3	94 42 14.6	274 04 05.8	Lone Mountain	90988.6	4.9589870
	116 27 39.620	967.3	141 25 42.7	320 52 29.5	Toiyabe Dome	124144.6	5.0939278
			244 26 28.6	65 02 02.3	White Pine	93027.9	4.9686134
Montezuma Peak, 1879–1881	37 41 41.99	1294.5	128 14 24.1	307 21 27.0	Mount Grant	158579	5.200246
	117 21 41.56	1018.1	162 23 46.0	342 18 53.8	Lone Mountain	38396	4.584283
			180 21 36.7	0 21 57.1	Toiyabe Dome	126321	5.101474
Butler, 1902	38 03 02.463	75.9	82 55 22.6	262 45 41.3	Lone Mountain	23185.3	4.365213
	117 13 54.294	1323.8					
Bradford, 1902	38 08 43.821	1351.2	5 14 03.9	185 13 39.5	Butler	10568.8	4.024024
	117 13 14.747	359.1	60 50 09.6	240 40 03.3	Lone Mountain	27453.0	4.438599
Booker, 1902	38 05 57.986	1788.0	36 21 21.9	216 19 41.2	Butler	6718.5	3.827271
	117 11 10.945	266.6	149 28 46.0	329 27 29.6	Bradford	5936.1	3.773502
Oddie, 1902	38 04 22.362	689.5	20 34 00.6	200 33 37.2	Butler	2631.1	3.420133
	117 13 16.385	399.4	77 28 26.8	257 18 21.6	Lone Mountain	24516.9	4.389465
			180 16 59.7	0 17 00.8	Bradford	8061.4	3.906412
			226 01 34.4	46 02 51.8	Booker	4247.0	3.628085
Tonapah astronomic, 1902	38 04 08.546	263.5	246 05 22.0	66 05 46.3	Oddie	1051.1	3.021649
	117 13 55.808	1360.4	358 57 44.9	178 57 45.8	Butler	2037.8	3.309161
Tonopah north meridian, 1902	38 04 44.665	1377.2	305 45 11.0	125 35 35.3	Oddie	1181.6	3.072462
	117 13 55.808	1360.3	359 19 44.8	179 19 45.7	Butler	3151.3	3.498489
			0 00 00.0	180 00 00.0	Tonopah astronomic	1113.6	3.046738
Golden, 1902	38 03 46.914	1446.6	54 29 33.8	234 28 45.2	Butler	2359.3	3.372777
	117 12 35.524	866.0	108 49 33.9	288 48 44.4	Tonopah astronomic	2067.6	3.315459
			137 39 35.8	317 39 10.6	Oddie	1478.7	3.169878
			207 01 04.8	27 01 56.9	Booker	4536.6	3.656726
Tonopah southeast base, 1902	38 03 30.833	950.7	162 41 25.8	342 41 13.3	Oddie	1664.1	3.221184
	117 12 56.071	1367.0	225 17 26.0	45 17 38.7	Golden	704.8	2.848056
Tonopah northwest base, 1902	38 03 42.306	1304.5	41 29 35.4	221 29 07.9	Butler	1639.9	3.214818
	117 13 09.732	237.2	172 31 14.0	352 31 09.9	Oddie	1245.6	3.095383
			260 19 40.1	80 20 01.2	Golden	845.9	2.927338
			316 43 24.2	136 43 32.6	Tonopah southeast base	485.84	2.686493
Davis, 1902	38 02 51.881	1599.7	95 48 51.3	275 47 30.1	Butler	3226.8	3.508775
	117 11 42.628	1039.4	140 40 47.2	320 39 49.4	Oddie	3606.5	3.557080
			142 46 05.7	322 45 33.1	Golden	2131.2	3.328628
			187 39 45.2	7 40 04.8	Booker	5789.7	3.762655
Douglas, 1902	37 59 59.544	1835.7	96 09 28.1	275 58 34.5	Lone Mountain	26026.2	4.415411
	117 11 56.728	1384.1	153 03 34.2	333 02 21.8	Butler	6326.8	3.801185
			173 17 48.7	353 17 00.6	Bradford	16275.9	4.211545
			183 42 06.7	3 42 15.4	Davis	5324.6	3.726285
			185 45 49.9	5 46 18.2	Booker	11107.6	4.045622
Lothrop, 1902	38 01 39.863	1229.2	40 59 22.8	220 58 15.0	Douglas	4097.0	3.612471
	117 10 06.584	160.6	114 39 26.1	294 37 05.8	Butler	6109.0	3.785967
			133 28 49.6	313 27 50.4	Davis	3227.4	3.508850
			168 51 10.9	348 50 31.3	Booker	8111.6	3.909105
Ralston, 1902	38 00 38.967	1201.5	76 09 01.2	256 06 56.9	Douglas	5071.5	3.705133
	117 08 34.912	851.7	130 01 35.7	310 00 39.2	Lothrop	2919.8	3.465352
Cutting, 1902	37 59 15.706	484.2	105 58 52.8	285 56 53.6	Douglas	4914.1	3.691445
	117 08 43.102	1051.8	155 23 19.9	335 22 28.3	Lothrop	4889.0	3.689221
			184 27 01.8	4 27 06.8	Ralston	2574.8	3.410750
Short, 1902	38 00 12.960	399.6	248 20 19.4	68 21 10.4	Ralston	2173.0	3.337055
	117 09 57.696	1407.6	314 07 01.0	134 07 46.9	Cutting	2535.5	3.404065
Crest, 1902	38 00 04.653	143.5	194 28 20.5	14 28 22.2	Short	264.5	2.422441
	117 10 00.406	9.9	243 05 50.4	63 06 43.1	Ralston	2338.7	3.368980
			308 39 20.0	128 40 07.6	Cutting	2415.6	3.383033
Watch, 1902	38 00 07.103	219.0	60 17 16.7	240 17 13.3	Crest	152.4	2.182975
	117 09 54.980	1341.4	159 51 09.8	339 51 08.1	Short	192.4	2.284095
			312 05 32.9	132 06 17.0	Cutting	2363.7	3.373595
Esmeralda County corner stone, 1902.	38 00 07.283	224.6	70 40 22	250 40 22	Watch	16.806	1.22546
	117 09 54.330	1325.5	138 51 47.4	318 13 20.0	Hot Spring	135852.8	5.1330685
Toiyabe Peak, 1880	39 21 35.275	1087.9	22 25 49.5	202 15 18.7	Toiyabe Dome	63228.5	4.800913
	117 04 28.411	680.4	60 02 44.2	238 57 58.8	Mount Grant	172616.4	5.237082
			195 20 58.6	15 25 43.6	Mount Callahan	40295.2	4.605253
			256 33 59.1	77 21 54.7	Diamond Peak	110981.1	5.045249

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Shoshone Peak, north, 1880	39 09 02.762	85.2	60 54 50.7	240 05 28.5	Mount Grant	130777.8	5.116534
	117 28 45.574	1094.4	126 39 30.0	306 10 45.0	Carson Sink	80902.0	4.907959
			216 07 03.5	36 27 13.4	Mount Callahan	76984.8	4.886405
			342 38 44.8	162 43 32.3	Tolyabe Dome	36950.4	4.567619
Shoshone Peak, south, 1880	39 03 24.100	743.2	323 58 08.3	144 05 58.6	Tolyabe Dome	30681.3	4.486874
	117 33 36.864	886.3	63 36 03.0	242 49 46.4	Mount Grant	119718.4	5.078161
			135 21 50.4	314 56 11.7	Carson Sink	82478.0	4.916338
Tolyabe Range Peak, 1880	38 56 11.97	369.1	21 12 19.0	201 10 42.0	Tolyabe Dome	10357.0	4.015235
	117 18 33.30	802.3	73 42 32.2	252 46 54.6	Mount Grant	134505.2	5.128739
			132 57 54	312 22 46	Carson Sink	108657.6	5.036060
Tolyabe Range Peak,[1] cairn, 1880	39 06 55.86	1725.7	22 11 02	202 05 28	Tolyabe Dome	33862.1	4.529714
	117 12 18.55	445.7	198 19 51	18 29 34	Mount Callahan	69525.3	4.842143
Toiyabe Dome, southeast summit, 1880.	38 47 53.37	1645.7	234 20 26	55 14 47	Diamond Peak	151554.9	5.180570
	117 15 04.98	120.1	288 39 07	109 44 34	White Pine	161521.7	5.208231
			13 55 37	193 46 35	Lone Mountain	88431.9	4.946609
Bunker Hill, cairn, 1880	39 15 11.538	355.8	22 54 53.4	202 46 18.7	Toiyabe Dome	50618.3	4.704308
	117 07 31.514	755.7	62 50 41.9	241 47 56.0	Mount Grant	163103.8	5.212464
			111 20 42.2	290 38 26.3	Carson Sink	102322.2	5.009970
			196 30 40.5	16 37 21.6	Mount Callahan	52878.9	4.723282
			251 27 19.1	72 17 07.8	Diamond Peak	118465.3	5.073591
			305 46 56.7	126 47 59.4	White Pine	175075.4	5.243225
Vigus, 1898	39 33 15.109	465.9	227 23 14.6	47 31 37.9	Mount Callahan	25539.0	4.407203
	117 10 09.657	230.6	339 15 45.2	159 19 22.1	Toiyabe Peak	23073.1	4.363106
Mount Prometheus or Lander Hill, 1880.	39 29 46.801	1443.2	9 43 58.1	189 42 49.2	Toiyabe Peak	15379.3	4.186936
	117 02 39.813	951.3	120 54 56.2	300 50 09.9	Vigus	12518.4	4.097550
			198 49 38.3	18 53 14.5	Mount Callahan	24522.4	4.389563
South Hill, 1898	39 29 13.950	430.3	131 20 06.7	311 16 21.2	Vigus	11267.8	4.051838
	117 04 15.285	365.3	246 02 48.1	66 03 48.8	Mount Prometheus	2496.2	3.397288
			1 16 21.0	181 16 12.7	Toiyabe Peak	14148.7	4.150717
North Hill, 1898	39 29 57.837	1783.7	2 21 05.2	182 20 48.4	Toiyabe Peak	15511.8	4.190661
	117 04 01.826	43.6	13 22 04.5	193 21 56.0	South Hill	1391.2	3.143380
			124 44 06.6	304 40 12.6	Vigus	10686.2	4.028822
			279 50 46.0	99 51 38.2	Mount Prometheus	1989.0	3.298625
Union, 1898	39 29 11.345	349.8	94 42 14.3	274 41 48.3	South Hill	980.6	2.991510
	117 03 34.389	821.9	155 25 46.8	335 25 29.3	North Hill	1576.6	3.197731
			230 06 59.5	50 01 34.2	Mount Prometheus	1701.9	3.230935
Reservoir, 1898	39 29 35.207	1085.8	29 15 03.9	209 14 54.1	South Hill	751.3	2.875835
	117 03 59.923	1432.0	176 16 18.1	356 16 16.8	North Hill	699.4	2.844741
			320 20 00.1	140 20 16.3	Union	956.0	2.980442
Austin longitude eccentric, 1898	39 29 32.650	1006.9	197 21 46.5	17 21 52.9	North Hill	813.9	2.910549
	117 04 11.991	286.4	254 42 40.8	74 42 48.5	Reservoir	299.0	2.475613
			306 10 20.1	126 10 44.0	Union	1113.2	3.046570
Austin longitude, 1889	39 29 32.59	1005.1	250 41	70 41	Austin longitude eccentric	5.56	0.74507
	117 04 12.21	291.7					
Wheeler Stone, U. S. E., 1898	39 29 21.081	650.1	28 33 20.0	208 33 16.7	Union	341.8	2.533821
	117 03 27.551	658.4	79 05 34.2	259 05 04.9	South Hill	1161.7	3.065103
			119 23 21.1	299 23 01.6	Reservoir	887.8	2.948314
Austin courthouse flagstaff, 1898	39 29 32.38	998.6	196 43 28	16 43 34	North Hill	819.9	2.91377
	117 04 11.70	279.6	306 01 49	126 02 13	Union	1102.6	3.04243
Austin Catholic Church spire, 1898	39 29 36.85	1136.4	279 42 18	99 42 26	Reservoir	299.7	2.47673
	117 04 12.29	293.7	356 52 33	176 52 33	Austin longitude eccentric	129.5	2.11243
Austin Methodist Church spire	39 29 31.89	983.5	188 37 37	8 37 40	North Hill	809.4	2.90818
	117 04 06.91	165.1	309 11 14	129 11 35	Union	1002.7	3.00115
Austin Episcopal Church spire, 1898	39 29 28.42	876.4	189 33 21	9 33 25	North Hill	920.0	2.96378
	117 04 08.22	196.5	303 04 43	123 05 05	Union	964.8	2.98445
Roberts Creek, 1880	39 52 12.925	398.6	306 43 30.1	127 02 21.9	Diamond Peak	52723.2	4.722002
	116 18 35.762	849.9	337 37 42.0	158 08 17.8	White Pine	185810.0	5.269069
			3[illegible] 17 49.9	217 38 10.2	Toiyabe Dome	146063.9	5.164543
			72 12 01.7	251 47 26.6	Mount Callahan	57665.1	4.760913
			79 41 33.1	258 27 44.2	Carson Sink	168066.4	5.225481
Mount Lewis, 1880	40 24 13.25	408.8	315 14 38	135 54 51	Diamond Peak	127229	5.104586
	116 51 38.72	913.0	5 41 03	185 37 36	Mount Callahan	77430	4.888907
			13 45 58	193 27 10	Toiyabe Dome	179422	5.253875
Granite Peak, summit, south end, 1880.	40 22 36.653	1130.6	300 31 29.9	121 37 19.5	Diamond Peak	170273.9	5.231148
	117 31 31.432	741.5	326 16 51.7	146 39 04.0	Mount Callahan	88863.0	4.948721
			354 59 25.3	175 06 02.4	Toiyabe Dome	172048.1	5.235650
			34 44 53.7	214 17 32.9	Carson Sink	106923.7	5.029074
Star Peak, 1879	40 31 22.011	678.9	310 33 56.9	131 21 06.7	Mount Callahan	137713.7	5.138977
	118 10 12.323	290.1	339 14 06.9	159 45 26.5	Toiyabe Dome	200295.0	5.301670
			3 02 55.7	183 00 25.8	Carson Sink	104448.9	5.018904

[1] No check on this position.

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
	° ′ ″		° ′ ″	° ′ ″		Meters.	
Supplementary points—Continued.							
North Augusta, 1880	39 41 08.510	262.4	267 38 45.7	88 11 31.1	Mount Callahan	73471.8	4.866121
	117 48 22.386	533.5	337 22 39.1	157 39 53.0	Toiyabe Dome	102448.1	5.010504
			72 58 47.4	252 42 23.3	Carson Sink	38502.4	4.585488
Fairview, cairn, 1880	39 13 31.450	969.9	37 31 44.6	217 07 40.3	Mount Grant	91402.8	4.9609595
	118 09 06.612	158.6	169 50 24.1	349 47 14.6	Carson Sink	40381.5	4.6061825
			301 55 43.9	122 25 56.2	Toiyabe Dome	81791.0	4.9127055
			336 31 47.2	156 56 26.0	Lone Mountain	145085.5	5.1616241
Mount Lincoln, peak, 1880	39 32 59.137	1823.8	212 25 44.2	32 26 47.5	Carson Sink	4425.0	3.645912
	118 15 44.525	1063.0	315 03 28.0	135 37 58.1	Toiyabe Dome	111857.2	5.048664
			22 59 07.7	202 39 09.1	Mount Grant	117920.7	5.071590
Carson Table, summit, 1880	39 32 30.34	935.7	229 42 58.5	49 45 24.1	Carson Sink	7152.5	3.854459
	118 17 53.73	1283.0	313 36 55.2	134 12 46.8	Toiyabe Dome	113443.3	5.054779
			21 43 48.6	201 25 11.5	Mount Grant	115925.5	5.064179
			105 56 36.6	285 11 35.8	Pah-Rah	104687.3	5.019894
Augusta, monument, 1878	39 32 25.167	776.1	35 18 40.6	214 45 42.8	Mount Grant	131465.7	5.1188124
	117 55 07.696	183.8	100 05 22.2	279 53 17.8	Carson Sink	27569.9	4.4404349
			102 27 16.9	281 27 44.1	Pah-Rah	136366.4	5.1347074
			256 56 55.9	77 33 59.8	Mount Callahan	85267.1	4.9307815
			327 53 19.7	148 14 48.1	Toiyabe Dome	92525.4	4.9662608
Desatoiya, 1879	39 21 55.959	1725.8	45 43 16.1	225 04 18.9	Mount Grant	125659.1	5.099194
	117 45 30.306	725.5	120 41 47.8	300 23 37.6	Carson Sink	47591.0	4.677525
			240 56 05.8	61 26 58.0	Mount Callahan	79297.4	4.899259
			329 09 24.4	149 24 46.2	Toiyabe Dome	68766.7	4.837378
			351 07 29.3	171 17 24.9	Lone Mountain	150618.4	5.177878
Desatoiya, north twin, 1879	39 22 10.740	331.2	45 33 19.5	224 54 23.6	Mount Grant	125940.1	5.100164
	117 45 32.527	778.7	120 15 15.3	299 57 06.5	Carson Sink	47314.0	4.674990
			241 14 30.3	61 45 24.0	Mount Callahan	79123.4	4.898305
			261 13 38.4	82 27 41.1	Diamond Peak	168712.4	5.227147
Wassack, 1879	38 47 04.532	139.8	153 59 56.39	333 35 37.87	Pah-Rah	125001.09	5.0969138
	118 50 01.542	37.2	210 04 49.55	30 27 32.06	Carson Sink	102678.84	5.0114810
			267 08 39.72	88 04 22.10	Toiyabe Dome	128784.01	5.1098619
			351 01 23.19	171 03 00.02	Mount Grant	24039.63	4.3809278
Sherman Peak, 1879–80	38 56 13.790	425.2	346 23 23.5	166 33 48.9	Lone Mountain	104179.6	5.0177828
	117 46 22.716	547.1	65 37 25.6	244 59 12.1	Mount Grant	97375.3	4.9884488
			151 05 32.9	330 48 00.9	Carson Sink	82070.7	4.9141879
Paradise Peak, cairn, 1879–80	38 48 25.733	793.5	265 51 41.1	86 09 30.3	Toiyabe Dome	41246.8	4.6153898
	117 49 34.244	826.2	341 24 57.7	161 37 21.2	Lone Mountain	91580.8	4.9618044
			72 55 57.3	252 19 46.9	Mount Grant	87930.5	4.9441397
			157 51 21.3	337 35 51.8	Carson Sink	93124.9	4.9690656
Pilot Cone or Basalt, cairn, 1878–1880	38 59 19.447	599.6	280 04 51.0	100 45 41.5	Toiyabe Dome	95573.2	4.9803360
	118 26 09.952	239.5	33 41 44.6	213 28 25.0	Mount Grant	55707.3	4.7459122
			92 39 27.8	272 00 17.9	Mount Como	89912.5	4.9538200
			194 40 44.3	14 48 23.3	Carson Sink	68266.1	4.8342049
Mill, 1902	38 57 47.314	1458.9	98 55 58.6	278 48 02.7	Basalt	18432.1	4.265574
	118 13 33.388	803.8					
Hot Spring, 1902	38 55 09.407	290.1	110 22 11.9	290 13 07.5	Basalt	22230.2	4.346944
	118 11 44.044	1061.0	151 36 16.7	331 35 08.0	Mill	5535.8	3.743182
Miller, 1902	38 53 29.527	910.4	119 49 42.1	299 41 29.6	Basalt	21738.7	4.337233
	118 13 06.371	153.5	175 19 19.7	355 19 02.7	Mill	7975.9	3.901780
			212 46 38.5	32 47 30.2	Hot Spring	3663.5	3.563896
Mount Annie, 1902	38 58 31.472	970.4	37 04 55.2	217 01 51.6	Miller	11667.3	4.066971
	118 08 14.470	348.3	39 01 26.4	218 59 14.7	Hot Spring	8018.5	3.904093
			79 58 14.0	259 54 53.4	Mill	7797.4	3.891952
			93 21 53.5	273 10 36.9	Basalt	25928.7	4.413780
Hot Spring west base, 1902	38 56 23.729	731.7	179 01 20.2	359 01 19.1	Mill	2577.9	3.411263
	118 13 31.561	760.0	242 40 51.3	62 44 10.9	Mount Annie	8591.2	3.934053
			311 29 52.0	131 30 59.6	Hot Spring	3458.3	3.538859
			353 33 07.6	173 33 23.5	Miller	5406.0	3.732873
Hot Spring east base, 1902	38 56 13.478	415.6	12 28 55.6	192 28 26.5	Miller	5178.0	3.714163
	118 12 19.934	480.0	100 23 23.7	280 22 38.7	Hot Spring west base	1753.82	3.243985
			148 34 11.0	328 33 24.8	Mill	3391.4	3.530381
			336 21 51.8	156 22 14.4	Hot Spring	2156.6	3.333771
Churchill, 1902	39 02 36.668	1130.8	316 25 39.6	136 29 21.4	Mill	12309.5	4.090239
	118 19 25.794	620.3	321 05 47.2	141 10 37.7	Hot Spring	17713.0	4.248293
			331 32 09.8	151 36 08.1	Miller	19186.1	4.282986
			58 00 36.7	237 56 22.3	Basalt	11468.6	4.059512
Mount Grant, highest peak, 1902	38 34 07.850	242.0	213 19 46.9	33 33 05.6	Basalt	55858.1	4.747086
	118 47 25.184	609.7	228 04 50.3	48 26 02.9	Mill	65741.6	4.817840
			232 51 34.3	53 13 54.3	Hot Spring	64707.1	4.810952
			234 03 20.4	54 24 48.5	Miller	61287.6	4.787373

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Cory Peak or Mount Hull, summit, 1879.	38 26 54.263	1673.1	200 25 56.6	20 46 36.2	Carson Sink	134608.9	5.1290739
	118 46 54.096	1311.8	227 57 51.7	49 07 08.6	Mount Callahan	211472.1	5.3252531
			250 37 08.4	71 30 41.5	Tolyabe Dome	131559.5	5.1191224
			292 14 36.3	113 02 25.9	Lone Mountain	122173.8	5.0869780
Volcano, 1879	38 23 44.08	1359.2	305 03 24	125 28 04	Lone Mountain	71314	4.853177
	118 09 31.09	754.5	109 36 35	289 12 59	Mount Grant	58477	4.766986
			235 05 09	55 35 20	Tolyabe Dome	85374	4.931324
Two Tips, north summit, 1878	39 43 01.227	37.8	19 03 20.6	198 51 38.0	Mount Como	81622.5	4.911810
	119 09 55.873	1330.8	108 13 31.4	288 01 42.3	Pah-Rah	27774.3	4.443643
			280 13 19.2	100 48 57.4	Carson Sink	81253.5	4.909842
Mucca or Elephant Peak, 1879	39 58 35.137	1083.7	288 10 23.9	109 08 18.9	Carson Sink	136406.5	5.134835
	119 44 36.027	854.9	331 55 11.0	152 31 22.0	Mount Grant	176388.0	5.246469
			347 33 02.1	167 43 20.6	Mount Como	108514.8	5.035489
Pond Summit, monument, 1879	39 39 09.079	280.0	176 43 51.2	356 43 27.0	Pah-Rah	15826.6	4.199389
	119 27 46.758	1114.8	273 46 12.2	94 33 11.8	Carson Sink	105747.2	5.024269
			295 51 48.0	117 11 55.2	Tolyabe Dome	203655.0	5.308895
			333 57 13.7	154 22 40.6	Mount Grant	133435.4	5.125271
Virginia Peak, monument, 1878	39 45 21.628	667.0	165 25 02.3	345 24 32.1	Pah-Rah	4454.7	3.648822
	119 27 37.550	893.9	279 56 07.8	100 43 04.5	Carson Sink	106902.0	5.028986
			336 02 41.6	156 28 04.2	Mount Grant	143757.6	5.157631
Sage, 1879	39 07 42.324	1305.2	244 16 21.7	65 03 27.4	Carson Sink	118037.5	5.072020
	119 28 20.987	504.1	316 04 36.5	136 30 16.1	Mount Grant	85653.1	4.932743
			0 18 23.2	180 18 21.5	Mount Como	11849.8	4.073712
			41 46 30.6	221 26 37.4	Round Top	68957.1	4.838579
Galena Saddle, 1879	38 53 24.068	742.1	60 05 27.1	239 46 42.4	Round Top	50086.2	4.699718
	119 30 05.376	129.6	189 30 25.7	9 31 29.6	Mount Como	14820.3	4.170858
			234 27 42.2	55 15 46.8	Carson Sink	133741.1	5.126265
			271 16 08.1	92 37 02.7	Toiyabe Dome	186638.8	5.271002
			299 36 50.6	120 03 31.5	Mount Grant	71250.7	4.852789
Freel Peak, 1893	38 51 28.456	877.4	22 11 30.64	202 07 43.28	Round Top	23244.72	4.3663244
	119 53 57.980	1398.0	147 58 18.55	327 40 41.98	Mount Lola	75474.16	4.8777983
			243 40 06.69	63 56 11.04	Mount Como	41183.83	4.6147267
Rose Knob, 1893	39 17 25.836	796.8	351 37 41.62	171 40 46.37	Freel Peak	48539.62	4.6860964
	119 58 51.080	1224.1	1 23 41.26	181 22 57.20	Round Top	69573.68	4.8424450
			115 45 15.32	295 30 39.77	Mount Lola	36657.70	4.5641652
Rubicon Point, 1893	38 59 58.883	1815.6	197 01 22.39	17 05 42.83	Rose Knob	33771.56	4.5285511
	120 05 43.631	1049.9	312 44 18.44	132 51 41.84	Freel Peak	23165.81	4.3648476
Observatory Point, 1893	39 11 13.437	414.4	220 33 12.51	40 37 32.03	Rose Knob	15122.84	4.1796334
	120 05 41.358	992.6	335 05 31.61	155 12 54.47	Freel Peak	40268.74	4.6049680
			0 09 02.46	180 09 01.02	Rubicon Point	20801.64	4.3180976
Genoa Peak, 1893	39 02 36.137	1114.5	4 31 18.84	184 30 36.38	Freel Peak	20653.22	4.3149877
	119 52 50.448	1213.2	75 27 18.24	255 19 11.43	Rubicon Point	19221.58	4.2837892
			130 48 24.00	310 40 17.65	Observatory Point	24443.62	4.3881655
Hot Spring Mountain, 1897	39 03 58.888	1816.1	33 52 12.53	213 45 27.72	Freel Peak	27852.11	4.4448581
	119 43 14.210	341.6	79 36 54.08	259 30 51.01	Genoa Peak	14088.63	4.1488688
Folsom Peak, 1893	38 59 09.518	293.5	96 54 31.33	276 49 00.63	Rubicon Point	12739.44	4.1051504
	119 56 58.068	1397.6	150 38 58.86	330 33 28.93	Observatory Point	25622.83	4.4086271
			223 03 15.90	43 05 51.77	Genoa Peak	8722.75	3.9406533
			343 00 55.57	163 02 48.71	Freel Peak	14864.74	4.1721573
Anderson, 1897	38 58 27.953	861.9	57 45 15.26	237 36 22.12	Freel Peak	24195.19	4.3837290
	119 39 49.279	1186.3	112 13 26.01	292 05 14.31	Genoa Peak	20293.73	4.3073620
			154 14 00.09	334 11 51.07	Hot Spring Mountain	11333.49	4.0543636
Mount Rose or Washoe Peak, 1893	39 20 38.952	1201.3	312 53 00.01	133 09 49.74	Mount Como	52468.75	4.7199007
	119 55 01.797	43.0	331 06 17.04	151 13 44.30	Hot Spring Mountain	35204.44	4.5465974
			354 35 45.57	174 37 08.57	Genoa Peak	33540.36	4.5255678
			42 42 18.76	222 39 53.50	Rose Knob	8101.66	3.9085740
			104 33 27.24	284 16 25.69	Mount Lola	39776.86	4.5996305
Overlook, 1897	39 09 14.204	438.0	307 23 27.95	127 29 01.41	Hot Spring Mountain	15995.51	4.2039982
	119 52 02.831	68.0	5 19 46.60	185 19 16.57	Genoa Peak	12328.64	4.0909151
			168 31 41.72	348 29 48.50	Mount Rose	21548.14	4.3334099
Mount Davidson flagstaff, 1897	39 18 30.756	948.5	10 34 12.62	190 32 00.76	Hot Spring Mountain	27349.17	4.4369442
	119 39 45.529	1090.8	32 41 19.35	212 33 03.51	Genoa Peak	34951.54	4.5434663
			45 55 17.38	225 47 31.07	Overlook	24643.48	4.3917021
			100 17 31.44	280 07 50.77	Mount Rose	22300.18	4.3483084
Peavine, 1893	39 35 14.157	436.6	323 08 06.03	143 18 20.71	Mount Davidson flagstaff	38634.71	4.5869777
	119 55 52.952	1263.7	327 40 11.57	147 57 36.34	Mount Como	74190.84	4.8703503
			357 24 05.02	177 24 37.54	Mount Rose	27018.61	4.4316630
			7 22 58.57	187 21 05.41	Roso Knob	33220.63	4.5214079
			65 29 11.03	245 12 39.38	Mount Lola	40969.32	4.6124588
			239 26 59.14	59 44 31.79	Pah Rah	45536.45	4.6583592

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Prison Hill, 1897	39 07 36.944	1139.3	0 03 46.7	180 03 46.4	Hot Spring Mountain	6724.3	3.827649
	119 43 13.903	334.0	56 15 05.1	236 09 01.6	Genoa Peak	16675.3	4.222073
			103 19 53.2	283 14 19.3	Overlook	13051.9	4.115675
			144 54 58.5	324 47 30.7	Mount Rose	29492.6	4.469713
			193 54 22.1	13 56 33.8	Mount Davidson flagstaff	20772.8	4.317495
East Peak, 1893	38 56 34.312	1058.2	142 13 37.7	322 12 00.8	Folsom Peak	6056.0	3.782186
	119 54 23.944	576.6	191 23 35.6	11 24 34.5	Genoa Peak	11382.2	4.056225
			229 33 11.0	49 40 12.6	Hot Spring Mountain	21157.6	4.325466
			260 28 34.3	80 37 44.3	Anderson	21349.3	4.329384
			356 12 09.1	176 12 25.4	Freel Peak	9452.2	3.975535
Deadman, 1893	39 06 42.011	1295.6	45 24 21.03	225 18 51.15	Rubicon Point	17692.16	4.2477808
	119 57 00.080	1.9	123 48 56.64	303 43 27.54	Observatory Point	15058.02	4.1777680
			172 22 08.61	352 20 58.45	Rose Knob	20032.18	4.3017281
			351 08 27.21	171 10 21.77	Freel Peak	28510.15	4.4549995
			359 48 04.32	179 48 05.59	Folsom Peak	13953.74	4.1446907
Tallac Peak, 1893	38 54 22.889	705.9	209 20 54.8	29 26 30.8	Deadman	26160.4	4.417644
	120 05 53.748	1295.1	235 32 08.5	55 37 45.3	Folsom Peak	15637.6	4.194171
			287 15 13.5	107 22 42.8	Freel Peak	18071.4	4.256993
			342 24 58.9	162 28 39.8	Round Top	28220.6	4.450566
Carson, capitol dome, 1897			18 53 15.1	198 48 11.3	Freel Peak	35936.7	4.555538
	39 09 51.358	1583.9	316 52 14.4	136 53 56.5	Prison Hill	5678.3	3.754217
	119 45 55.513	1332.6	340 21 48.4	160 23 30.1	Hot Spring Mountain	11539.5	4.062187
			82 37 47.8	262 33 55.9	Overlook	8893.2	3.949060
Genoa flagstaff, 1897	39 00 12.405	382.6	218 14 40.0	38 19 23.7	Prison Hill	17464.1	4.242145
	119 50 43.962	1057.8	237 06 44.8	57 11 28.1	Hot Spring Mountain	12876.0	4.109780
			281 29 46.4	101 36 38.3	Anderson	16082.2	4.206346
Sutro, 1897	39 17 47.965	1479.2	28 25 08.4	208 20 40.2	Prison Hill	21417.1	4.330760
	119 36 09.568	229.3	104 19 32.9	284 17 16.1	Mount Davidson flagstaff	5340.2	3.727556
Cedar Hill, 1897	39 19 26.020	802.4	306 24 20.6	126 26 09.0	Sutro	5093.2	3.706994
	119 39 00.635	15.2	32 15 28.8	212 15 00.4	Mount Davidson flagstaff	2015.3	3.304329
Virginia City astronomic, 1889	39 18 39.641	1222.5	292 30 00.7	112 31 42.4	Sutro	4161.9	3.619287
	119 38 50.028	1198.5	78 21 41.1	258 21 06.0	Mount Davidson flagstaff	1357.6	3.132785
			169 55 38.3	349 55 31.6	Cedar Hill	1452.7	3.162167
Wheeler Monument	39 17 44.784	1381.1	186 10 24.3	6 10 33.2	Cedar Hill	3140.2	3.496961
	119 39 14.733	353.0	268 43 02.0	88 44 59.3	Sutro	4438.2	3.647202
			152 30 23.3	332 30 03.8	Mount Davidson flagstaff	1598.3	3.203650
Virginia City Catholic Church spire, 1897.	39 18 34.068	1050.6	199 04 22.3	19 04 23.8	Virginia City astronomic	181.8	2.259697
	119 38 52.508	1258.0	289 59 45.2	110 01 28.4	Sutro	4155.0	3.618566
			173 04 21.3	353 04 16.1	Cedar Hill	1613.9	3.207882
Verdi Peak, 1897	39 28 22.128	682.4	216 00 36.7	36 04 43.2	Peavine	15715.5	4.196328
	120 02 20.140	481.4	323 40 32.3	143 45 10.6	Mount Rose	17720.4	4.248474
Ranch Hill, 1897	39 30 01.818	56.1	72 46 38.3	252 42 15.0	Verdi Peak	10362.1	4.015447
	119 55 26.064	622.8	176 11 20.8	356 11 03.7	Peavine	9653.9	3.984703
Bender, 1897	39 29 17.956	553.8	75 20 57.8	255 18 02.9	Verdi Peak	6796.2	3.832266
	119 57 45.055	1076.7	193 41 08.9	13 42 20.3	Peavine	11306.7	4.053336
			247 49 38.4	67 51 06.8	Ranch Hill	3586.1	3.554621
Verdi Bluff, 1872	39 31 06.515	200.9	291 53 43.1	111 55 55.2	Ranch Hill	5346.2	3.728045
	119 58 53.680	1282.3	333 54 05.2	153 54 48.9	Bender	3727.8	3.571458
			44 14 14.9	224 12 03.6	Verdi Peak	7073.8	3.849653
North Flat, 1872	39 31 35.895	1107.0	307 50 38.9	127 52 18.3	Ranch Hill	4727.6	3.674637
	119 58 02.314	55.3	354 27 44.1	174 27 55.1	Bender	4273.9	3.630829
			53 33 28.6	233 32 55.9	Verdi Bluff	1525.2	3.183329
Point of Rocks, 1872	39 31 41.224	1271.3	278 24 21.0	98 24 50.6	North Flat	1123.6	3.050607
	119 58 48.852	1166.8	6 08 56.1	186 08 53.0	Verdi Bluff	1076.6	3.032058
Verdi east base, 1872	39 31 06.103	188.2	90 29 54.4	270 29 15.1	Verdi Bluff	1476.5	3.169239
	119 57 51.869	1239.0	128 31 33.6	308 30 27.4	Point of Rocks	1739.4	3.240407
			164 48 33.8	344 48 27.2	North Flat	952.1	2.978664
Verdi west base, 1872	39 30 59.921	1848.0	104 40 41.7	284 40 21.0	Verdi Bluff	802.7	2.904530
	119 58 21.174	505.8	152 34 20.5	332 34 02.9	Point of Rocks	1435.1	3.156884
			202 05 52.6	22 06 04.6	North Flat	1197.4	3.078241
			254 45 46.5	74 46 05.1	Verdi east base	725.510	2.860643
California-Nevada iron monument, 1897.	39 31 29.513	910.2	258 37 27.3	78 38 15.2	Point of Rocks	1832.0	3.262937
	120 00 04.052	96.8	266 07 00.4	86 08 17.9	North Flat	2914.3	3.464535
			292 52 16.7	112 53 01.5	Verdi Bluff	1824.4	3.261125
			320 41 15.4	140 42 43.9	Bender	5242.9	3.719574
			29 22 38.4	209 21 11.9	Verdi Peak	6630.9	3.821572

GEOGRAPHIC POSITIONS—Continued.

Thirty-ninth parallel—Continued.

Station.	Latitude and longitude.	Seconds in meters.	Azimuth.	Back azimuth.	To station.	Distance.	Logarithm.
Supplementary points—Continued.	° ′ ″		° ′ ″	° ′ ″		*Meters.*	
Verdi longitude, 1889	39 31 14.486	446.7	106 24 23.3	286 23 41.3	California-Nevada iron monument.	1641.4	3.215211
	119 58 58.129	1388.5	195 02 26.0	15 02 31.9	Point of Rocks	853.9	2.931383
			243 38 50.5	63 39 26.0	North Flat	1487.7	3.172516
Cone Peak, white flag, 1872	39 27 23.582	727.3	178 03 28.8	358 03 22.6	Verdi Bluff	6879.1	3.837533
	119 58 43.921	1050.1	179 09 02.6	359 08 59.5	Point of Rocks	7946.4	3.900173
			190 16 09.7	10 15 42.8	Verdi east base	6974.3	3.843500
Crystal Peak, flagstaff, 1872	39 31 29.937	923.3	260 08 43.7	80 09 37.1	Point of Rocks	2035.4	3.308660
	120 00 12.818	306.2	266 36 51.7	86 38 14.7	North Flat	3122.4	3.494492
			290 54 21.1	110 55 11.4	Verdi Bluff	2023.6	3.306122
Crystal Peak, mountain top, 1872	39 33 29.938	923.3	288 46 25.7	108 51 01.0	North Flat	10906.9	4.037700
	120 05 14.676	350.4	289 57 48.0	110 01 53.7	Point of Rocks	9804.0	3.991403
			292 43 07.3	112 47 49.2	Verdi east base	11467.0	4.059451
California-Nevada stone monument, 1872.	39 31 34.863	1075.2	266 16 33.2	86 17 53.8	Point of Rocks	3029.2	3.481321
	120 00 55.414	1323.6	269 32 36.9	89 34 27.1	North Flat	4134.5	3.616419
			286 43 25.4	106 44 42.9	Verdi Bluff	3036.3	3.482342
California-Nevada wood monument,[1] 1872.	39 31 33.85	1043.9	265 41 20.0	85 42 40.6	Point of Rocks	3032.0	3.481724
	120 00 55.44	1324.2	286 09 19.7	106 10 37.2	Verdi Bluff	3028.1	3.481165
Lone tree, 1872	39 34 43.398	1338.4	17 19 41.4	197 18 45.6	Verdi east base	7019.7	3.846318
	119 56 24.341	580.9	22 01 57.1	202 00 54.7	North Flat	6237.8	3.795029
			28 04 30.1	208 02 55.0	Verdi Bluff	7579.7	3.879654
Verdi meridian mark, 1872	39 33 47.747	1472.5	359 59 47.8	179 59 47.8	Verdi east base	4985.1	3.697674
	119 57 51.882	1238.5	3 30 23.7	183 30 17.1	North Flat	4073.9	3.610014
			7 41 57.8	187 41 39.2	Verdi west base	5222.8	3.717903
			16 32 06.6	196 31 27.3	Verdi Bluff	5186.7	3.714895
Watertank, brick chimney, 1872	39 31 05.416	167.0	110 19 15.5	290 18 10.1	California-Nevada stone monument.	2616.1	3.417659
	119 59 12.697	303.3	207 16 50.8	27 17 06.0	Point of Rocks	1242.5	3.094304
			240 46 59.5	60 47 44.3	North Flat	1926.1	3.284674
Verdi azimuth mark, 1872	39 32 05.015	154.7	11 41 44.7	191 41 34.7	Verdi east base	1855.3	3.268425
	119 57 36.124	862.8	34 51 35.3	214 51 18.7	North Flat	1094.4	3.039179
			45 45 44.8	225 44 55.5	Verdi Bluff	2585.7	3.412586
Peavine East, cairn, 1897	39 35 23.444	723.0	14 47 32.2	194 46 12.9	Bender	11657.3	4.066600
	119 55 40.509	966.6	36 20 03.8	216 15 49.4	Verdi Peak	16122.0	4.207418
			46 02 20.7	226 02 12.8	Peavine	412.5	2.615457
Reno Congregational Church spire,[1] 1897.	39 30 33.02	1018.3	69 28 40.8	249 25 56.4	Bender	6596.3	3.819300
	119 53 26.54	634.1	158 03 16.0	338 01 42.7	Peavine	9348.5	3.970742
White house, chimney,[1] 1872	39 31 20.24	624.2	76 42 39.9	256 41 52.2	Verdi Bluff	1840.0	3.264822
	119 57 38.71	924.6	111 07 51.1	291 07 06.5	Point of Rocks	1796.0	3.254296
Railway whistle post,[1] 1872	39 31 13.83	426.5	169 36 02.6	349 35 58.5	Point of Rocks	858.9	2.933944
	119 58 42.36	1011.8	234 34 07.0	54 34 32.5	North Flat	1173.9	3.069618

[1] No check on this position.

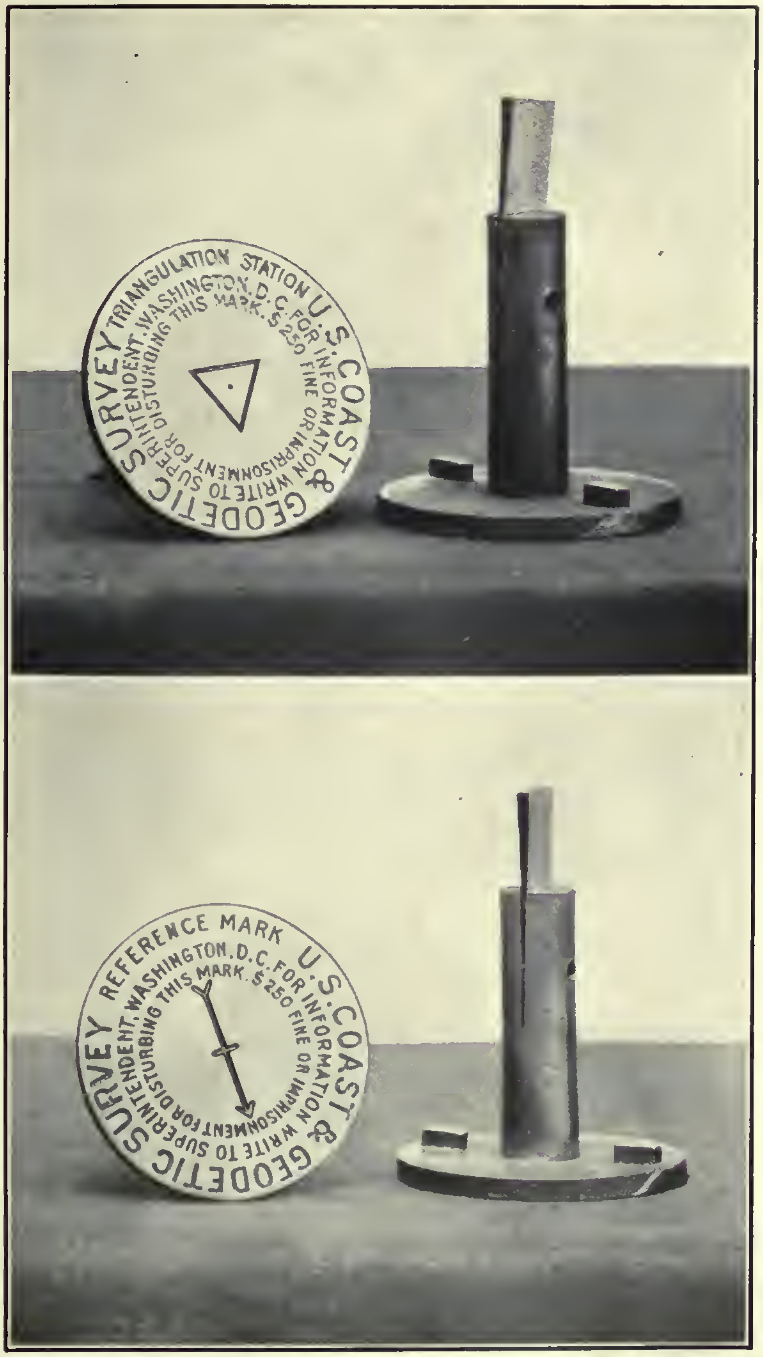
DESCRIPTIONS OF STATIONS.

This list may be conveniently consulted by reference to the illustrations at the end of this publication or to the index. All azimuths given in these descriptions are reckoned continuously from true south around by west to 360°, south being 0°, west 90°, north 180°, and east 270°. Where magnetic azimuths are given they are indicated as such. All distances to reference marks are horizontal distances unless otherwise stated.

In general the surface and underground marks are not in contact, so that a disturbance of the surface mark will not necessarily affect the underground mark. The underground mark should be resorted to only in cases where there is evidence that the surface mark has been disturbed.

The dates and initials given in each description immediately after the county refer to the date of establishment of the station, the man by whom it was established, and the date when the station was last visited.

Any person who finds that one of the stations herein described has been disturbed, or that the description no longer fits the facts, is requested to send such information to the Superintendent, Coast and Geodetic Survey, Washington, D. C.



STANDARD TRIANGULATION STATION AND REFERENCE MARKS.

Marking of stations.—The standard triangulation disk station mark referred to in the following notes and descriptions consists of a disk and shank, as shown in illustration No. 4, made of brass and cast in one piece. The disk is 90 millimeters in diameter, with a small hole at the center surrounded by a 20-millimeter equilateral triangle, and has the following inscribed legend: "U. S. Coast and Geodetic Survey triangulation station. For information write to Superintendent, Washington, D. C. $250 fine or imprisonment for disturbing this mark." The shank is 25 millimeters in diameter and 80 millimeters long, with a slit at the lower end into which a wedge is inserted so that when it is driven into a drill hole in the rock it will bulge at the bottom and hold the mark securely in place.

Another type of station mark is made in the form of a cap, to fit a 3-inch pipe, instead of with the shank, but in other respects is similar to the disk station mark described above.

The standard disk reference mark referred to in the following notes and descriptions and shown in illustration No. 4 is similar to the standard disk triangulation station mark described above, except that the center of the disk is inscribed with an arrow instead of with the triangle and that the words "reference mark" replace the words "triangulation station" in the legend. A short perpendicular groove across the shank of the arrow indicates the point to which the measurements are made. The mark is set so that the arrow points toward the station.

GENERAL NOTES IN REGARD TO STATION MARKS.

Note 1.—The station is marked by a standard disk station mark, described above, set in the top of a concrete cylinder 7 inches in diameter and 30 inches long incased in a galvanized-iron pipe which was used for the form. The cylinder projects 3 inches above the ground. The underground mark is a brass bolt one-fourth inch in diameter and 2 inches long set in a block of concrete 6 inches square on top and 4 inches thick. The bolt projects one-fourth or one-half inch above the concrete and is about 33 inches below the surface of the ground.

Note 2.—The station is marked by a standard disk station mark, described above, cemented in solid rock.

Note 3.—The station is marked by a standard cap station mark, described above, screwed to the top of a 3-inch iron pipe, which is embedded in a cylinder of concrete 10 inches in diameter and 30 inches long. The cylinder projects 3 inches above the ground.

Note 4.—The station is marked by a heavy cast-iron cap on the top of a 5-inch iron pipe. The cap is marked by a small hole at the center surrounded by a raised triangle and has on it the legend "U. S. Missouri River Commission."

Note 5.—The station is marked by a heavy cast-iron cap on the top of a 5-inch iron pipe. On the cap is a concentric cylindrical knob one-half inch high and the legend "Missouri River Commission U. S. B. M."

Note 6.—The station is marked by a United States Geological Survey disk station mark cemented in a rock. The rock is embedded in the ground flush with the surface. The disk is marked with a triangle in outline at the center and with the legend "U. S. Geological Survey B. M."

GENERAL NOTES IN REGARD TO REFERENCE MARKS.

Note 7.—This mark consists of a standard disk reference mark, described above, set in the top of a concrete cylinder 5½ inches in diameter and 30 inches long incased in a galvanized-iron pipe which was used for the form. The cylinder projects about 3 inches above the ground.

Note 8.—This mark is a standard disk reference mark, described on above, cemented in solid rock.

ONE HUNDRED AND FOURTH MERIDIAN.

PRINCIPAL POINTS.

Elbert (Elbert County, Colo., C. V. H., 1912).—Two and one-half miles west and one-half mile north of Elbert in a cultivated field one-fourth mile north of a large square house. The station is on the highest knoll in the vicinity and is marked according to note 1.[1] A reference mark, described in note 7,[1] is about 0.4 meter west of a fence line, 0.9 meter south of the fence corner where there is a flag left by the United States Geological Survey, and 92.053 meters from the station. Latitude observations were made in 1913 at a point, not marked, 0.025 meter east and 0.045 meter south of the station. Station *Table* is on this same hill.

Hilltop (Elbert County, Colo., C. V. H., 1912).—One and one-half miles east and one-half mile north of the railroad station at Hilltop, on the highest point of a low hill in the pasture of Daniel Mayer, near the northeast corner of the SE. ¼ sec. 10, T. 7 S., R. 65 W. The station is marked according to note 1.[1] A reference mark, described in

[1] See above.

note 7,[1] is in the fence line at the northeast corner of the quarter section mentioned above, 321.810 meters from the station in azimuth 231° 02′.

Morrison (Jefferson County, Colo., F. D. G., 1895; 1912).—This station is identical with the United States Geological Survey station of the same name. It is about 3 miles northwest of the town of Morrison, on the highest point of Mount Morrison, 40 meters northwest of the upper landing of the cable railway. The station is marked according to note 2,[1] in a drill hole in a large bowlder. The copper bolt marking the eccentric station occupied by the United States Geological Survey is 3.130 meters distant in azimuth 311° 45′. Latitude observations were made in 1913 at a point, not marked, 3.71 meters from the station in azimuth 322° 13′.

Douglas (Douglas County, Colo., C. V. H., 1912).—About 7 miles east of Parker on the south side of the section road running east from that town, about 5 feet south of the south road-fence at the highest point of the road in that vicinity. The station is on land belonging to Andrew Johnson, near the middle of the north side of sec. 21, T. 6 S., R. 65 W., and is marked according to note 1.[1] A reference mark, described in note 7,[1] is in the fence line on the opposite side of the road, 20.06 meters from the station in azimuth 170° 33′.

Indian (Arapahoe County, Colo., C. V. H., 1912).—This station is identical with the United States Geological Survey station "Indian Mound." It is on the center one of a group of mounds known as the Indian Mounds, about 6 miles south and 1 mile east of Watkins, near the southeast corner of sec. 36, T. 4 S., R. 65 W. The station is marked by a United States Geological Survey iron-pipe station mark projecting 20 inches above the ground. A reference mark, described in note 7,[1] is 188.922 meters from the station in azimuth 199° 21′. The southeast corner stone of section 36 is 135.251 meters distant in azimuth 214° 58′. A cairn is 3.0 meters from the reference mark and 192.0 meters from the station in azimuth 199° 31′.

Watkins astronomic (Adams County, Colo., C. V. H., 1912).—On the Union Pacific Railroad right of way at Watkins, 35.2 meters south of the main-line track on the north side of the Watkins-Denver wagon road. The station is marked according to note 1,[1] with the addition of 6 inches of concrete outside the iron pipe of the surface mark. A reference mark, described in note 7,[1] except that there is a nail in place of the brass disk, is on the south side of the wagon road running southeast from Watkins and nearly on line with the north-and-south section fence, and is 289.603 meters from the station in azimuth 308° 51′. A United States Geological Survey iron-pipe bench mark (U. S. Coast and Geodetic Survey bench mark G_2) is 266.017 meters distant in azimuth 244° 16′. The southeast corner of the depot is 27.85 meters from the station in azimuth 142° 54′, and a railroad water tank is about 175 meters distant in azimuth 103° 09′. Azimuth observations were made at this station and longitude observations were made at a point, not marked, 48.64 meters south and 4.60 meters east of the station.

Brighton (Weld County, Colo., C. V. H., 1912).—This station is identical with the United States Geological Survey station of the same name. It is about 4½ miles northeast of the town of Brighton on the highest hill in the NE. ¼ sec. 27, T. 1 N., R. 66 W. The station is marked by a United States Geological Survey iron pipe triangulation mark projecting 1 foot above the ground. A reference mark, described in note 7,[1] is 0.27 meter below the station and 93.563 meters distant in azimuth 124° 24′.

Boulder (Boulder County, Colo., C. V. H., 1912).—This station is identical with the United States Geological Survey station of the same name. It is about 4 miles direct and 9 miles by road and trail from the town of Boulder, on the northeastern one of the two peaks locally known as South Boulder Peak, between South Boulder and Bear Canyons. The station is marked by a United States Geological Survey bronze tablet set in solid rock. A reference mark, described in note 8,[1] is 0.43 meter above the station and 4.454 meters distant in azimuth 8° 59′. A cross cut in the solid rock 1 meter above the station and 0.08 meter below the top of the highest rock on the peak is 1.88 meters from the station in azimuth 90° 51′. Azimuth observations were made at this station.

Horsetooth (Larimer County, Colo., C. V. H., 1912).—This station is identical with the United States Geological Survey station of the same name. It is 8 miles southeast of Fort Collins on a high bare rocky point of the divide, immediately east of Redstone Creek, and 1¼ miles north of the point where the Fort Collins-Estes Park road crosses the divide. Deep vertical clefts divide the peak into three nearly equal parts, which have the appearance of gigantic teeth when viewed from the eastward. The station is on the highest and most southern one of the three divisions of the peak and is marked by a United States Geological Survey triangulation tablet set in solid rock. A reference mark, described in note 8,[1] is 0.04 meters below the station and 4.74 meters distant in azimuth 171° 24′.

Dewey (Weld County, Colo., C. V. H., 1912).—This station is identical with the United States Geological Survey station of the same name. It is 8 miles east and 1 mile south of Eaton, a town on the Union Pacific Railroad, and 1½ miles east and 1 mile south of Galeton, a new town on a branch of the Union Pacific Railroad. The station is on a round-topped knoll on the open prairie near the center of the north side of sec. 9, T. 6 N., R. 64 W., and is marked by a United States Geological Survey iron-pipe bench mark projecting about 20 inches above the surface of the ground. A reference mark, described in note 7,[1] is 136.190 meters from the station in azimuth 309° 56′. Azimuth and latitude observations were made at this station.

Warren (Laramie County, Wyo., C. V. H., 1912).—At the extreme western end of a high ridge about 10½ miles south 17° west from Cheyenne, 2 miles north 57° east from the old Terry ranch, now the headquarters of the Warren Live Stock Co., and one-half mile northeast of the section house at Gleason, a station on the Union Pacific Railroad. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is 0.18 meter below the station and 10.728 meters distant in azimuth 127° 54′. The conspicuous conical hill on which *Terry* is located is about three-eighths mile north-northwest from the station.

[1] See p. 115.

Twin (Laramie County, Wyo., C. V. H., 1912).—On the highest point of the more eastern one of the two peaks known as Twin Mountain, about 20 miles a little south of west from Cheyenne and 7 miles by road southwest of Granite Canyon, a station on the Union Pacific Railroad. The station is marked according to note 2.[1] A reference mark, described in noto 8,[1] is 0.15 meter above the station and 3.494 meters distant in azimuth 159° 58′. The bronzo tablet marking the United States Geological Survey triangulation station "East Twin" is 0.16 meter above the station and 2.674 meters distant in azimuth 96° 08′. Azimuth observations were made at this station.

Wadill (Laramie County, Wyo., C. V. H., 1912).—Thirteen miles by road northwest of Cheyenne, 2 miles west of the Cheyenne-Chugwater road, and 1¼ miles west of the Cheyenne-Whitaker ranch road along which there is a telephono line. The station is on a ridge on the open prairie at the highest point of the divide between Lodge Pole Creek and Crow Creek, and about 300 meters south 31° west from the center of sec. 24, T. 15 N., R. 68 W., on homestead land belonging to James Wadill, who lives about three-eighths mile south of the station. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is on the quarter section line, 1.74 meters below the station and 88.778 meters distant in azimuth 274° 38′. The chimney of William Kipp's house is in azimuth 197° 23′ from the station and Mr. Ritzke's windmill in azimuth 249° 00′.

Russell (Laramie County, Wyo., C. V. H., 1912).—Near the eastern edge of Fort D. A. Russell target and maneuver reserve on top of a bare rocky peak about 3½ miles east of Pole Mountain. The peak is the highest in that immediate vicinity and has a rocky, partially wooded ridge making off from it toward the west. The station is on the south side of the peak slightly below a high bowlder to the north, with Greentop Mountain showing through a small notch in the summit. It is marked according to note 2.[1] A reference mark, described in note 8,[1] is 1.03 meters above the station and 10.27 meters distant in azimuth 168° 41′.

Greentop (Albany County, Wyo., C. V. H., 1912).—On the timbered, rocky summit of Greentop Mountain, 8 miles west and 4 miles south of station Horse Creek on the Colorado & Southern Railway, and about one-eighth mile south of the south fork of Horse Creek. The station is marked according to note 2.[1] A reference mark, described in note 8,[1] is 0.5 meter above the station and 3.13 meters distant in azimuth 59° 03′. A cairn is 6.0 meters from the station in azimuth 90°.

Whitaker (Laramie County, Wyo., C. V. H., 1912).—About 18 miles north and 8½ miles west of Cheyenne and 3 miles south and three-fourths mile east of the D. R. Whitaker ranch buildings on Horse Creek. Tho station is on rolling prairie land at the highest point of the divide between Pole Creek and Horse Creek, about three-fourths mile northeast of the Cheyenne-Whitaker ranch road at the point where the road passes the quarter section corner and bench mark referred to below. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is 1.17 meters below the station and 91.038 meters distant in azimuth 270° 57′. The southwest corner post of sec. 33, T. 17 N., R. 68 W., is 800.12 meters distant in azimuth 45° 37′. The United States Geological Survey iron-pipe bench mark "6702 Denver" is 1110.82 meters distant in azimuth 59° 55′ 30″. A cairn is 8 meters from the station on the line toward Ragged Top Mountain. Latitude observations were made at this station in 1913.

Ragged (Albany County, Wyo., C. V. H., 1912).—About 10 miles west of Horse Creek, a post office on the Colorado & Southern Railway, 8 miles west of McLaughlin's ranch, and one-half mile south of the North Fork of Horse Creek, on the highest rock of a group of pinnacles known as Ragged Top Mountain. The rock referred to is the middle one of three prominent peaks on the most western ridge and is about 300 meters west of an old wood road in a canyon opening to the south. The station is marked by a United States Geological Survey bench mark tablet set in solid rock. The tablet has a triangle cut in the top and is stamped "Elevation above sea level 8230 feet." A reference mark, described in note 8,[1] is 0.20 meter below the station and 3.12 meters distant in azimuth 185° 04′. Azimuth observations were made at this station.

Cheyenne west base (Laramie County, Wyo., C. V. H., 1913).—About 17 miles by road northwest of Cheyenne and one-half mile south of the house of Mr. William Pellis, on the highest part of an east-and-west ridge and about 15 meters south of the quarter section corner on the line between secs. 5 and 6, T .15 N., R. 68 W. The station is marked by a standard disk station mark, described on page —, set in a cylinder of concrete 16 inches in diameter and 24 inches long, the top of which is flush with the surface of the ground. The underground mark is similar to the surface mark except that the cylinder of concrete is only 10 inches in diameter and 10 inches long. It is 30 inches below the ground and 6 inches below the bottom of the surface mark. A standard disk reference mark, described on page —, set in a cylinder of concrete 12 inches in diameter and 24 inches long is on the section line 18.80 meters from the station in azimuth 7° 28′.

Cheyenne east base (Laramie County, Wyo., C. V. H., 1913).—About 14 miles by road northwest of Cheyenne, on the highest point of a ridge extending east and west, and about 25 meters south of the quarter section corner on tho line between secs. 11 and 12, T. 15 N., R. 68 W. Section 11 is owned by Mr. Clarence Sorenson, who lives five-eighths mile north of the station. The station is marked by a standard disk station mark, described on page —, set in a cylinder of concrete 16 inches in diameter and 24 inches long, the top of which is flush with the surface of the ground. The underground mark is a 20-penny nail set in a cylinder of concrete 10 inches in diameter and 10 inches long, about 30 inches below the surface of the ground. A standard disk reference mark, described on pago —, set in a cylinder of concrete 12 inches in diameter and 24 inches long, is 16.47 meters from the station in azimuth 180° 51′.

Chugwater (Laramie County, Wyo., C. V. H., 1912).—About 9 miles west of Chugwater and 18 miles south 12° west of Wheatland, towns on the Colorado & Southern Railway. The station is about 5 miles east of the Hugh Ferguson

[1] See p. 115.

ranch, 2 miles west of Reshaw Creek, and one-half mile north of Maxwell Creek, on the extreme northeastern round-topped hill of the Reshaw Range. The top of the hill is about 100 meters in diameter, covered with large ragged bowlders and almost surrounded by a small cliff 4 to 10 feet high. The station is marked according to note 2.[1] A reference mark, consisting of a horizontal drill hole 0.56 meter above the ground in the west face of the largest bowlder on the peak, is 1.78 meters from the station in azimuth 259° 36′. The chimney of a large stone house on Rainsford's "Hill Ranch" on Maxwell Creek is about 1 mile distant in azimuth 359° 20′.

Notch (Albany County, Wyo., C. V. H., 1912).—About 21 miles west of Wheatland and 2 miles southwest of the Wheatland-Owen wagon road, near the center of the highest part of Collins Peak, which is also called Notch Peak because of the deep notch in its top as seen from the east. The station is marked according to note 2.[1] A reference mark, described in note 8,[1] is in a large bowlder 0.41 meter above the station and 3.095 meters distant in azimuth 240° 23′.

Coleman (Laramie County, Wyo., C. V. H., 1912).—About 13 miles northwest of Hartville Junction, on the Colorado & Southern Railway, and 7½ miles west of north from M. F. Coleman's ranch, which is on the Wheatland-Douglas wagon road where it crosses Cottonwood Creek. The station is 1½ miles north of this wagon road, just west of a large table-topped ridge devoid of trees, on the top and near the western slope of a round-topped knoll on which slope are three trees, two near the top and one near the bottom. The station is marked according to note 2.[1] A reference mark, described in note 8,[1] is in the top of a large rounded bowlder at the top of the western slope of the knoll, 0.26 meter below the station and 20.90 meters distant in azimuth 122° 36′. A cairn 6 feet in diameter at the bottom and 6 feet high is 11.8 meters distant in azimuth 107° 48′. A triangular blaze on the nearest pine tree is 13 meters from the station in azimuth 62° 02′. Latitude observations were made in 1913 at a point, not marked, 0.045 meter south and 0.05 meter west of the station.

Haystack (Laramie County, Wyo., C. V. H., 1912).—About 7½ miles northeast of Guernsey, 1½ miles north 79° east (magnetic) from the Chicago Iron Mines, and 1½ miles east of the Guernsey-Lusk wagon road. The station is near the highest point at the western end of the middle one of the three highest peaks of the Haystack Hills, about one-fourth mile south of a slightly lower ridge, known locally as Haystack Hill, which has an abrupt descent at its northwest end and a natural cairn at its southeast end. The station is marked according to note 2.[1] A reference mark, described in note 8,[1] is in the top of a large bowlder 0.35 meter above the station and 3.293 meters distant in azimuth 121° 52′. A triangular blaze on a pine tree is 19 meters from the station in azmuth 122° 15′.

Hobbs (Laramie County, Wyo., C. V. H., 1912).—About 15 miles direct and 20 miles by road south 30° west from Lusk, 6½ miles north 55° west from the Rawhide ranch, and 4 miles south of the Hobbs ranch, on the most easterly of a group of hills and the only wooded hill in the vicinity. The station is at the intersection of three lines cut through the timber to other triangulation stations and is marked according to note 2.[1] A reference mark, described in note 8,[1] is 0.92 meter below the station and 19.172 meters distant in azimuth 111° 12′.

Willow (Converse County, Wyo., C. V. H., 1912).—About 5 miles north of Willow post office and 7 miles south 21° west from Manville, on the most northern and western high hill in that vicinity. The hill is a bare-topped ridge about 350 meters in length north and south, with a rim of rock along the east side and gentle slopes to the west. The station is near the south end of the highest part of the ridge, about 190 meters from the north end of the hill, and is marked according to note 2.[1] A reference mark, described in note 8,[1] is in the top of a small bowlder 10 inches above the surface of the ground and 11.218 meters from the station in azimuth 286° 41′. Azimuth observations were made at this station.

Rawhide (Laramie County, Wyo., C. V. H., 1912).—About 12 miles south of Lusk, 2½ miles north of the Rawhide ranch, and 2 miles east of the Guernsey-Lusk wagon road, on the highest point of Rawhide Butte. The station is on the crest of a narrow rocky ridge extending north and south and is marked according to note 2.[1] A reference mark, described in note 8,[1] is 0.55 meter above the station and 2.810 meters distant in azimuth 302° 13′.

Manville (Converse County, Wyo., C. V. H., 1912).—About 4¾ miles direct and 6 miles by road north 20° east from Manville, on a small round-topped knob about 8 meters in diameter, which marks the highest point of the ridge in that vicinity. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is on an adjacent conical mound 274.38 meters from the station in azimuth 83° 13′ 35″.

Kirtley (Converse County, Wyo., C. V. H., 1912).—About 3½ miles north and 1½ miles east of Kirtley post office, on the highest knob in the SE. ¼ sec. 5, T. 33 N., R. 60 W., one-fourth mile south of some conspicuous high chalky bluffs. The station is 375 meters north 43° east from the southwest corner of the above section and is marked according to note 1.[1] A reference mark, described in note 7,[1] is 0.49 meter below the station and 125.713 meters distant in azimuth 158° 50′ 30″. Latitude observations were made in 1913 at a point, not marked, 0.04 meter west and 0.07 meter south of the station.

Alkali (Weston County, Wyo., C. V. H., 1912).—On Alkali Butte, the best-known butte within 30 miles, at the head of Muskrat, Robbers Roost, and Alkali Creeks, about 22 miles west of south from Newcastle. The station is 29 meters from the south end of the butte and is marked according to note 2.[1] A 1-inch drill hole in solid rock is 0.92 meter below the station and 17.180 meters distant in azimuth 177° 48′. The United States Geological Survey station "Alkali," marked by a 1-inch copper bolt set in bedrock, is 0.17 meter below the station and 28.640 meters distant in azimuth 20° 14′. Azimuth observations were made at this station in 1913. Latitude observations were made in 1913 at a point, not marked, 5.060 meters from the station in azimuth 8° 32′.

[1] See p. 115.

Parker (Fall River County, S. Dak., C. V. H., 1912).—About 2¾ miles south of Minnekahta and about three-fourths mile northeast of Arnold's ranch house, on the highest point of Parkers (or Arnolds) Peak, the top of which is about 150 meters long north and south and about 40 meters wide. The station is 50 meters from the north end of the peak and is marked according to note 1.[1] A reference mark, described in note 8,[1] is 0.34 meter above the station and 25.471 meters distant in azimuth 206° 15′, and a 1-inch drill hole in solid rock is 1.42 meters below the station and 11.450 meters distant in azimuth 124° 49′.

Cottonwood (Converse County, Wyo., C. V. H., 1912).—About 14½ miles direct and 18 miles by road south 76° west from Edgemont, S. Dak., 2 miles north of east of the Valentine Phester ranch, and 2½ miles west of the State boundary line, on the highest part of the bald Cottonwood divide in that vicinity. The United States Geological Survey station "Cottonwood" is in this same locality, but it could not be found in 1912. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is 41.228 meters from the station in azimuth 347° 21′.

Sullivan (Custer County, S. Dak., C. V. H., 1912).—About 4½ miles northwest of Dewey and 3 miles by road northwest of the Sullivan ranch, on the highest point of a sparsely timbered peak known locally as Sullivan Peak. The station is marked according to note 2.[1] A 1-inch drill hole in solid rock is 0.72 meter below the station and 4.595 meters distant in azimuth 152° 30′. The United States Geological Survey station "Sullivan," marked by a copper bolt, is 0.4 meter above the station and 4.53 meters distant in azimuth 30° 29′.

Elk (Custer County, S. Dak., C. V. H., 1912).—About 15 miles north of Dewey, 15 miles southeast of Newcastle, and one-fourth mile east of the State boundary, at the extreme north end of the Elk Mountains, on a timbered peak which has abrupt slopes to the west and north. The station is marked according to note 2.[1] A reference mark, described in note 8,[1] is 0.2 meter above the station and 4.497 meters distant in azimuth 333° 20′. The United States Geological Survey station "Elk," marked by a copper bolt, is 1.035 meters from the station in azimuth 190° 20′.

Provo west base (Fall River County, S. Dak., C. V. H., 1912).—About 4¼ miles west and 1½ miles south of Provo and 60 meters southeast of the southeast corner of a log schoolhouse. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is one-half meter east of the west section line fence, 0.11 meter below the station, and 58.860 meters distant in azimuth 359° 35′.

Provo east base (Fall River County, S. Dak., C. V. H., 1912).—About 4½ miles east of Provo, on the homestead of A. G. Riley, 270 meters north 55° west from the southeast corner of sec. 3, T. 10 S., R. 3 E., 155 meters from the south section line and 200 meters from the east section line. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is in the fence line 4.01 meters below the station and 151.348 meters distant in azimuth 358° 14′.

Provo astronomic (Fall River County, S. Dak., C. V. H., 1912).—About 600 meters northeast of the railroad station at Provo, on the highest point of a low hill on the open prairie. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is 0.16 meter below the station and 29.294 meters distant in azimuth 355° 07′. The center of sec. 12, T. 10 S., R. 2 W., is 4.56 meters from the station in azimuth 201° 33′. Azimuth observations were made at this station. Observations for longitude were made at a point, not marked, 12.355 meters north and 1.404 meters west of the station. Latitude observations were made in 1913 at a point, not marked, 3.598 meters from tho station in azimuth 95° 04′.

Cambria (Weston County, Wyo., C. V. H., 1912).—About 7 miles north of Cambria and 1½ miles west of the Cambria-Horton wagon road, on a flat-topped ridge extending east and west, locally known as Sweetwater Mountain. The station is on the highest part of the ridge, a few meters from the abrupt slope to the north and about 140 meters east of a small cultivated field. It is marked according to note 1.[1] A reference mark, described in note 7,[1] is 1.4 meters below the station and 27.67 meters distant in azimuth 52° 38′. Azimuth observations were made at this station in 1913. Latitude observations were made in 1913 at a point, not marked, 0.115 meter north and 1.865 meters east of the station.

Crow (Pennington County, S. Dak., C. V. H., 1912).—About three-fourths of a mile east of the road from Newcastle to Deadwood and 2½ miles south of where a branch of that road turns down Castle Creek, in the SE. ¼ sec. 10, T. 1 N., R. 1 E., on a flat-topped ridge sloping gently in all directions and covered with a growth of cottonwoods and small pines. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is 1.26 meters below the station and 33.488 meters distant in azimuth 285° 40′. The United States Geological Survey station "Crows Nest," marked by a 1-inch copper bolt, is 2.016 meters from the station in azimuth 77° 56′.

Laird (Lawrence County, S. Dak., E. H. P., 1912).—About 3 miles northwest of the Laird water tank on the McLaughlin tie and timber road, 2 miles west of the Ham ranch (old McQuaig homestead), and about 2 miles east of tho State boundary line, on the highest hill in the vicinity. The hill has a considerable area cleared of trees. The station is marked at the surface according to note 1,[1] but has for an underground mark a brass bolt set in solid rock 2 feet below the surface of the ground. A reference mark, described in note 7,[1] is in the clearing on the west slope of the hill, 14.62 meters from the station in azimuth 73° 35′.

Inyankara (Crook County, Wyo., E. H. P., 1912).—On the top of Inyankara Mountain, about 14 miles south of Sundance and 2 miles west of the ranch of F. M. Clark. The station is in a slight depression, about 3 feet lower than the highest point of the peak, and is marked according to note 2.[1] A reference mark, described in note 8,[1] is about 1 foot higher than the station and 6.38 meters distant iu azimuth 236° 56′.

Sundance (Crook County, Wyo., E. H. P., 1912).—About 6 miles northwest of Sundance, on the most westerly one of the Warren Peaks, which are the highest peaks of the Bearlodge Mountains. The peak is sharp and the station

[1] See p. 115.

is about 3 meters from the highest point, on which there is a cairn 8 feet high. The station is marked according to note 1.[1] A reference mark, described in note 8,[1] is on the north slope of the hill about 11 feet below the station and 22.77 meters distant in azimuth 288° 20′. The azimuth of the cairn is 261° 31′. Latitude observations were made in 1913 at a point, not marked, 0.05 meter north and 0.03 meter east of the station.

Terry (Lawrence County, S. Dak., E. H. P., 1912).—About 1½ miles southwest of Terry, on the top of Terry Peak, a well-known peak of the Black Hills. The station is on the south end of the peak, about 3 feet below the highest point, which is at the north end of the peak. It is marked according to note 2.[1] A reference mark, described in note 8,[1] is on the north end of the peak at the edge of the pile of rocks marking the highest point and is 17.51 meters from the station in azimuth 156° 28′.

Wymonkota (Custer County, Mont., E. H. P., 1912).—This station is identical with the United States Geological Survey station of the same name. It is about 2½ miles west-northwest of the southeast corner of the State, at the edge of the breaks and just south of the wagon road leading into the Badlands, on a small conical-shaped hill, the highest in that vicinity. The station is marked by a United States Geological Survey bronze tablet cemented in a large rock set in the ground. A 1-inch drill hole in solid rock is 4 meters from the station in azimuth 260° 31′. Azimuth observations were made at this station.

Castle (Butte County, S. Dak., E. H. P., 1912).—About 28 miles east of Bellefourche on the west spur of Castle Rock Butte, which is a well-known peak. The station is about 4 meters west of the highest part of the butte and is marked according to note 1.[1] The United States Geological Survey station "Castle Rock," marked by a bronze tablet cemented in a flat rock flush with the surface of the ground, is on the highest point of the butte, 3.92 meters from the station in azimuth 291° 10′.

Harding (Harding County, S. Dak., E. H. P., 1912).—About 4 miles southwest of Harding, on the highest point about 1 mile from the southeast end of a prominent mesa which is a part of the Sioux National Forest. The station is in the NE. ¼ sec. 9, T. 16 N., R. 2 E., and is marked according to note 3,[1] with the addition of an underground mark as described in note 1.[1] A reference mark, described in note 7,[1] is on the west brow of the mesa, 49.15 meters from the station in azimuth 112° 28′. Latitude observations were made in 1913 at a point, not marked, 0.005 meter north and 0.010 meter east of the station.

Moreau (Harding County, S. Dak., E. H. P., 1912).—About 7 miles southeast of Harding, in the northeast corner of sec. 23, T. 16 N., R. 3 E., on the southwest end of a prominent mesa which is a part of the Sioux National Forest. The station is about 25 meters from the south edge of the mesa and about 50 meters from the southwest end, and is marked according to note 1.[1] A reference mark, described in note 7,[1] is on the south edge of the bluff, 22.68 meters from the station in azimuth 342° 34′. Another reference mark, described in note 8,[1] is also on the south edge of the bluff, 66.41 meters from the station in azimuth 253° 53′.

Reva (Harding County, S. Dak., E. H. P., 1912).—About 16 miles east of Buffalo and about one-half mile north of the top of the old Moonshine trail, on the highest point at the north end of the Slim Buttes, on an isolated knob connected to the main butte by a short low spur. It is the highest point in sec. 25, T. 19 N., R. 8 E. The station is marked according to note 1,[1] except that the underground mark is a brass bolt set in solid rock 25 inches below the surface. A reference mark, described in note 8,[1] is on the south end of the knob 7 meters lower than the station and 48.72 meters distant in azimuth 345° 23′. Latitude and azimuth observations were made at this station.

Table (Harding County, S. Dak., E. H. P., 1912).—About 2 miles east of Karinen post office, on the highest point of Table Mountain, a flat-topped butte with steep rocky slopes and bluffs. The station is on the east side of the summit a little north of the center and just west of the head of the more northerly large cove with sheer rocky walls on the east side of the mountain. The station is marked at the surface as in note 1,[1] except that the cylinder is 9½ inches in diameter and 14 inches long. The underground mark is a brass bolt set in solid rock 12 inches below the surface. A reference mark, described in note 8,[1] is within 1 foot of the edge of the bluff, 28.71 meters from the station in azimuth 275° 27′, and a drill hole in solid rock is at the edge of the bluff, 48.65 meters from the station in azimuth 306° 56′.

Lodge (Harding County, S. Dak., E. H. P., 1912).—About 18 miles south and 4 miles west of Reeder, N. Dak., and one-half mile south of the ranch house of L. B. Vines, in the NE. ¼ sec. 24, T. 22 N., R. 8 E., on the flat grassy mesa at the west end of the Lodgepole Buttes, about one-fourth mile south of the northwest end and 15 meters from the brow of the hill. The station is marked according to note 1,[1] except that the underground mark is a brass bolt set in solid rock 28 inches below the surface. A reference mark is near the edge of the mesa, 40.18 meters from the station in azimuth 172° 46′. A 1-inch drill hole in a large bowlder at the extreme western edge of the mesa is on the lower flat about 8 meters below the station and 90.46 meters distant in azimuth 79° 24′, and a cross chiseled in solid rock near the second reference mark is 92.23 meters from the station in azimuth 82° 16′.

Butte (Bowman County, N. Dak., E. H. P., 1912).—About 1½ miles north of Bowman, on the northeast one of the Twin Buttes near the middle of the summit north and south and about 40 meters from the west edge of the slope. The station is in range with the east slope of the southwest one of the Twin Buttes and the water-tank tower at Bowman, the base of which is just visible over the edge of the butte on which the station is located. The station is marked according to note 1.[1] A reference mark, described in note 8,[1] is at the top of the slope on the southwest edge of the butte, 38.31 meters from the station in azimuth 59° 57′.

Whetstone (Adams County, N. Dak., E. H. P., 1912).—About 10 miles north of Reeder, a town on the Chicago, Milwaukee & Puget Sound Railway, on the middle and highest peak of the Whetstone Buttes, which peak is quite

[1] See p. 115.

sharp, the other two having rounded or flat tops. The station is just west of a mass of crumbling rock which is on the highest point of the peak, and is marked according to note 1,[1] except that the brass bolt of the underground mark is set in rock. The highest point of the butte near the west edge of the mass of crumbling rock is 2.32 meters above the station and 5.80 meters distant in azimuth 278° 58′.

Rainy (Billings County, N. Dak., E. H. P., 1912).—About 8 miles west-southwest of New England, a town on a branch of the Chicago, Milwaukee & Puget Sound Railway, near the center of the south side of West Rainy Butte, which is a large grassy, flat-topped hill about 2 miles long east and west and one-half mile wide at the widest point. About 200 meters west of the station the ridge narrows to low rough, rocky knobs extending for several hundred meters, beyond which there is high flat top again. The station is about one-half mile northwest of the house of J. O. Hanson, who lives in a cove on the south side of the butte, and it is about 100 meters west of the southwest point of the bluff overlooking the cove and 12 meters from the south edge of the cliff. The station is marked according to note 1,[1] except that the brass bolt of the underground mark is in a rock 22 inches below the surface. The reference mark, described in note 8,[1] is 11.79 meters from the station in azimuth 287° 25′. The chimney of John Moord's house is 2 miles distant in azimuth 65° 57′.

Black (Billings County, N. Dak., E. H. P., 1912).—About 15 miles north and 2 miles west of Bowman, on the southwest end of Black Butte, a grassy flat-topped butte about 2 miles long east and west and one-fourth to three-fourths mile wide, formerly known as H. T. Butte, as it was included in the range of the H. T. ranch. The station is about 20 meters from the west edge of the bluff and about 30 meters from the ledge at the southwest corner of the butte. It is marked according to note 1,[1] except that the brass bolt of the underground mark is in rock 24 inches below the surface. A reference mark, described in note 7,[1] is about 15 meters from the sheer wall on the west side of the butte, and is 13.44 meters from the station in azimuth 130° 22′. A drill hole in solid rock is on a corner made by a break in the ledge on the south side of the butte, 1 meter from the edge and 28.18 meters from the station in azimuth 18° 06′.

Badland (Billings County, N. Dak., E. H. P., 1912).—About 13 miles south and 7 miles west of Belfield and about 7 miles west and 1 mile south of Gaylord, in the NE. ¼ sec. 8, T. 137 N., R. 100 W., on the highest point in the section. The station is at the edge of the "Breaks," where the level land breaks off abruptly into the Badlands to the west, and is near the road which leads west along section 8 and turns to the southwest, passing between the station and the reference mark just before it descends into the Badlands. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is on the opposite side of the road on the highest point of a somewhat lower knob and is 56.77 meters from the station in azimuth 26° 34′. The chimney of E. Meyer's house is about 600 meters from the station in azimuth 275° 45′. Latitude observations were made at this station in 1913.

Sentinel (Billings County, N. Dak., E. H. P., 1912).—About 4 miles south of the town of Sentinel Butte, on the highest point of Sentinel Butte, a high well-known mesa about 2 miles long east and west and one-fourth to one-half mile wide. The top of the butte is divided by a ravine which is just south of a rocky bluff visible from the town. The station is on a knoll near the middle of the southeast section and is in range with the east tangent of the rocky bluff described above and the point in the town of Sentinel Butte where the road from the north crosses the railroad. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is near the north edge of the knoll in range from the station to the highest point of Camel Hump Butte, 67.62 meters distant in azimuth 197° 10′.

Saddle (Billings County, N. Dak., E. H. P., 1912).—About 6½ miles north and 1½ miles west of Belfield, in the SE. ¼ sec. 33, T. 141 N., R. 99 W., on the south end and highest point of Saddle Butte, the only butte in this vicinity. The northwest corner of Stark County is about 400 meters in a southwesterly direction from the station, but a large cairn about 8 feet high on the edge of the cliff 7 meters to the south obstructs the view to the county corner. The station is on a smooth rock ledge and is marked according to note 2.[1] A reference mark, described in note 8,[1] is 8.96 meters from the station in azimuth 113° 53′, and a 1-inch drill hole in solid rock is 8.93 meters distant in azimuth 187° 09′. Azimuth observations were made at this station.

Hump (Billings County, N. Dak., E. H. P., 1912).—About 5 miles northeast of the town of Sentinel Butte, on the highest point of Camel Hump Butte, on a narrow ridge running east and west. Large bowlders are scattered about over the top and down the sides of the ridge. The station is marked according to note 2.[1] A cross cut in the eastern oblique face of a large bowlder on the ridge is 6.32 meters from the station in azimuth 104° 27′, and a 1-inch drill hole in another bowlder is 2.14 meters distant in azimuth 269° 46′.

Cook (Billings County, N. Dak., E. H. P., 1912).—About 18 miles north and 4 miles east of the town of Sentinel Butte, about 5 miles northeast of the ranch of Almond T. Stone on Elk Creek, and about 1 mile north of the ranch of James E. Cook. There is a petrified stump about 10 feet high about 200 meters northwest of the northwest corner of Mr. Cook's pasture and about one-half mile south of the station. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is on the south point of the ridge somewhat lower than the station, 30.42 meters distant, in azimuth 32° 01′.

Blue (Dawson County, Mont., E. H. P., 1912).—About 20 miles due north of Wibaux and three-fourths mile west of the road from that place, on the highest point of Blue Mountain. The station is marked according to note 2.[1] The United States Geological Survey station "Blue Camel," marked by a bronze tablet set in solid rock over which is a cairn 6 feet high, is 4.09 meters from the station in azimuth 138° 47′. A 1-inch drill hole in solid rock is 6.76 meters

[1] See p. 115.

from the station in azimuth 340° 57′, and a cross chiseled in solid rock is 15.81 meters distant in azimuth 334° 03′. Azimuth observations were made at this station.

Trotter (Billings County, N. Dak., E. H. P., 1912).—About 2½ miles a little south of east of the Trotter post office and about 1 mile south of the county line, in the SE. ¼ sec. 4, T. 144 N., R. 104 W., on the most southern one of the three rounded hills just east of the rough eroded land at the head of Smith Creek. The station is about 300 meters north of the section line and is marked according to note 1.[1] A reference mark, described in note 7,[1] is 22.07 meters from the station in azimuth 92° 13′.

Flat (McKenzie County, N. Dak., E. H. P., 1912).—About 7 miles north and 3½ miles east of Trotter post office, about 9 miles east of the state line, about 7 miles north of the county line, and 3 miles in a northwesterly direction from Parson's ranch, on the top of a very prominent hill, the highest in the vicinity, known locally as Flat Top. The hill or butte is at the head of the south fork of Beno Pierre Creek and is conical in shape with a flat top of solid rock 10 meters in diameter having nearly perpendicular sides 10 to 30 feet in height. The station is on the northwest or main section of the rock about 4 meters from the northwest corner and 2 meters from the west face. It is marked according to note 2.[1] A reference mark, described in note 8,[1] is 8.89 meters from the station in azimuth 356° 24′, on the overhanging southwest section of the rock, which is separated from the main top by a crack about 9 inches wide.

Lovering (Dawson County, Mont., E. H. P., 1912).—About 10 miles due west of Sidney, on the highest point of a grassy hill whose top is a nearly level ridge of varying width. The station is on range land belonging to Charles Oldfelt and is about one-fourth mile west of the head of the draw leading up from the group of trees and the spring on the east slope of the hill. The station is marked according to note 1.[1] The United States Geological Survey station "Lovering," marked by an aluminum tablet in a block of quartzite flush with the surface of the ground, is 2.88 meters from the station in azimuth 85° 14′.

Sheep (McKenzie County, N. Dak., E. H. P., 1912).—About 12 miles east of the state boundary, 3 miles south of the county boundary, and 1½ miles east of the ranch house of R. B. Burns, in sec. 22, T. 148 N., R. 103 W., on the highest point of the most prominent butte in this vicinity, locally known as Sheep Butte. The north side of the butte is partly grass covered and has a cluster of small trees and brush in a recess half way up the slope, but the other three sides are steep and jagged. The station is marked according to note 1.[1] A reference mark is 39.15 meters from the station in azimuth 164° 04′. A schoolhouse flagstaff is about 1¼ miles distant in azimuth 178° 36′. Latitude observations were made at this station in 1913.

Jackson (Dawson County, Mont., E. H. P., 1912).—This station is identical with the United States Geological Survey station of the same name. It is about 15 miles southwest of Mendak, one-half mile southwest of the Sioux Pass post office and store, and about one-half mile west of the wagon road leading through the pass, on a high flat ridge about 250 meters in a westerly direction from the brow of the hill facing the pass. The station is on land belonging to George C. Peterson, about 3 meters from an old Indian grave, a hole in the ground 4 feet long, 2 feet wide, and 4 feet deep. The station is marked according to note 6.[1] A reference mark, described in note 8,[1] is on a large white bowlder on the south side of the ridge near the head of a draw leading up from the south and is about 10 feet lower than the station and 64.51 meters (inclined distance) from the station in azimuth 138° 24′.

Buford (Williams County, N. Dak., E. H. P., 1912).—About 3 miles north of Buford, in sec. 30, T. 153 N., R. 103 W., on the highest point of a prominent knob overlooking the Missouri and Yellowstone Rivers, the highest knob in this vicinity. The top of the knob is about 40 meters long southeast and northwest and has a gentle grassy slope on the northeast side and an abrupt bare face on the southwest. As viewed either from the northeast or the southwest the knob has the appearance of a flat-topped hill. The station is on the middle of the top about 4 meters from a red stone ledge on the southwest side of the hill and is marked according to note 3,[1] with an underground mark as described in note 1.[1] A cross cut in the more western one of two bowlders on the north slope of the hill is about 25 feet below the station and 46.99 meters (inclined distance) from the station in azimuth 173° 24′. A drill hole in solid rock is near the bottom of the slope on the northeast side, about 15 feet below the station and 22.59 meters (inclined distance) from the station in azimuth 226° 25′. Joseph Evans's house is about 1 mile distant in azimuth 154° 07′, and C. L. Barr's log house is about three-fourths mile distant in azimuth 225° 32′.

Montana (Valley County, Mont., E. H. P., 1912).—This station is identical with the Missouri River Commission station and the United States Geological Survey station of the same name. It is about 2 miles north by west from Mondak, on the highest point of the bluff along which is the wagon road. The station is nearly in range with a small, conical, white-topped hill from the lowest point of the road from Mondak where it crosses a wide ravine. To reach the station, follow the road referred to above until the prairie level is reached, then turn southeast to the station about one-fourth mile distant. The station is the center of a 5-inch iron pipe. The chimney of Frank Steihl's house is about 1½ miles from the station in azimuth 34° 21′.

Lanark (Valley County, Mont., E. H. P., 1912).—This station is identical with the Missouri River Commission station and the United States Geological Survey station of the same name. It is about 2½ miles south of Bainville, about 4½ miles north of the Missouri River, and 2½ miles northwest of the bridge on the Mondak-Bainville wagon road over the Little Muddy River, on a prominent conical hill with white bluffs and a large bowlder on the south side. The station is marked according to note 4.[1]

Cutoff (Dawson County, Mont., E. H. P., 1912).—This station is identical with the Missouri River Commission station and the United States Geological Survey station of the same name. It is about 5½ miles nearly west of

[1] See p. 115.

Mondak, on the bluff south of the Missouri River, about 90 meters west of the top of Beaver Slide, the point where the Beaver Slide wagon road reaches the top of the bluff. The station is marked according to note 4.[1]

Mondak (Valley County, Mont., E. H. P., 1912).—In Mondak, about 93 meters south of the main-line track of the Great Northern Railway, on vacant land belonging to Jacob Seel, of the townsite company. The station is marked according to note 3,[1] with an underground mark as described in note 1.[1] A rough cross about 1 foot above the ground on the south face of the concrete foundation at the southeast corner of the engine room and office of the W. I. Saxton elevator is about 40 meters south of the main-line track of the railway and 53.25 meters from the station in azimuth 208° 16′. Bench mark 123/2 of the Missouri River Commission, marked by a 5-inch iron pipe, is at the edge of the weeds just south of a wagon track, 46.6 meters nearly south of the southeast corner of the depot, and 96.89 meters from the station in azimuth 256° 08′. The southeast corner of the depot is 119.60 meters from the station in azimuth 234° 22′. Latitude and azimuth observations were made at this station. Observations for longitude were made at a point, not marked, 3.995 meters north, 0.25 meter east of the station.

Ferry (Dawson County, Mont., E. H. P., 1912).—This station is identical with the Missouri River Commission station of the same name. It is about 1½ miles west of the ferry at Mondak and 1¾ miles south of the Missouri River, on a knoll a short distance back from the bluff overlooking the river. The edge of the bluff on the line to station *Mondak* was dug away a little in order to make the two stations intervisible. The station is marked according to note 4,[1] the pipe projecting about 3 feet above the ground.

Bainville (Valley County, Mont., E. H. P., 1912).—About 4½ miles north 30° east from Bainville, in sec. 12, T. 28 N., R. 58 E., on the highest point of the highest hill in the immediate vicinity, on land recently filed on by Lesley Wilde. The hill is abrupt and nearly bare to the west and southwest, and there is a large, bare, black ridge with a flat top making out to the westward about 100 meters west and 50 feet below the station. The station is marked according to note 1.[1] A reference mark is 38.14 meters from the station in azimuth 311° 12′. Another reference mark is on a rock, 76.41 meters from the station in azimuth 225° 59′. The Catholic Church at Bainville is in azimuth 28° 44′.

Snake (Valley County, Mont., E. H. P., 1912).—About 12 miles north 15° east of Bainville, three-fourths mile southwest of the ranch of George Reynolds and one-fourth mile west of the Bainville-Snake Creek wagon read, on a prominent rocky hill known as Snake Butte, in sec. 15, T. 29 N., R. 58 E. The station is marked according to noto 1.[1] A 1-inch drill hole in solid rock is 24.84 meters from the station in azimuth 112° 54′. A cross chiseled on a ledge of rock about 15 feet below the level of the station is 17.83 meters distant in azimuth 25° 45′, and a 1-inch drill hole in a rocky ledge about 10 feet below the station is 40.64 meters (inclined distance) from the station in azimuth 322° 01′.

Bull (Williams County, N. Dak., E. H. P., 1912).—About 22 miles north of Mondak, Mont., 4 miles east of John C. Dwyer's ranch, and one-third mile east of the State line, in the NW. ¼ sec. 14, T. 156 N., R. 104 W., on the highest point of a prominent grassy hill locally known as Bull Butte. The station is marked according to note 1.[1] A drill hole in solid rock is 34.57 meters from the station in azimuth 119° 19′, a cross chiseled in solid rock is 23.33 meters from the station in azimuth 147° 10′, and another drill hole in the rock is 3.18 meters distant in azimuth 5° 56′.

Williston (Williams County, N. Dak., E. H. P., 1912).—About 10 miles northwest of Williston, in the NW. ¼ sec. 13, T. 155 N., R. 102 W., on a round-topped knoll at the highest point in the vicinity, about 1 mile south of west of the house of G. A. Rutledge, who lives on the old Bonetraill Road. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is on the section line, 365.62 meters from the station in azimuth 110° 11′. The northwest corner of section 13 is 447.70 meters distant in azimuth 129° 03′.

Bonetraill (Williams County, N. Dak., E. H. P., 1912).—About one-half mile east of the town of Bonetraill, on the south section line near the center of sec. 14, T. 157 N., R. 102 W., on the highest point on the north side of the wagon road running east from the town. The land to the north belongs to Samuel Meek. The station is marked according to note 2,[1] in a large bowlder 2 feet in diameter. A reference mark, described in note 8,[1] is in a large bowlder on the south side of the road, 20.70 meters from the station in azimuth 54° 38′. A 1-inch drill hole in a large bowlder on the north side of the road is 14.03 meters from the station in azimuth 92° 29′. The schoolhouse at Bonetraill is in azimuth 77° 39′. Latitude observations were made at this station in 1913.

Gladys (Williams County, N. Dak., E. H. P., 1912).—About 2 miles west and 2 miles nerth of Bonetraill, on a knoll locally known as Observation Butte, the highest point in the SW. ¼ sec. 4, T. 157 N., R. 102 W. The station is on land belonging to R. W. Nudd, who lives in Williston, and is marked according to note 1.[1] A reference mark, described in note 8,[1] is 28.20 meters from the station in azimuth 99° 45′. The southwest corner of section 4 is 36.61 meters distant in azimuth 20° 03′. Azimuth observations were made at this station.

Marmon (Williams County, N. Dak., E. H. P., 1912).—About 2½ miles east and 1 mile north of Marmon, on the bare prairie at the highest point of a small rounded knob in the NW. ¼ NE. ¼ sec. 2, T. 157 N., R. 100 W. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is one-fourth meter south of the rock that marks the center of the north side of section 2 and is 278.86 meters from the station in azimuth 154° 29′.

Howard (Williams County, N. Dak., E. H. P., 1912).—About 4 miles north and 1 mile east of the town of Howard, on the highest point in the NE. ¼ SE. ¼ sec. 35, T. 160 N., R. 102 W., in the yard of R. A. Witsoe. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is on the section line west of the road 162.77 meters from the station in azimuth 272° 15′.

Muddy (Divide County, N. Dak., E. H. P., 1912).—About 4½ miles east and 2 miles north of Rudser and about three-fourths mile south of east of Nora post office, on a round-topped hill known as Smoky Butte, the highest point of

[1] See p. 115.

land in the NE. ¼ sec. 23, T. 160 N., R. 100 W. The station is marked according to note 2.[1] A reference mark, described in note 8,[1] is just over the crest of the hill, 17.49 meters from the station in azimuth 340° 29′. A drill hole in solid rock is 2.99 meters from the station in azimuth 201° 55′, and a third reference mark is 10.35 meters distant in azimuth 43° 15′.

Stady (Divide County, N. Dak., E. H. P., 1912).—About 4½ miles north and 3¾ miles east of Stady, in the SE. ¼ NE. ¼ sec. 10, T. 161 N., R. 100 W., called Alexandria Township, and just south of a piece of land belonging to a Miss Brady, of Ambrose. The station is on level land at about the highest point just north of a deep coulee and is marked according to note 1.[1] A reference mark, described in note 7,[1] is in the fence line which follows the half section line and is 33.27 meters from the station in azimuth 186° 30′. The belfry of a schoolhouse about 2½ miles distant is in azimuth 187° 56′.

Crosby (Divide County, N. Dak., E. H. P., 1912).—About 6¾ miles south and 3½ miles west of Ambrose, in the NE. ¼ sec. 17, T. 162 N., R. 99 W., on land belonging to C. J. Christianson, who lives about 2 miles east. The station is marked according to note 1,[1] except that there is no underground mark. A reference mark, described in note 7,[1] is on the half section line on the south slope of the knoll, 137.46 meters distant (measured over the ground) in azimuth 349° 59′. The chimney of a white schoolhouse a little more than one-half mile distant is in azimuth 209° 47′.

Norge (Divide County, N. Dak., E. H. P., 1912).—About 14 miles west and 4 miles south of Ambrose and about 1½ miles west and 1 mile south of Norge post office, in the NW. ¼ NW. ¼ sec. 3, T. 162 N., R. 101 W., on a rounded ridge in a cultivated field belonging to Martin Knutson, whose house is about 400 meters southwest by west from the station. The station is about 90 meters south of the township road and is marked according to note 1.[1] A reference mark, described in note 7,[1] is on the township road on the west slope of the hill, 87.10 meters from the station in azimuth 173° 20′.

Ambrose southwest base (Divide County, N. Dak., E. H. P., 1912).—About 6 miles west of Ambrose and 3¼ miles south of the Canadian boundary, in the NE. ¼ NW. ¼ sec. 13, T. 163 N., R. 100 W., about 60 meters south of an east-and-west road and 70 meters east of a north-and-south road. The station is marked according to note 3,[1] with the addition of an underground mark as described in note 1.[1] A reference mark, described in note 7,[1] is close to the property line in the southeast corner of the road crossing and is 79.58 meters from the station in azimuth 127° 37′.

Bowie (Divide County, N. Dak., C. H. S., 1911; 1912).—This is one of the stations of the United States and Canada Boundary Survey. It is about 11½ miles west and 3 miles north of Ambrose, in the SW. ¼ SE. ¼ sec. 25, T. 164 N., R. 101 W., on a knoll about 65 meters south of the Canadian boundary on land belonging to Frank Christianson. The station is marked by a boundary survey tablet in a block of concrete 12 by 12 by 19 inches, set firmly in the ground and surmounted with a cairn. Boundary monument No. 232A is 90.70 meters from the station in azimuth 134° 05′. Ivar Eideness's house is about three-fourths mile distant in azimuth 268° 47′, and a small shack at the west end of a lake is 1½ miles distant in azimuth 304° 31′. Azimuth observations were made at this station.

Ambrose (Divide County, N. Dak., E. H. P., 1912).—About 3 miles south and 1½ miles west of Ambrose, in the SE. ¼ sec. 27, T. 163 N., R. 99. W., about 175 meters southeast of a house. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is about 2 meters from the southeast corner of the house and 173.43 meters from the station in azimuth 150° 30′.

School, or Ambrose northeast base (Divide County, N. Dak., C. H. S., 1911; 1912).—This is the station of the United States and Canada Boundary Survey called *School.* It is about 2½ miles north of Ambrose, 0.7 mile south of the Canadian boundary, and about 0.1 mile north of a deep ravine, in the SW. ¼ NW. ¼ sec. 36, T. 164 N., R. 99 W., in the public road on top of the highest knoll in the vicinity. The station is marked by a bench-mark post projecting 16 inches above the ground. A drill hole in the top of a stone post projecting 4 inches above the ground is 17.09 meters from the station in azimuth 352° 28′. The east gable of T. O. Moan's house is about 180 meters from the station in azimuth 99° 01′. Latitude observations were made in 1913 at a point, not marked, 0.030 meter north and 0.025 meter west of the station.

SUPPLEMENTARY POINTS.

Brighton bench mark R_2 (Adams County, Colo., C. V. H., 1912).—This station is identical with the United States Geological Survey bench mark "R_2." It is about 1 mile north of Brighton, near the north county line, on the south side of the base line road 1 meter north of the fence line and 7.25 meters west of the west rail of the Union Pacific Railroad. The station is marked by an iron pipe and a cap on which are the figures 4966. *Brighton bench mark eccentric,* the point occupied, is 39.832 meters distant in azimuth 89° 22′. A reference mark, described in note 7,[1] with the arrow pointing toward the eccentric point, is in the fence line on the north side of the base line road and 1 meter west of the west fence line of the county road and is 54.30 meters from the bench mark in azimuth 110° 00′. Latitude observations were made in 1913 at a point, not marked, 14.256 meters south and 0.285 meter west of the eccentric station.

Loveland tall white chimney (Larimer County, Colo., C. V. H., 1912).—The center of a tall white chimney in the town of Loveland. Latitude observations were made in 1913 at a point, not marked, 196.20 meters from the station in azimuth 193° 55′.

Dover bench mark E_3 (Weld County, Colo., C. V. H., 1912).—This station is identical with precise leveling bench mark E_3 established by this Survey. It is in the southeast corner of the Union Pacific Railroad section-house yard, 17 meters from the southeast corner of the section house and 25 meters west of the center of the track. It is marked by a granite post 6 inches square on top and 4½ feet long, projecting 6 inches above the ground, and inscribed on the

[1] See p. 115.

top with a square and the letters U.S.B.M. The station was occupied eccentrically. *Dover bench mark eccentric*, which is not marked, is 10.44 meters from the station in azimuth 240° 38′. *Dover bench mark reference mark*, described in note 7,[1] with the arrow pointing toward the eccentric point, is on the railroad right of way 16 meters west of the center of the track, 36 meters north of tho east gable of the section house, and 53.23 meters from the station in azimuth 162° 00′. The reference mark is on the east side of the Denver-Cheyenne wagon road and is south of the wagon road which crosses the track at this point.

Terry (Laramie County, Wyo., C. V. H., 1912).—This station is identical with the United States Geological Survey station of the same name. It is about 10 miles south 17° west from Cheyenne and about 2 miles northeast of the house on the old Terry ranch, now the headquarters of the Warren Live Stock Co. The station is on a bare conical hill and is marked by a United States Geological Survey iron bench-mark post set 3 feet in the ground. A reference mark, described in note 7,[1] is 0.94 meter below the station and 10.87 meters distant in azimuth 202° 55′.

Colorado-Wyoming boundary monument, milepost 44 (Weld County, Colo., and Laramie County, Wyo., C. V. H., 1912).—About 11 miles west of south of Cheyenne, on the ranch of the Warren Live Stock Co., about one-half milo southeast of their ranch house. The monument is a dressed red sandstone post standing about 4 feet above the surface of the ground and is surrounded by a mound of loose rock. It is marked as follows: "44M" on the east side, "Colorado" on the south, "41 N. L. 1873" on the west, and "Wyoming" on the north side. It is the only permanent boundary monument for several miles in either direction. The station is marked by a standard disk station mark, described on page ——, set in the top of the monument. A reference mark, described in note 7,[1] is in a fence line near an angle in the fence, 3.92 meters below the station and 110.184 meters distant in azimuth 75° 18′. Latitude observations were made in 1913 at a poiut, not marked, 14.838 meters directly north of the monument.

Wheatland standpipe (Laramie County, Wyo., C. V. H., 1912).—The center of the conical top of the tall red steel water tank at Wheatland, on a ridge on the open prairie about 1100 meters south 29° west from the railroad and telegraph offico and 400 meters east of the railroad. Observations for latitude and longitude were made at a point, not marked, 25.21 meters east and 6.41 meters south of the station.

Nebraska-Wyoming boundary monument 123 (Converse County, Wyo., and Sioux County, Nebr., C. V. H., 1912).—About 3½ miles east and 2½ miles south of Kirtley, on open prairie land at the center of the east side of sec. 3, T. 32 N., R. 60 W., at the northeast corner of tho farm of H. Z. Bayles and one-half mile north of his home. The monument is a granite post 10 inches square and 3½ feet high, marked as follows: "Neb." on the east side, "123 M" on the south side, and "Wyo." on the west side. *Nebraska-Wyoming boundary monument eccentric*, the station occupied, is marked by a nail in the top of a stake 3 inches square, 19.052 meters from the monument in azimuth 142° 36′.

Bluff (Converse County, Wyo., C. V. H., 1912).—About 30 miles west of Ardmore, 12 miles north of west from the Hermann ranch, and 9 miles north 78° west from the boundary monument common to the northwest corner of Nebraska, the southwest corner of South Dakota, and the east line of Wyoming. The station is on the most northeasterly ono of the high flat-topped buttes in this vicinity, on the northeast edge of the highest knob along the north bluff and 10 meters back from the edge of the bluff. The station is marked according to note 1.[1] A reference mark, described in note 7,[1] is 1.51 meters below the station and 204.667 meters distant in azimuth 51° 41′.

South Dakota-Nebraska boundary monument (Fall River County, S. Dak., and Sioux County, Nebr., C. V. H., 1912).—About 2¾ miles east of the point common to the northwest corner of Nebraska, the southwest corner of South Dakota, and the eastern line of Wyoming, 1 mile northwest of the Hermann ranch and three-fourths mile northwest of the Kirtley-Eckard wagon road, in a pasture 500 meters east of Indian Creek. The monument is a granite post 10 inches square on top, projecting 2½ feet above tho ground, and marked as follows: "222½ M" on the east side, "N" on the south side, and "N. D." on the north side. *South Dakota-Nebraska boundary monument eccentric*, the station occupied, is 2.572 meters from tho monument in azimuth 5° 57′.

South Dakota-Wyoming boundary monument (Converse County, Wyo., and Fall River County, S. Dak., C. V. H., 1912).—About 4½ miles north and 2½ miles west of the Hermann ranch and 4 miles north of the point common to the northwest corner of Nebraska, the southwest corner of South Dakota, and tho east line of Wyoming. The monument is a granite post 10 inches square, projecting 2½ feet above the ground, and is marked as follows: "1904" on the north side, "S. D." on tho east side, "4 M" on the south side, and "Wy." on the west side.

Jireh College cupola (Converse County, Wyo., C. V. H., 1912).—The cupola of Jireh College, which is east of the town of Keeline. Latitude observations were made in 1913 at a point, not marked, 67.868 meters from the station in azimuth 180° 13′.

Montana, southeast corner eccentric (Butte County, S. Dak., E. H. P., 1912).—On the northeastern gentle slope of a ridge about one-half mile east of the point on the Hash Knife wagon road, where it crosses the Montana-South Dakota State line. Tho station is marked according to note 1.[1] The *southeast corner of Montana* is marked by a granite post 11 inches square, projecting 30 inches above the ground, and is 271.66 meters from the eccentric station in azimuth 243° 41′.

Wyoming, northeast corner eccentric (Custer County, Mont., E. H. P., 1912).—About 2 meters east of the center of the Hash Knife wagon road, a short distanco north of the Montana-South Dakota Stato line, on the first knoll covered with red rock seen on approaching along the road from the south. The station is marked according to note 1.[1] The *northeast corner of Wyoming* is marked by a red granite post 12 inches square, projecting 3 feet above the ground, and is 269.41 meters from the eccentric station in azimuth 35° 18′. About 3 feet west of the corner monument is a block of soft white sandstone 18 by 22 inches on top and projecting about 2 feet above the ground. Thirty-seven paces east

[1] See p. 115.

of the corner monument is a 2-inch iron pipe with bronze cap projecting 1 foot above the surface of the ground and marked: "U. S. General Land Office Survey, 1910. $250 fine for removal. Mont.-Wyo.-S. D., T. 9, R. 62–63, sec. 36–sec. 31." Latitude observations were made in 1913 at a point, not marked, 0.01 meter north and 0.06 meter east of the eccentric station.

North Dakota-South Dakota, milepost 333, eccentric (Bowman County, N. Dak., E. H. P., 1912).—About 16 miles south and 2 miles west of Bowman, about 50 meters south of the highest point of a low ridge, on top of the first knoll west of the shack of Emil Thom. The station is marked according to note 1,[1] except that the brass bolt of the underground mark is set in solid rock 25 inches below the ground. *North Dakota-South Dakota milepost 333* is a red granite post 10 inches square, projecting about 40 inches above the ground and is 326.07 meters from the station in azimuth 306° 12′.

Bowman longitude (Bowman County, N. Dak., H. A. S., 1912).—About 10 meters northwest of the northwestern support of the Bowman city water tank, which is on a slight elevation on the western edge of the town. The station is marked by a concrete pier. Latitude observations were made at this station in 1913.

Buffalo Springs (Bowman County, N. Dak., E. H. P., 1912).—At Buffalo Springs, south of the Chicago, Milwaukee & Puget Sound Railway track, in a lot on which a church is to be built. The station is marked according to note 1.[1] The northwest corner of the parsonage is 47.48 meters from the station in azimuth 273° 49′. The rail in front of the box car used as a depot is 294.26 meters distant in azimuth 191° 08′.

North Dakota-Montana boundary monument eccentric (Billings County, N. Dak., and Dawson County, Mont., E. H. P., 1912).—About 20 miles north of Beach, in a small saddle on the crest of the divide about 300 meters west of the house of L. C. Callender, who lives on the Wibaux-Trotter wagon road, and 3.28 meters north of the *North Dakota-Montana boundary monument*, which is an old oak post. The station is marked according to note 1[1]. The southwest corner of section 7, T. 143 N., R. 105 W., is 33.48 meters from the station in azimuth 00° 08′, and the southeast corner of section 22, T. 17 N., R. 60 E., is 261.31 meters distant in azimuth 00° 09′. The old oak boundary post is in azimuth 359° 40′, and the chimney of Mr. Callender's house is in azimuth 293° 21′. Latitude observations were made at the eccentric station in 1913.

Bench mark $\frac{122}{2}$ (Valley County, Mont., E. H. P., 1912).—This station is a bench mark of the Missouri River Commission. It is about 2 miles west of Mondak, three-fourths mile east of Snowden, and 100 feet south of the Great Northern Railway track, on the north side of a public road close to the gate at the private road crossing opposite Dan Steele's house. The station is marked according to note 5.[1]

Bench mark $\frac{121}{2}$ (Valley County, Mont., E. H. P., 1912).—This station is a bench mark of the Missouri River Commission. It is about 2 miles west of Snowden water tank and section house, 350 meters north of the Great Northern Railway track, and about 15 meters south of the Mondak-Bainville wagon road, in a hay field owned by Peter Belland. The station is marked according to note 5,[1] the pipe projecting about 6 inches above the ground.

Bilby (Divide County, N. Dak., C. H. S., 1911).—This is one of the United States and Canada Boundary Survey stations. It is about 5 miles southwest of Ambrose and about 2 miles south of the road from Ambrose to Colgan, on a hill about one-half mile southeast of a house having a sun parlor on the east side. The house is gray and there is a yellow barn near it. The station is marked by a boundary survey bronze tablet set in a block of concrete.

Jasper (Divide County, N. Dak., C. H. S., 1911).—This is one of the United States and Canada Boundary Survey stations. It is about 10 miles southwest of Ambrose and 2½ miles nearly due south of Colgan, on a prominent rounded knoll of a range of hills running east and west. The station is marked by a boundary survey bronze tablet set in concrete. There are a few large bowlders about 6 feet northwest of the station. Mr. Henry Highland's house is about 1½ miles northeast of the station.

THIRTY-NINTH PARALLEL

PRINCIPAL POINTS.

Arapahoe (Cheyenne County, Colo., F. W. P., 1892).—About 7 miles southeast of Arapahoe and 11 miles southwest of Weskan, towns on the Union Pacific Railroad, and 3 miles west of the Kansas-Colorado boundary line, on the highest and most prominent hill in the vicinity, in the NW. ¼ NE. ¼ sec. 10, T. 15 S., R. 42 W. The station is marked at the surface by a tack in the top of a squared white-oak stake. Below the stake are two underground marks, a 4-gallon stone jar with a small hole in the bottom buried with the top down about 2 feet below the surface, and a 1-gallon stone jug buried mouth upward about 3 feet below the surface.

Monotony (Cheyenne County, Colo., F. W. P., 1892).—Near the north boundary of the county, in the NW. ¼ NE. ¼ sec. 8, T. 12 S., R. 43 W., on the highest point of the divide between the north fork of the Smoky Hill River to the north and Sand Creek to the south and about 3 miles distant from each. The nearest house is on the Cheyenne Wells-Burlington road, about 4½ miles northwest of the station and belongs to Mr. A. Eichels. The station is marked at the surface by a tack in the top of a squared white-oak stake. Below the stake are two underground marks, a 3-gallon stone jar with a small hole in the bottom, buried with the top down, about 2½ feet below the surface, and a 1-gallon jug, buried mouth upward, about 4 feet below the surface. Some broken crockery was mixed with the soil about the stake and a pyramid of large rocks was built over the station. There are two reference marks similar to the surface marks of the station, one 10 feet to the east and the other the same distance to the west.

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[1] See p. 115.

Cheyenne Wells (Cheyenne County, Colo., F. W. P., 1892).—About 9 miles northwest of Cheyenne Wells, a town on the Union Pacific Railroad, on the highest part of a ridge about one-half mile west of the Cheyenne Wells-Beloit road about 2½ miles toward Beloit from where the road crosses the Smoky Hill River. The station is in the northern part of T. 13 S., R. 45 W., and is marked at the surface by a cross in the top of a limestone post which projects about 2 inches above the ground. Below the post are two underground marks, a 1-gallon crock with a small hole in the bottom, buried with the top down, about 3½ feet below the surface, and a 1-gallon jug, buried mouth upward, about 4½ feet below the surface. Pieces of broken crockery were mixed with the soil when the marks were set and a 4-foot pyramid of rocks was built over the station.

First View (Cheyenne County, Colo., F. W. P., 1892).—About 1½ miles south by west of First View, a town on the Union Pacific Railroad, on the western extremety of the plateau east of the Big Sandy Creek, and 221.19 meters south 83° west of the half-section corner between sections 27 and 34, T. 14 S., R. 46 W., which corner is marked by a block of limestone surrounded by four pits. The station is marked at the surface by a cross in the top of a block of soft limestone and underground by a cross in an irregular-shaped stone about 3 feet below the surface. Just below the surface mark is a circular paving 3 feet in diameter consisting of pieces of broken tile, and below this paving other pieces of tile are mixed with the soil.

Landsman (Cheyenne County, Colo., F. W. P., 1892).—About 9 miles north-northwest of First View, a town on the Union Pacific Railroad, about 4½ miles north-northwest of a large lake, and 3 miles north of the old Overland Trail, on the highest hill at the extreme western edge of the plateau, and about one-half mile east of a deep ravine which extends northwest and southeast. The station is in the northwest corner of T. 13 S., R. 46 W., and is marked at the surface by a cross in the top of a sandstone post, which projects about 2 inches above the ground and is surrounded at a depth of 3 inches by a circular paving 4 feet in diameter made of pieces of broken tile. The underground mark is a cross in an irregular-shaped black rock about 3 feet below the surface. Between the upper and lower marks are several rings 3 or 4 feet in diameter made with pieces of sandstone.

Kit Carson (Cheyenne County, Colo., O. H. T., 1882).—About 5 miles southwest of Kit Carson, a town on the Union Pacific Railroad, on top of a high sand dune west of the Pueblo trail at a point about 1 mile southwest of where the trail crosses the old abandoned roadbed of the Arkansas Valley Railroad. The station is marked both at the surface and underground by a cross in the top of a lead bolt embedded in an irregular-shaped stone, which is inscribed with the letters U. S. T. S. Four stones, each marked with a cross, are respectively 1 meter distant north, east, south, and west, and they form a square whose diagonals intersect at the station.

Eureka (Cheyenne County, Colo., O. H. T., 1881).—About 14 miles north of Kit Carson, a town on the Union Pacific Railroad, and 2 miles north-northwest of the Big Springs ranch house, on a hill just west of a side road that branches from the main road a short distance north of the ranch house. The station is marked at the surface by a cross cut in stone, and underground by a cross in the top of a lead bolt in an irregularly shaped stone, which is marked with the letters U. S. T. S., and is set about 2½ feet below the surface. Four stones, each marked with a cross, are respectively 1 meter distant north, east, south, and west, and they form a square whose diagonals intersect at the station. There is a pyramid of loose stones about 3 feet high over the station mark.

Aroya (Lincoln County, Colo., O. H. T., 1881).—About 4 miles south 21° west (magnetic) from the telegraph office at Aroya, a town on the Union Pacific Railroad, on the eastern slope of a high ridge of sand hills which forms the watershed between Rush Creek and Big Sandy Creek. There is an unobstructed view from the station to the north, east, and south. The station is marked at the surface by a cross in a lead bolt in a bowlder, and underground by a cross and the letters U. S. T. S. in a bowlder about 3 feet below the surface. Four bowlders, each marked with a cross, are respectively 1 meter distant, and they form a square whose diagonals intersect at the station.

Overland (Lincoln County, Colo., O. H. T., 1881).—About 20.6 kilometers north 22° west (magnetic) from Aroya, a town on the Union Pacific Railroad, and 734.8 meters north 82° 50′ west (magnetic) from the stake at the corner of townships 11 and 12, ranges 51 and 52 west, north of the old stage road, on one of the highest southern spurs of the ridge which forms the divide between Big Sandy Creek and Republican Creek. There is higher land north and northwest of the station. The station is marked at tho surface by a cross cut in a bowlder, and underground by a cross in the top of a lead bolt in a bowlder about 1½ feet below the surface. Four stones, each marked with a cross, are respectively 1 meter distant north, east, south, and west, and they form a square whose diagonals intersect at the station. There is a pile of stones over the station mark.

Hugo (Lincoln County, Colo., O. H. T., 1880).—On a high sand dune about 4 miles south 18° west (magnetic) from the railroad office at Hugo, a town on the Union Pacific Railroad. On the north side of the dune a deep sand pit has been hollowed out by the erosive action of wind and water, and the pit presents the appearance of a huge excavation. The station is marked at the surface by a cross in the top of a lead bolt in a soft grayish stone marked with a triangle and the letters U. S. T. S. The underground mark, 3 feet below tho surface, is similar to the surface mark, except there is no triangle marked on tho stone. Four small stones, each marked with a cross, aro at the following distances from the station: North, 1.52 meters; east, 1.80 meters; south, 1.45 meters; and west, 1.80 meters. The diagonal lines from these four stones intersect at the station.

Adobe (Lincoln County, Colo., O. H. T., 1881).—On the highest one of the bold bluish-colored bluffs on the south side of the head of Adobe Creek, about 4 miles south of the Las Animas road. The station is marked at the surface by a cross in the top of a lead bolt in a round conglomerato bowlder marked with the letters U. S. T. S., and underground by a cross in the top of a lead bolt in a block of sandstone 2½ feet below the surface. Four stones, each marked with a cross, are respectively 1 meter distant north, east, south, and west, and they form a squaro whose diagonals intersect at the station.

Square Bluffs (Lincoln County, Colo., O. H. T., 1880).—On tho high land known as the Horse Creek Square Bluffs, on the eastern side of Horso Creek, and about 1½ miles northeast of Seldomridge's sheep corral, which is besido the creek. Tho station is marked at the surfaco by a lead bolt in a bowlder which is inscribed U. S. T. S., and underground by a small bowlder marked with a trianglo and tho letters U. S. T. S. and set 2 feet below the surface. Four referenco stones, each marked with a cross, are respectively 4 feet distant north, east, south, and west, and they form a squaro whoso diagonals intersect at the station. There is a pile of stones over the station mark.

Holt (Elbert County, Colo., O. H. T., 1880).—About 6 miles a littlo east of north of Col. Holt's homo ranch on Horse Creek and about 4 miles due north of Antelope Springs, near the southern extremity of a point of tho high plateau which forms tho divide between Big Sandy Creek and Rush Creek. The station is marked by a cross on a bowlder slightly below the surface, and by a cross in the top of a lead bolt in a bowlder 3 feet below the ground. Four referenco stones, each marked with a cross, are respectively 1 meter distant north, east, south, and west, and they form a square whose diagonals intersect at the station. The west referenco stone is red.

Cramer Gulch (Lincoln County, Colo., O. H. T., 1880; 1895).—About 8 miles south of tho "M. C." ranch, on one of the sand dunes forming the eastern border of Cramer Gulch or Creek, about 2 miles in a northerly direction from the springs and the adobe house in tho gulch. Tho house is not visible from the station, as tho view is cut off by a hill about 1000 meters to tho southward. The station is marked at the surface by a cross in a small bowlder, and underground by a similar mark 3 feet below the surface. Four reference stones, each marked with a cross, are at the following distances from tho station: North, 0.995 meter; east, 1.040 meters; south, 1.004 meters; and west, 1.000 meter. The diagonal lines from theso four stones intersect at the station.

Big Springs (El Paso County, O. H. T., 1880; 1895).—About 30 miles east of Colorado Springs and about 6 miles south of Mr. Pebble's home ranch, which is known as Big Springs. The station is a short distance southwest of a road connecting various outlying ranches with the home ranch and is on the highest point within a radius of 6 miles. It is marked at the surface by a lead bolt in a red sandstone bowlder and underground by a triangle in a white conglomerato rock inscribed U. S. T. S. and set one-half meter below the surface. Four reference marks of red sandstone, each marked with a lead bolt in its upper surface, are respectively 1 meter distant, and they form a square whose diagonals intersect at the station. A pile of loose stones is over the station.

Holcolm Hills (El Paso County, O. H. T., 1880).—About 1 mile northeast of tho Paint Rocks, on the highest land bordering Bracket Creek valley on the east. The station overlooks the plain to the westward and the head of the valley of Big Sandy Creek to the northeastward and eastward. It is marked at the surface by a lead bolt in a large irregular stone inscribed U. S. T. S., and underground by a cross in a lead bolt in a bowlder marked with a triangle and the letters U. S. T. S. and set 3 feet below the surface. Four small reference stones, each marked with a cross, are respectively 4 feet distant, north, east, south, and west. There is a cairn over the station mark.

Divide (El Paso County, O. H. T., 1880; 1912).—About 3 miles east of Eastonville, a town on the Colorado & Southern Railway, and about one-fourth mile south of the bluffs forming the southern edge of a large plateau or mesa, near the western end of the middle and largest one of three small hills or buttes. The station is marked at the surface by a drill hole in a stone 20 inches square and 6 inches thick set flush with the surface of the ground. The underground mark is a cross in a lead bolt in a bowlder 1½ feet below the ground. Four reference stones, in each of which is a lead bolt marked with a cross, are respectively 1.83 meters from the station, north, east, south, and west. A large cairn, visible from the Eastonville road, is on the edge of the bluff 14 meters from the station in azimuth 30° 10′. Two pine trees, one marked with a square blaze and the other with a triangular blaze, are respectively 22.93 meters from the station in azimuth 212° 12′, and 21.43 meters in azimuth 232° 15′.

Corral Bluffs (El Paso County, Colo., O. H. T., 1879).—On the edge of the bluff forming the northern boundary of what is known as the Big Corral, a natural formation used to pen up cattle during the round-up. The station is on the highest land in the vicinity and commands a view of the plains as far south as the Arkansas River. It is marked by a solid brick pier, capped by a hewn stone, the top of which is 1.3 meters above the ground. There is an underground mark below the pier.

El Paso east base (El Paso County, Colo., O. H. T., 1878; 1913).—On Munson and Hamlin's ranch, commonly known as tho Townsend ranch, which is included in tho SW. ¼ sec. 33 and the SE. ¼ sec. 32, T. 12 S., R. 63 W. Tho west gable of Munson and Hamlin's barn is 376.6 meters north 14° 35′ east (magnetic) from the station. The station is marked by a copper tack in a lead plug in the top of a granite post 1 foot squaro and 2½ feet long which is set in concrete and inscribed with the letters U. S. E. B. The underground mark, 3½ feet below the ground, is similar to the surface mark.

El Paso west base (El Paso County, Colo., O. H. T., 1878; 1913).—About 15 miles northeast of Colorado Springs and about 1 mile north of tho sheep corral and main spring of water of the so-called Pugsley ranch. The station is on a knoll somewhat higher than a similar one to the southward and lower than a knoll to the northward. It is marked in tho same manner as *El Paso east base* above, except that tho letters W. B. are substituted for the letters E. B.

Plateau (Pueblo County, Colo., F. D. G., 1894; 1895).—About 9 miles north-northeast of Pueblo and 3½ miles northeast of Overton, on tho highest ground at tho north end of the plateau near the east line fence of M. Steele's property, whose home ranch is on the county road 1½ miles north of Overton. Tho station is near the trail which branches from the main road one-fourth mile from Burke's ranch and is 77.1 meters northwest of tho north gatepost in the fence described abovo and 51.2 meters west of the second post from the north gatepost where tho fence bends a little to the north. The station is marked at the surface by a cross in the top of a granite post dressed 6 inches square and inscribed U. S. C. S. Below the post are two underground marks, a half-gallon stone jug 3 feet below the surface, and above this an inverted milk crock with a small hole in the bottom. Two lava stone posts, each dressed 6 inches square at the top and marked with an arrow pointing toward the station, are respectively 3.04 meters northward and 3.00 meters southward from the station.

Pikes Peak (El Paso County, Colo., O. H. T., 1879; 1912).—On the summit of Pikes Peak, just north of the apex of the first northward bend in the burro trail leading west from the Summit Hotel and the terminus of the cogwheel railway. The nearest point of the precipice is about 25 meters north 25° west from the station and the northwest corner of the hotel is 160 meters distant in azimuth 273° 29′. The station is marked by a wire nail leaded in a drill hole in the concrete foundation of an old masonry pier. The pier, only a part of which remains, was built on four pillars in order to leave access to this nail. The station is also marked by a nail in a 4 by 4 inch scantling at the top of the remnants of the pier about 1 meter above the foundation. A United States Geological Survey triangulation station mark is on the southwest corner of the pier 0.467 meter distant in azimuth 50° 46′. A United States Geological Survey bench-mark tablet is embedded in the top of a large bowlder 13.594 meters from the station in azimuth 99° 52′. In the south face of this same bowlder is an aluminum tablet inscribed with the latitude and longitude, but it is badly defaced by bullet marks.

Bison (Park County, Colo., F. W. P., 1894).—On the highest point of rocks on Bison Peak, the king peak of the Tarryall Range, which is between Tarryall Creek and Goose Creek. The station is near the ninth meridian west, in township 9 south, and is marked by a nail leaded in a drill hole in the granite rock. A rough masonry pier used in mounting the instrument is above the station mark. Four drill holes in the rock near the station bear, respectively, 0°, 180°, 240°, and 300°.

Mount Ouray (Saguache County, Colo., W. E., 1894).—On the Great Continental Divide on the summit of Mount Ouray, about 4 kilometers in a northeasterly direction from Marshall Pass, a station on the Denver & Rio Grande Railroad. The station is marked by a cross in a copper bolt set in the solid surface rock. It is also marked by a drill hole filled with charcoal and plaster of Paris in a brick embedded in the top of a brick and concrete pier built above the lower mark. The station is surrounded by a ring wall of loose stones 4 feet high with an inner diameter of 11 feet. Four reference marks, each consisting of a brick set on end and marked with a drill hole filled with plaster of Paris, are just outside the wall at the following distances and azimuths from the station: 2.75 meters, 5° 31′; 2.80 meters, 96° 46′; 2.74 meters, 186° 11′; and 2.73 meters, 275° 54′. *Mount Ouray latitude station*, marked by a brick and concrete pier, is 20.514 meters distant in azimuth 188° 23′.

Mount Elbert (Lake County, Colo., P. A. W., 1894).—On the summit of Mount Elbert, about 7 miles by trail from the town of Twin Lakes (also called Dayton). The station is marked by a copper bolt leaded into a drill hole in a large surface rock. It is also marked, 5 inches above the bolt, by a drill hole in a rock embedded in a 5-inch layer of masonry built between the bases of the three small brick piers used in mounting the instrument. At a distance of 5 feet in each of the directions north, east, south, and west is a reference stone marked with a drill hole. The station is nearly surrounded by a square rock wall.

Treasury Mountain (Gunnison County, Colo., W. E., 1893).—On the summit of Treasury Mountain, a prominent peak in the Elk Mountain Range, about 2 miles southeast of the mining town of Crystal. The station is marked by a copper bolt set in a drill hole in the solid surface rock. It is also marked, 6 inches above the bolt, by a drill hole filled with plaster of Paris in a brick embedded in a layer of masonry built between the bases of the three small brick piers used in mounting the instrument. The station is nearly surrounded by a ring wall of rocks 4 feet high with an inner diameter of 10 feet. Four reference marks, each consisting of a drill hole in a surface rock, are just outside the wall at the following distances and azimuths from the station: 2.31 meters, 267° 10′; 2.25 meters, 351° 25′; 2.39 meters, 81° 45′; and 2.39 meters, 177° 20′. *Treasury Mountain latitude station*, marked by a brick pier, is 31.13 meters from the station in azimuth 327° 43′.

Uncompahgre (Hinsdale County, Colo., W. E., 1895).—On the summit of Uncompahgre Peak, one of the most prominent and best known peaks in southwestern Colorado, about 8 miles northwest of Lake City. The station is within about 10 feet of the perpendicular cliff on the north side of the summit. It is marked by a cross in a copper bolt which is leaded in a drill hole in the solid surface rock. The station is also marked, 4 inches above the copper bolt, by a drill hole in a brick embedded in a layer of concrete which connects the bases of three small brick piers used for mounting the instrument. The station is nearly surrounded by a ring wall of rocks 4 feet high with an inner diameter of 11 feet. Four reference marks, each consisting of a drill hole in a rock filled with lead, are at the following distances and azimuths from the station: 2.48 meters, 3° 36′; 2.85 meters, 89° 58′; 2.65 meters, 179° 49′; and 2.87 meters, 269° 56′. *Uncompahgre latitude station*, marked by a brick pier with a concrete foundation, is 15.275 meters from the station in azimuth 305° 55′.

Mount Waas (Grand County, Utah, W. E., 1893).—On the highest point of Mount Waas, which is the third prominent peak from the north end of the La Sal Mountains. The station is marked by a cross in a copper bolt which is set in a drill hole in the rock between the bases of three small brick piers used for mounting the instrument. The station is surrounded by a ring wall of rocks 4 feet high with an inner diameter of 10 feet. Four reference marks, each probably consisting of a drill hole in the rock, are just outside the wall at the following distances and azimuths from the station: 2.24 meters, 3° 58′; 2.29 meters, 104° 19′; 2.18 meters, 186° 37′; and 2.21 meters, 275° 45′. *Mount Waas astronomic station*, marked by a concrete pier, is 28.213 meters from the station in azimuth about 329°.

Tavaputs (Garfield County, Colo., W. E., 1891).—On the southern edge of the Book Mountains, which in this vicinity consist of low flat ridges sparsely covered with pine and aspen trees. The station is between West Salt Wash, 3 miles to the southeast, and Bitter Creek, three-fourths mile to the west. Bitter Creek has its source in a fresh-water spring 1¼ miles distant to the north. The marking of the station is similar to that of *Uncompahgre* (see above) except that there are only three reference marks which are at the following distances and azimuths from the station: 2.43 meters, 74° 41′; 2.40 meters, 196° 31′; and 2.43 meters, 322° 12′.

Patmos Head (Carbon County, Utah, W. E., 1890).—On Patmos Head, one of the peaks of the range of mountains known as West Tavaputs Plateau, and the highest point within several miles. It is about 12½ miles southeast from Sunnyside and 3 miles southeast of the upper end of Dry Canyon. The station is marked by a copper bolt in a rock bedded in the ground, and about 8 inches above the bolt by a drill hole in another rock which is cemented to the lower one. Three small brick piers, used for mounting the instrument, are about the station, and the whole is surrounded by a ring wall of rocks 3½ feet high with an inner diameter of 11 feet. Four reference marks are outside the ring wall at the following distances and azimuths from the station: Drill hole in a rock, 2.59 meters, 233° 16′; drill hole in a rock, 2.62 meters, 327° 07′; copper bolt in a rock, 3.45 meters, 343° 16′; and a stump, 3.35 meters, 90° 06′. *Patmos Head astronomic station* is 56.76 meters from the station in azimuth 190° 12′.

Mount Ellen (Garfield County, Utah, W. E., 1891).—On the summit of Mount Ellen, the northern peak of the Henry Mountains, a conical barren peak the upper part of which is covered with rough broken pieces of granite rock. The station is marked by a copper bolt in a rock embedded in concrete and a few inches above the bolt by a drill hole in another rock set between the bases of three small brick piers used for supporting the instrument. The station is nearly surrounded by a ring wall of rocks 4½ feet high with an inner diameter of 11 feet. Three reference marks, each consisting of a drill hole filled with plaster of Paris in the solid surface rock, are just outside of the wall at the following distances and azimuths from the station: 2.41 meters, 23° 35′; 2.44 meters, 144° 45′; and 2.39 meters, 263° 34′. *Mount Ellen astronomic station*, marked by a brick pier, is 15.02 meters from the station in azimuth 5° 20′.

Wasatch (San Pete County, Utah, W. E., 1890).—On a small peak or table near the southern end of the Wasatch Mountain Range, the highest point of this part of the range. It is between the South Fork of Ferron Creek to the north and the North Fork of Muddy Creek to the south, the sources of both creeks being within short distances of the station. The station is marked by two copper bolts in a drill hole in a limestone rock, the lower bolt being leaded and the upper one cemented in the hole. About the station are three small brick piers used in mounting the instrument, and the whole is surrounded by a ring wall of rocks 4 feet high with an inner diameter of 11½ feet. Four reference marks, each consisting of a brick set on end and marked with a drill hole filled with plaster of Paris, are just outside the wall at the following distances and azimuths from the station: 2.40 meters, 32° 12′; 2.33 meters, 91° 39′; 2.51 meters, 164° 26′; and 2.33 meters, 305° 39′. *Wasatch astronomic* station, marked by a brick pier, is 121.0 meters from the station in azimuth 218° 41′.

Tushar (Piute County, Utah, W. E., 1885).—On the summit of Mount Belknap, the northern one of the three highest peaks of the Tushar Mountains. The station is marked by a copper bolt leaded in a drill hole in the solid rock. It is also marked, above the bolt, by a drill hole in a flat rock fitted between the bases of the three small brick piers used in mounting the instrument. The station is nearly surrounded by a circular wall of rocks 4½ feet high, with an inner diameter of 11 feet.

Mount Nebo (Juab County, Utah, W. E., 1887).—On the southernmost summit of Mount Nebo. The station is marked by a copper bolt in a drill hole in the solid rock. Three small brick piers used in mounting the instrument are about the station, and these in turn are nearly surrounded by a ring wall of rocks 10 or 12 feet in diameter. Four reference marks, each consisting of a drill hole in the rock, are just outside the wall at the following distances and azimuths from the station: 2.56 meters, 38° 01′; 2.66 meters, 121° 28′; 4.25 meters, 204° 16′; and 3.32 meters, 309° 39′. *Mount Nebo astronomic* station, marked by a brick pier, is 23.25 meters (given 25.25 meters in latitude record) from the station in azimuth 321° 35′. The vertical circle station is 4.60 meters distant in azimuth 49° 00′. The latitude pier is partly surrounded by a square rock wall, and the vertical circle station by a circular wall similar to that about the station but smaller.

Ibepah (Juab County, Utah, W. E., 1889).—About 15 miles a little east of south from Ibepah post office, on Ibepah Peak, in the Deep Creek range of mountains. The peak has the general appearance of a roof of a house with the ridge extending east and west. The peak terminates in two principal summits of equal height, one at the extreme western end of the crest and the other near the middle, the station being on the latter. The station is marked by a copper bolt in a drill hole in solid rock, over which is a layer of masonry built between the bases of three small brick piers used in mounting the instrument. The station is nearly surrounded by a ring wall of rocks 5 feet high, with an inner diameter of 11 feet. Four drill holes in solid rock are just outside the wall at the following distances and azimuths from the station: 2.97 meters, 246° 20′; 3.07 meters, 300° 12′; 3.25 meters, 91° 32′; and 3.18 meters, 134° 32′. *Ibepah astronomic* station, marked by a masonry pier, is 21.2 meters from the station in azimuth 108° 51′.

Wheeler Peak (White Pine County, Nev., W. E., 1882).—On Wheeler Peak, the highest and most prominent mountain of the Snake Range, on the western or higher prong of the double peak. The station is marked by a copper bolt leaded in a drill hole in solid rock. It is also marked, a few inches above the bolt, by a drill hole in a flat stone secured in position by the masonry foundation built for the instrument. The station is nearly surrounded by a ring wall of rocks. Three drill holes in solid rock are just outside the ring wall at the following distances from the station: 2.40 meters north, 2.60 meters east, and 2.40 meters southwest. The vertical circle station, also surrounded by a ring wall, is 57.75 meters east of the station.

Pilot Peak (Elko County, Nev., W. E., 1889).—On Pilot Peak, the highest peak of a prominent range of mountains bordering the Great American Desert on the west. The peak is very rugged and rocky and is almost inaccessible. The station is on the highest point of the summit at the junction point of the three main spurs of the peak. It is marked by a copper bolt in a drill hole in solid rock. It is also marked about 10 inches above the bolt by a drill hole in a flat stone embedded in the masonry built between the bases of three small piers used for mounting the instrument. The station is nearly surrounded by a ring wall of rocks, about 4½ feet high, with an inner diameter of 11 feet. Four reference marks, each a drill hole in solid rock filled with lead, are just outside the wall at the following distances and azimuths from the station: 2.98 meters, 47° 36′; 2.73 meters, 123° 29′; 2.67 meters, 189° 13′; and 2.97 meters, 324° 59′. *Pilot Peak latitude* station, marked by a brick pier, is 12.65 meters from the station in azimuth 276° 26′.

Ogden Peak (Weber County, Utah, W. E., 1888).—On a peak of the Wasatch Mountains, about 4 miles east of Ogden. The west slope of the mountain is very steep and rough, and the station is more easily reached from the east. The station is marked by a copper bolt in a drill hole in solid rock. It is also marked by a drill hole in a flat rock embedded in the masonry built between the bases of three small piers used for mounting the instrument. The station is nearly surrounded by a ring wall of rocks, with an inner diameter of about 11 feet. Three reference marks, each a drill hole in solid rock filled with lead, are just outside the ring wall at the following distances and azimuths from the station: 2.84 meters, 22° 35′; 2.93 meters, 177° 55′; and 2.55 meters, 288° 43′. *Ogden Peak astronomic* station, marked by a brick pier, is 13.2 meters from the station in azimuth 92° 01′. The vertical circle station, with a ring wall similar to that about the station, is 7.0 meters distant in azimuth 310° 43′. The magnetic station is 20.4 meters from the station in azimuth 323° 56′.

Deseret (Tooele County, Utah, W. E., 1892).—On the summit of the highest peak of the Onaqui Mountains, about 8 miles a little west of south from Grantsville and about 12 miles east of Stockton. The station is marked by a copper bolt set in solid rock between the bases of three small piers used for mounting the instrument. The station is nearly surrounded by a ring wall of rocks 4 feet high, with an inner diameter of 11 feet. Three reference marks are just outside the wall at the following distances and azimuths from the station: 3.10 meters, 322° 53′; 2.18 meters, 88° 08′; and 2.62 meters, 198° 38′. *Deseret latitude* station, marked by a stone and brick pier, is 10.85 meters from the station in azimuth 27° 42′.

Promontory (Boxelder County, Utah, W. E., 1892).—On the most southeastern summit of the Promontory Mounains, on Promontory Peninsula, which extends into Great Salt Lake from the north. The summit is very rocky and rough, being composed of bare, sharp, stratified rocks, with the dip nearly vertical. The station is marked by a cross in a copper bolt set in solid rock and surrounded by a hollow brick pier 32 inches square supporting a red sandstone cap, which bears a second copper bolt directly abovo the first and is inscribed with a triangle and the legend "U. S. C. & G. Survey, 1892." The station is nearly surrounded by a ring wall of rocks 4 feet high, with an inner diameter of 12 feet. Three reference marks, each consisting of a drill hole in solid rock, are just outside the wall at the following distances and azimuths from the station: 2.50 meters, 213° 32′; 2.44 meters, 314° 08′; and 2.71 meters, 70° 48′. *Promontory latitude* station, marked by a stone and brick pier, is 16.61 meters from the station in azimuth 88° 41′. The vertical circle station is in azimuth 11° 11′.

Antelope (Davis County, Utah, W. E., 1892).—On the highest point of Antelope Island, in Great Salt Lake The station is marked by a copper bolt set in solid rock and surrounded by a hollow brick pier 28 inches square supporting a red sandstone cap, which bears a second copper bolt directly above the first and is inscribed with a triangle and the legend "U. S. C. & G. Survey, 1892." The station is nearly surrounded by a ring wall of rocks about 4 feet high, with an inner diameter of 10 feet. Three reference marks, each a drill hole in solid rock, are just outside the wall at the following distances and azimuths from the station: 2.43 meters, 40° 57′; 2.58 meters, 174° 22′; and 2.30 meters, 293° 42′. *Antelope latitude* station, marked by a brick pier, is 10.44 meters from the station in azimuth 13° 34′. The vertical circle station is 8.75 meters distant.

Waddoup (Davis County, Utah, W. E., 1892).—About three-fourths mile southeast of Centerville and 27 meters north and 88 meters west of the southeast corner of the NW. ¼ sec. 18, T. 2 N., R. 1 E., on the west side of Thomas Waddoup's barnyard, 24 meters west of his residence. The Union Pacific Railroad station at Centerville is in the northwest quarter of the same quarter section. The station is marked by a copper bolt in the top of a granite post 2 feet long, dressed 7 inches square on top, set 2 feet below the general surface of the ground. This mark is surrounded by a hollow brick pier 32 inches square and 4 feet high above the ground, on the top of which is a sandstone cap 4 inches thick. The station is marked on this cap by a drill hole surrounded by a triangle and the inscription "U. S. C. & G. Survey, 1892."

Salt Lake southeast base (Davis County, Utah, W. E., 1896).—In the second field southwest of Mr Hill's house and orchard, which is on the road between Kaysville and Syracuse. The station is about halfway between the first fence to the eastward and the edge of the salt grass to the southwest. It is marked underground by a cross in a copper bolt set in a block of sandstone 2 feet square and 10 inches thick, 4½ feet below the surface of the ground. Above this mark is a brick pier 4 feet square at the base built to a height of about 9 feet above the ground. There is an opening in the pier at the surface of the ground to give access to the surface mark, which is exactly the same as the underground mark and is embedded in the center of the pier.

Salt Lake northwest base (Davis County, Utah, W. E., 1896).—About 1½ miles north of Syracuse Grove, the terminus of the Syracuse Branch Railroad, in the field southeast of a road crossing, 51 meters from the fence to the north and 63 meters from the fence to the west. The station is on property belonging to Mr. Cato Love, whose house is about 350 meters to the eastward. Mr. Gilbert Parker's house is across the road southwest of the station, and Mr.

John W. Singleton's house is diagonally across the road crossing to the northwest. The station is marked the same as *Salt Lake southeast base*, except that the underground mark is only about 2½ feet below the surface.

Pioche (Lincoln County, Nev., W. E., 1883).—About 33 miles by road and 22.5 miles direct in an easterly direction from the town of Pioche, on the summit of Pioche Peak. The station is marked by a copper bolt leaded in a drill hole in solid bedrock. It is also marked a few inches above the bolt by a drill hole in a flat stone in the masonry foundation used for supporting the instrument. The station is nearly surrounded by a ring wall of rocks having an inner diameter of about 11 feet. Four reference marks, each a drill hole in solid rock, are just outside the wall at the following distances and azimuths from the station: 2.52 meters, 214° 28′; 2.41 meters, 271° 38′; 2.72 meters, 344° 46′; and 2.35 meters, 92° 30′. *Pioche latitude* station, marked by a masonry pier, is 12.10 meters from the station in azimuth 135° 57′. The vertical circle station, nearly surrounded by a ring wall of rocks with an inner diameter of 8 feet, is 21.1 meters noath-northwest from the station.

White Pine (Nye County, Nev., W. E., 1881).—On a peak locally known as Troy Peak, the highest and boldest point of the Grant Range of mountains. The station is marked by a copper bolt in a drill hole in solid rock, and above the bolt by a bottle embedded in plaster at the center of a low pier used for mounting the instrument. The station is nearly surrounded by a ring wall of rocks. Three drill holes in solid rock are just outside the wall at the following distances from the station: 3.14 meters northeast, 2.33 meters southeast, and 2.74 meters west. The vertical circle station, partly surrounded by a ring wall of rocks, is 8.42 meters north of the station.

Diamond Peak (Eureka County, Nev., W. E., 1881).—About 12 miles northeast of Eureka, on Diamond Peak, the highest point of the Diamond Range of mountains. The station is marked by a copper bolt set in solid rock. The bolt is protected by the low masonry foundation used for mounting the instrument. The station is nearly surrounded by a ring wall of rocks, and just outside this wall are four drill holes in the solid rock at the following distances and azimuths from the station: 2.65 meters, 10° 04′; 2.84 meters, 92° 59′; 3.27 meters, 204° 29′; and 4.72 meters, 291° 44′. *Diamond Peak latitude* station, marked by a masonry pier, is 25.85 meters from the station in azimuth 250° 24′. The vertical circle station, partly surrounded by a small ring wall of rocks, is 23.65 meters south of the station.

Toiyabe Dome (Nye County, Nev., W. E., 1880).—On a peak locally known as Bold Mountain and Mount Poston, the highest and boldest southern extremity of the Toiyabe Range of mountains. The peak is steep on the western side and very abrupt on the eastern side. The station is marked by a copper bolt set in solid rock under the center of the low masonry foundation used for mounting the instrument. The station is nearly surrounded by a ring wall of rocks. Four drill holes in the solid rock are outside the wall at the following distances and azimuths from the station: 4.70 meters, 135° 16′; 5.13 meters, 258° 20′; 2.48 meters, 308° 08′; and 5.61 meters, 6° 14′. *Toiyabe Dome latitude* station, marked by a masonry pier, is 24.86 meters from the station in azimuth 148° 56′. The vertical circle station, partly surrounded by a small ring wall of rocks, is 43.10 meters distant in azimuth 151° 03′.

Mount Callahan (Lander County, Nev., W. E., 1881).—About 20 miles north of Austin, on the summit of Mount Callahan, a large flat-topped mountain at the northern extremity of the Toiyabe Range of mountains. The station is marked by a copper bolt set with plaster of Paris in a drill hole in a large rock. This rock is embedded in the foundation of a masonry pier which is 4 feet square and 3 feet high with an opening at the center 6 inches square to give access to the bolt from the top of the pier. There is a bottle set with plaster of Paris in this opening or pit and the pier is capped with a large stone having a drill hole directly above the bolt. The station is nearly surrounded by a ring wall of rocks. Three drill holes in solid rock are outside the wall at the following distances and azimuths from the station: 3.38 meters, 60°; 3.48 meters, 180°; and 3.71 meters, 300°. *Mount Callahan astronomic* station, marked by a masonry pier, is 34.44 meters from the station in azimuth 248° 12′. The vertical circle station, nearly surrounded by a ring wall of rocks, is 11.53 meters from the station in azimuth 4° 10′. The magnetic station protected by a right angled wall of rocks is 18.60 meters from the station in azimuth 194° 12′.

Carson Sink (Churchill County, Nev., W. E., 1880).—About 20 miles in an easterly direction from the town of Stillwater, on the highest point of the Carson Sink Range of mountains. The station is marked by a copper bolt in a drill hole in solid rock. It is also marked, a few inches above the bolt, by a drill hole in a porous rock embedded in the masonry foundation used for mounting the instrument. The station is partly surrounded by a ring wall of rocks about 5½ meters in diameter. Four drill holes in solid rock are at the following distances and azimuths from the station: 5.36 meters, 253° 58′; 5.38 meters, 328° 07′; 3.12 meters, 69° 12′; and 1.99 meters, 163° 42′. *Carson Sink latitude* station pier is 22.68 meters from the station in azimuth 230° 40′. The vertical circle station, partly surrounded by a small ring wall of rocks, is 8.13 meters from the station in azimuth 39° 15′.

Lone Mountain (Esmeralda County, Nev., W. E., 1880, 1902).—On the summit of Lone Mountain. The station is marked by a copper bolt set in a drill hole in a solid ledge of slate. The bolt is protected by a hollow masonry pier built around it. The station is nearly surrounded by a ring wall of rocks about 4½ meters in diameter. Four drill holes in solid rock are outside the wall at the following distances and azimuths from the station: 2.50 meters, 103° 37′; 2.79 meters, 188° 16′; 4.20 meters, 226° 52′; and 6.58 meters, 351° 15′. The vertical circlo station, nearly surrounded by a small ring wall of rocks, is 21.67 meters from the station in azimuth 241° 57′.

Mount Grant (Mineral County, Nev., W. E., 1879).—West of Walker Lake, on the central one of the three peaks which form the summit of Mount Grant, about 200 meters north of the highest one of the three peaks. The station is marked by a copper bolt in a rock embedded in a masonry pier about 3 feet above the base and 8 inches below the top of the pier. An opening or pit in the top of the pier allows access to the bolt. The station is nearly surrounded by a ring wall of rocks about 4 or 5 meters in diamoter, from which there is a hook-shaped spur wall extending to and part way around the vertical circle station which is 9.9 meters south-southeast of the station.

Mount Conness (Tuolumne County, Cal., L. A. S., 1879; 1890).—On Mount Conness, a lofty peak of the Sierra Nevada Range, about 25 miles a little east of north from the Yosemite Valley. The station is on the highest pinnacle of the summit which is a very small irregular crag. It is marked by a cross in a copper bolt set in solid rock and 40 inches above this by another copper bolt in the top of a masonry pier built over the lower mark. The bolt in the top of the pier has a broad spherical head with a small silver pin in the center and a cross a little to one side of the pin to mark the station. *Mount Conness latitude* station marked by a concrete pier is 194.5 meters from the station in azimuth 301° 59′. The magnetic station pier is 180.4 meters from the station in azimuth 298° 20′, and the vertical circle station pier is about 30 meters southwest of the magnetic station.

Mount Como (Douglas County, Nev., W. E., 1879).—About 20 miles east of Genoa, on the summit of Mount Como, a sharp conical peak having a smooth outline and a flat western slope. The station is marked by a copper bolt in a large well-bedded granite rock. A masonry pier built around and over this bolt has a large flat cap stone in which there is a drill hole 9 inches directly above the bolt. A wall of rocks in the shape of a reversed 6, nearly surrounds the station and partly protects the vertical circle station which is 7.24 meters distant in azimuth 338° 12′. Another vertical circle station is 10.60 meters distant in azimuth 179° 04′, and a drill hole in solid rock is 6.25 meters from the station in azimuth 49° 13′. An old monument of a previous survey is in the wall described above about 10 feet southwest of the station.

Pah Rah (Washoe County, Nev., W. E., 1878).—On the most northern one of the three principal summits of the Virginia Mountains south of Pyramid Lake, about 35 miles by road and trail northeast of Reno and about 20 miles by road and trail northwest of Wadsworth. The station is marked by a copper bolt in solid rock and a few inches above the bolt by a drill hole in a flat stone cemented in place over the lower mark. The station is nearly surrounded by a ring wall of rocks. The vertical circle station, marked by a pier, is 2.5 meters from the station in azimuth 217° 30′.

Round Top (Alpine County, Cal., W. E., 1876; 1893).—About 20 miles south of Lake Tahoe, on the crest of the Sierra Nevada Range of mountains, on the highest and most easterly pinnacle, popularly known as Round Top, about 1 mile south of Carson Pass or the main summit of the Amador Grada. The station is marked by a copper bolt in a drill hole in solid rock with a rough masonry pier built over it. *Round Top latitude* station marked by a rough stone pier, is about 11 meters west of the station. There is another pier near the latitude pier and a third pier north of the station.

Mount Lola (Nevada County, Cal., W. E., 1876; 1893).—About 25 feet northwest from the highest part of the most southern summit of the high ridge between Weber and Independence Lakes and the town of Meadow Lake. Independence Lako lies at the southeast base of this ridgo and Browns Valley is on tho opposite side. The station is marked by a cross in a copper bolt set in a drill holo in a large flat stono embedded in a masonry pier about 15 inches above the ground. It is also marked by a drill hole in the capstone of the pier. The station is nearly surrounded by a ring wall of rocks. *Mount Lola latitude* station, marked by a brick pier, is 9.5 meters north 45° east from the station. Two other brick piers are respectively 8.5 meters north 36° east from the station and north 28° west.

SUPPLEMENTARY POINTS.

Glen Eyrie (El Paso County, Colo., O. H. T., 1880).—About 7 miles northwest of Colorado Springs and 2 miles northwest of General Parmer's dwelling house, on the foothills north of the Garden of the Gods and about 3 miles from the Gateway. Tho station is on the first ridge west of Glen Eyrie, and about 500 meters northwest of the point where a high bald hill beside the glen joins the main ridge. The station is marked by a cross on a lead bolt in a flat stone about 1 foot below the surface of the ground.

Bear Creek (El Paso County, Colo., O. H. T., 1879).—About 4 miles west-southwest of Colorado Springs and just south of Bear Creek on one of tho front foothills of Pikes Peak. The station is marked by a cross in the lead which fills a hole 3 inches in diameter and 1½ inches deep in a flat stone about 1 foot below the surface of the ground.

Colorado Springs latitude and longitude (El Paso County, Colo., E. S., 1873; 1879).—Just east of the Denver & Rio Grande Railroad passenger depot at Colorado Springs, in tho experimental garden just north of the main walk, about 60 meters west of the east gate. The station is marked by the foundation of an old masonry pier.

Colorado Springs astronomic (*U. S. E.*) (El Paso County, Colo., O. H. T., 1879).—On a rise of ground southeast of the freight depot of the Denver & Rio Grande Railroad at Colorado Springs. The station is marked by a drill hole in the top of a solid stono pier.

Table (Elbert County, Colo., F. D. G., 1895).—About 2½ miles northwest of the town of Elbert, on the highest hill in this vicinity, called Tablo Mountain by the owner, Mr. W. E. Foote, who lives just north of the hill. Tho station is marked at the surface by a nail in a small pine stub, and underground by a drill hole in a flat stono about 15 inches below the ground. A United States Geological Survey station is 1.12 meters east of the station and a fence post, to which is nailed a piece of wood 8 feet high with two cross pieces attached, is 1.55 meters north. Station *Elbert* is on the samo hill.

Mesa (Delta County, Colo., W. E., 1893).—A short distanco north of the most western point of that part of the Grand Mesa which is southeast of Connah Creek, within about 40 feet of tho edge of the rim rock which limits tho mosa. The station is marked by a copper bolt set in the solid lava rock. It is also marked about 10 inches abovo tho ground by a drill hole in a brick embedded in tho masonry which fills tho space between tho bases of the three small brick piers used to support tho instrument.

Chiquita (Mesa County, Colo., W. E., 1895).—About 12 miles south-southwest from Grand Junction, on the northern rim or brow or Piñon Mesa. The station is marked by a low brick pier used in mounting the instrument.

Grand Junction standpipe (Mesa County, Colo., W. E., 1895).—The center of the standpipe at Grand Junction, which is 10 feet in diameter and about 100 feet high. The station was occupied eccentrically at a point 12.03 meters distant in azimuth 166°. The eccentric point is marked by a brick pier.

Valley Knob (Grand County, Utah, W. E., 1890; 1898).—About 5 miles east of Green River, on a bare knoll 50 feet above the valley, one-fourth mile north of the railroad track. The station is marked by a drill driven into the ground. The signal pole and the heliotrope stand weighted down with stones were left in position.

Hartman (Emery County, Utah, C. H. S., 1898).—About 2 miles north of the town of Green River and one-half mile west of the Green River, on the southeast end of a mesa which rises about 40 feet above the general level, the first prominent bank north of a deep wash. The station is marked by a drill hole in a rock over which is a pile of rocks used to secure the base of the signal pole.

Mica (Emery County, Utah, C. H. S., 1898).—About 800 meters south of the depot at Green River, on the east end and highest point of a conspicuous hill sloping toward the westward. The station is marked by a drill hole in a piece of sandstone above which is a pile of bricks used for securing the base of the signal pole.

Reservoir (Emery County, Utah, C. H. S., 1898).—On the high hill just south of the railroad at Green River, near an old abandoned reservoir. The station is marked by a drill hole in a piece of sandstone, 6 feet from the north edge of the reservoir.

Wash (Emery County, Utah, C. H. S., 1898).—About 1½ miles northwest of the town of Green River on the high bluff that forms the rim of the plain just north of the railroad track. The station is about 10 feet north of the edge of the bluff and 75 feet above the plain. It is marked by a drill hole in a shale rock, over which is a pile of rocks used for securing the base of the signal pole.

Green River east base (Emery County, Utah, C. H. S., 1898).—Just west of the first curve of the railroad west of the depot at Green River, about 200 meters from the west water tank and 9 paces north of the track. A low ridge extending north and south is about 20 or 30 meters east of the station. The station is on the top of a low dirt pier and is marked by a drill hole in a piece of sandstone.

Green River west base (Emery County, Utah, C. H. S., 1898).—About one-half mile west of the first curve west of the depot at Green River, 194 meters west of wooden culvert No. 221A and 9 paces north of the north rail of the track. The station is between the line of telegraph poles and the track, and is about 15 or 20 meters southeast of an old railroad grade extending northeast and southwest. The station is marked by a drill hole in a shale rock set flush with the surface of the ground.

Green River north meridian (Emery County, Utah, C. H. S., 1898).—About 625 meters directly north of *Green River longitude* station, about 30 meters north of a large wash and just west of a wagon road. The station is marked by a drill hole in a sandstone block 10 inches square and 18 inches long having a pile of bricks around the top.

Green River south meridian (Emery County, Utah, C. H. S., 1898).—Fifty paces south of the railroad and 12.40 meters north of *Green River longitude* station. The station is marked by a drill hole in a piece of sandstone with four reference bricks placed around it just below the surface of the ground.

Green River longitude (Emery County, Utah, C. H. S., 1898).—On the railroad right of way, 65 paces west of the depot at Green River, 64 paces southwest of the railroad water tank and 50 paces from the railroad. The station is marked by a brick pier 17 by 25 inches, 3 feet high above the ground. *Green River latitude* station, marked by a brick pier 17 inches square, is 51 inches due west of the station.

Cliff (Emery County, Utah, C. H. S., 1898).—This station was neither occupied or marked as its location is nearly inaccessible. It is north-northwest of the town of Green River on a lofty butte about 3 miles long east and west which rises about 2,000 feet above the plain. The upper part of the cliff is composed of stratified rock with the dip vertical and has the general appearance of a huge battleship. The station is the highest point of the cliff which is near the middle of its length.

Green River schoolhouse (Emery County, Utah, C. H. S., 1898).—The flagstaff on the cupola of the small wooden schoolhouse about one-eighth mile northeast of the depot at Green River.

Green River hotel (Emery County, Utah, C. H. S., 1898).—The flagstaff on the railroad hotel just south of the depot at Green River.

Sanpete (Sanpete County, Utah, W. E., 1884).—In the Wasatch Mountain Range, on the north end of the east spur of what is locally known as the Horseshoe. (See *West Sanpete* below.)

West Sanpete (Sanpete County, Utah, W. E., 1890).—In the Wasatch Range of mountains, on the north end of the west spur of what is locally known as the Horseshoe. The Horseshoe is formed by two spurs about two-thirds of a mile apart extending north from an undulating table which slopes toward the south. The station is marked by a copper bolt in a drill hole in solid rock.

Cedar (Juab County, Utah, W. E., 1884).—On the highest peak of the mountains immediately west of Levan. The station is marked by a copper bolt in a drill hole in the rock at the highest point of the peak.

Levan (Juab County, Utah, W. E., 1884).—South 60° east (magnetic) from Levan, on the highest peak of the mountains immediately east of Levan. The station is marked by a copper bolt in a drill hole in the rock at the highest point of the peak about 20 inches below the general surface of the ground.

Scipio (Millard County, Utah, W. E., 1884).—On the highest peak of the Canon Mountains, east of the town of Oak City and northwest of the town of Scipio. The station is on the highest part of the summit, about 10 or 12 feet from the edge of the abrupt slope on the eastern and northeastern side of the peak. The station is marked by a copper bolt set in a drill hole in solid rock. It is also marked, about 15 inches above the bolt, by a drill hole in a flat stone embedded in the top of a low masonry pier used for mounting the instrument. The station is nearly surrounded by a ring wall of rocks about 5 feet high, with an inner diameter of about 11 feet. Four reference marks, each a drill hole in solid rock, are just outside the wall at the following distances and azimuths from the station: 2.74 meters, 177° 55′; 2.77 meters, 284° 55′; 2.94 meters, 41° 33′; and 2.47 meters, 126° 51′.

Cervera (Millard County, Utah, C. H. S., 1898).—On the top of a large sand hill about 8 miles east of Oasis and about 1 mile south of the Oak Creek road. The station is marked by a 2 by 4 inch stub.

Camara (Millard County, Utah, C. H. S., 1898).—On a high sand hill across the valley and about 8 miles northeast of the depot at Oasis. The station is marked by a 2 by 4 inch stub.

Manterola (Millard County, Utah, C. H. S., 1898).—About 3½ miles northeast of Oasis, on high ground overlooking a depression extending northwest and southeast. The station is marked by a 2 by 4 inch stub.

Montijo (Millard County, Utah, C. H. S., 1898).—On a sand hill about 4½ miles east of Oasis, on the north side of the Oak Creek road. The station is marked by a 2 by 4 inch stub.

Augusti (Millard County, Utah, C. H. S., 1898).—On a sand hill on the desert about 3 miles east of the depot at Oasis. The station is marked by a 2 by 4 inch stub.

Blanco (Millard County, Utah, C. H. S., 1898).—On a very prominent sand hill about 2½ miles northeast of the depot at Oasis. This station is marked by a 2 by 4 inch stub.

Canovas (Millard County, Utah, C. H. S., 1898).—On the desert about 1¾ miles east of Oasis, about 200 meters southeast of the first sand hill. The station is marked by a 2 by 4 inch stub.

Oasis northeast base (Millard County, Utah, C. H. S., 1898).—About 1½ miles northeast of the depot at Oasis, on the open desert on the southeast side of the railroad, 24.46 meters from the rail. The station is marked by a 2 by 4 inch stub.

Oasis southwest base (Millard County, Utah., C. H. S., 1898).—One-fourth mile north-northeast of the depot at Oasis, on the bank of a large irrigation ditch on the southeast side of the railroad, 24.61 meters from the rail. The station is marked by a 2 by 4 inch stub.

Oasis north meridian (Millard County, Utah, C. H. S., 1898).—About 1 kilometer north-northwest of the depot at Oasis, on the south side of a large irrigation ditch lined with willows near the Sevier River. The station is 4 paces south of the line of willows and 10 paces west of the third fence post south of the ditch. It is marked by a 4-inch spike driven in the top of a section of an old brick pier, 17 inches square and 2½ feet long, which projects 1 foot above the ground.

Oasis south meridian (Millard County, Utah, C. H. S., 1898).—This station is 5.22 meters due north of *Oasis astronomic* station and is marked by a 2 by 4 inch stub.

Oasis astronomic (Millard County, Utah, C. H. S., 1898).—About 75 meters southwest of the depot at Oasis. The station is marked by a 4-inch spike in the top of the pier.

Oasis schoolhouse tower (Millard County, Utah, C. H. S., 1898).—The schoolhouse is about one-fourth mile southeast of the depot at Oasis.

City Creek (Salt Lake County, Utah, W. E., 1893).—About 2½ miles north of Salt Lake City, on a low east-and-west ridge of the Wasatch Mountains. The station is marked by a cross in a brass bolt in a granite monument 7 inches square on top and 18 inches long. The underground mark is a bottle, and both it and the surface mark are embedded in a mass of concrete.

Salt Lake City longitude (Salt Lake County, Utah, G. W. D., 1869; 1898).—Near the southeast corner of Temple Block, in Salt Lake City. The station is marked by a brass bolt in the top of a sandstone pier.

Salt Lake City latitude (Salt Lake County, Utah, G. W. D., 1869).—This station is 4.8 feet directly east of *Salt Lake City longitude* station. It is marked by a red sandstone post, 22 inches square and 5 feet long, projecting 3 feet above the ground.

Ogden longitude (Weber County, Utah, C. H. S., 1886).—The station is the east pier in the west room of the brick and stone observatory established by Lieut. Wheeler in 1873. It is on the ridge above the west bank of the Weber River, directly opposite Ogden, and about 1½ miles from the courthouse.

Bullwhacker (Eureka County, Nev., C. H. S., 1898).—About 2 miles west of the town of Eureka, on a flat-topped hill on the most western part of the mesa, about 30 meters north of the hoisting mill of the Bullwhacker mine. The station is marked by a drill hole in a stone and by a pile of rocks around the foot of the signal pole.

Desert (Eureka County, Nev., C. H. S., 1898).—About one-third mile west of the ranch house of Morris Regli and about 90 meters north of the east-and-west road. The station is marked by a piece of 1-inch pipe 2 feet long at the center of a piece of 2-inch pipe 14 inches long, both pipes projecting about 2 inches above the ground. There are six stones around the top of the pipes and the base of the signal pole.

Richmond (Eureka County, Nev., C. H. S., 1889; 1898).—On the slope of the hill northeast of the old Richmond smelter. The station is marked by a drill hole in a rock and by a pile of rocks around the foot of the signal pole.

Leo (Eureka County, Nev., C. H. S., 1898).—On the slope of a high hill north-northeast of Eureka courthouse. The station is marked by a drill hole in a rock and by a pile of rocks around the base of the signal pole.

Tank (Eureka County, Nev., C. H. S., 1889; 1898).—West of the courthouse at Eureka, on a hill known locally as Maupin Hill, about 50 meters north of a large round water tank and 12 meters from the east brow of the hill. The station is marked by a drill hole in a fast rock nearly flush with the surface of the ground, with a pile of rocks over it.

Eureka courthouse (Eureka County, Nev., C. H. S., 1889; 1898).—The flagstaff on the east front of the large red brick building on the southwest corner of Main and Bateman Streets, Eureka.

Eureka Catholic Church (Eureka County, Nev., C. H. S., 1889; 1898).—The wooden cross on the wooden tower of a small stone church, near the schoolhouse on the west side of the town of Eureka.

Eureka longitude (Eureka County, Nev., C. H. S., 1889; 1898).—In a stone quarry just east of a large ditch on the east side of the town of Eureka, about 11 meters north of the north line of Bateman Street and about the same distance west of the nearly vertical wall of the quarry. There is a stone wall about 25 meters north of the station and a similar wall about 30 meters south. The station is marked by a drill hole in a large black stone placed on the stone foundation of the old pier.

Prospect Peak (Eureka County, Nev., W. E., 1881; 1898).—On the summit of Prospect Peak, south-southwest from Eureka and overlooking the town. The station is marked by a short signal pole with a cairn around the base.

Butler (Esmeralda County, Nev., C. H. S., 1902).—On the highest summit of the small range of mountains 1¼ miles due south of *Tonopah longitude* station. The station is marked by a drill hole in solid rock surmounted by a cairn about the base of the signal pole.

Bradford (Nye County, Nev., C. H. S., 1902).—About 6 miles north of Tonopah and about 1 mile south of the ice. plant, on the southwest part of a conspicuous mountain with a long palisade top extending southwest and northeast. The mountain is on the the west side of the wagon road and just southeast of a conical peak. The station is marked by a drill hole in solid rock, over which is a pile of stones about the base of the signal pole.

Booker (Nye County, Utah, C. H. S., 1902).—About 3 miles northeast of the town of Tonopah, on the highest point of high mesa land which rises gradually to a rounded top. The station is marked by a drill hole in a rock surmounted by a pile of stones about the base of the signal pole.

Oddie (Nye County, Nev., C. H. S., 1902).—On the summit of Mount Oddie, a mountain well known on account of the Mispah mine. The station is marked by a drill hole in solid rock over which is a pile of rocks about the base of the signal pole.

Tonopah astronomic (Nye County, Nev., C. H. S., 1902).—In the town of Tonopah, on the east edge of Central Street about 30 meters south of Oddie Avenue, just west of the office of the Tonopah Miner. and on the same lot. The station is marked by a drill hole in the top of the longitude pier, which consists of two long stone blocks set on end side by side with the bases embedded in concrete.

Tonopah north meridian (Nye County, Nev., C. H. S., 1902).—About three-fourths mile due north of *Tonopah astronomic* station, on the farthest one of the ridges near Tonopah. The station is marked by a drill hole in the top of a stone post 48 inches long dressed 7 inches square on top and projecting 1½ feet above the ground.

Golden (Nye County, Nev., C. H. S., 1902).—On the southern one of two summits near together, a short distance east of the town of Tonopah. The station is marked by a drill hole in solid rock over which is a pile of rocks about the base of the signal pole.

Tonopah southeast base (Nye County, Nev., C. H. S., 1902).—About one-third mile southeast of the town limits of Tonopah, on the northeast side of the wagon road leading southeast from the town. The station is marked by a drill hole in the top of a stone post 20 inches long set flush with the surface of the ground.

Tonopah northwest base (Nye County, Nev., C. H. S., 1902).—Just outside the town limits southeast of the town of Tonopah, on the east side of a wagon road. The station is marked by a drill hole in the top of a stone post 20 inches long set flush with the surface of the ground.

Davis (Nye County, Nev., C. H. S., 1902).—About 2 miles southeast of the town of Tonopah, on a high summit northeast of the wagon road which extends southeast from the town. The station is marked by a drill hole in solid rock, surmounted by a pile of rocks about the base of the signal pole.

Douglas (Esmeralda County, Nev., C. H. S., 1902).—About 4 miles south-southeast of the town of Tonopah, on a conspicuous black-top mountain on the west side of the San Antonio Range. The station is on the highest part of the summit and is marked by a drill hole in a rock over which is a pile of black lava rocks around the base of the signal pole.

Lothrop (Nye County, Nev., C. H. S., 1902).—About 4 miles southeast of the town of Tonopah, at the edge of the Ralston Desert on the east side of the San Antonio Range, on a black summit southwest of the wagon road. The station is marked by a drill hole in a fast rock over which is a pile of rocks about the base of the signal pole.

Ralston (Nye County, Nev., C. H. S., 1902).—On the Ralston Desert about 6 miles southeast of the town of Tonopah, a little more than a mile east of the east side of the San Antonio Range, and just east of a north-and-south wagon road a short distance north of where this road joins the road extending southeast from Tonopah. The station is marked by a drill hole in a rock and by a pile of rocks around the base of the signal pole.

Cutting (Nye County, Nev., C. H. S., 1902).—About 7½ miles southeast of the town of Tonopah, on the east side of the San Antonio Range on a prominent rock summit rising vertically above the hill about one-half mile southwest of the road from Tonopah. The hill is jagged on the north side and is easily recognized from the road. The station is marked by a drill hole in a rock and by a pile of rocks around the base of the signal pole.

Short (Esmeralda County, Nev., C. H. S., 1902).—About 6 miles southeast of the town of Tonopah, a short distance northwest of the corner of Esmeralda County, on the summit of the first hill almost due north of station *Crest*. The station is not marked except by a pile of rocks around the base of a short signal pole.

Crest (Esmeralda County, Nev., C. H. S., 1902).—About 6 miles southeast of the town of Tonopah, near the corner of Esmeralda County on the backbone of the second hill west of the edge of Ralston Desert. The station is not on the highest part of the summit. It is marked by a drill hole in a rock and by a pile of rocks around the base of a short signal pole.

Watch (Esmeralda County, Nev., C. H. S., 1902).—About 6 miles southeast of the town of Tonopah, near the corner of Esmeralda County, in a pocket surrounded on all sides by hills, on a small ridge extending eastward from the summit on which station *Crest* is located. The station is marked by a drill hole in solid rock and by a pile of rocks around the base of the signal pole.

Esmeralda County corner stone (Esmeralda County, Nev., C. H. S., 1902).—About 6 miles southeast of the town of Tonopah, 16.806 meters northeast of station *Watch*. The corner stone is supposed to mark the intersection of latitude parallel 38° and the meridian 40° 07′ west of Washington. The station is marked by a slender stone post 8 feet long, projecting 5 feet above the ground and surrounded by a pile of rocks.

Tioyabe Peak (Lander County, Nev., W. E., 1881; 1898).—On a small prominent peak on a long-top mountain about 9 miles south and east of Austin. The station is marked by a cairn of shaly rocks 3 feet in diameter at the base and 5½ feet high.

Vigus (Lander County, Nev., C. H. S., 1898).—On the west side of the valley about 7 miles west-northwest of Austin, on a hill about 1 mile west of the ranch rented by the Vigus brothers. There is another and somewhat higher hill about one-half mile west of the station. The station is at about the center of the summit and is marked by a drill hole in a small fast rock and by a pile of rocks around the foot of the signal pole.

Mount Prometheus or *Lander Hill* (Lander County, Nev., W. E., 1880; 1898).—On the summit of Mount Prometheus about 1 mile northeast of Austin. The station is marked by a drill hole in a rock near the bottom of a cairn 5½ feet high.

Wheeler stone (*U. S. E.*) (Lander County, Nev., C. H. S., 1898).—On a gentle slope at the base of Mount Prometheus, 100 meters north of the road leading up over the divide, a short distance west of a dwelling house and near the last big dump extending north and south across the ravine. The station is marked by a cross in the top of a granite post 6 inches square on top, projecting 8 inches above the ground and inscribed U. S. E. 1871.

Pilot Cone or *Basalt* (Mineral County, Nev., W. E., 1878; 1902).—On a conspicuous black bell-shaped mountain rising about 2000 feet above the plain just west of the large soda and borax flat or old lake bed. The summit is a mass of huge basaltic crystals. The station is marked by a copper cylinder in a cairn.

Mill (Mineral County, Nev., C. H. S., 1902).—Near the intersection of several roads north of an old lake bed, on a light-colored pile of earth a short distance southeast of the old Eagle mill. The station is marked by a 1-inch iron pipe 15 inches long.

South Hill (Lander County, Nev., C. H. S., 1898).—On the top of a high hill south of the courthouse at Austin. The station is marked by an iron bolt in an outcrop of granite rock.

North Hill (Lander County, Nev., C. H. S., 1898).—On the first prominent hill almost due north of the courthouse at Austin. The station is marked by a drill hole in a fast rock and by a pile of rocks around the foot of the signal pole. An iron bolt, marking one of the points of the mining company's survey, is 2.82 meters northwest of the station.

Union (Lander County, Nev., C. H. S., 1898).—On the steep slope of a hill northeast of the hoisting works of the Union mine. The station is marked by a drill hole in a fast rock near an outcropping ledge.

Reservoir (Emery County, Utah, C. H. S., 1898).—On a high hill just south of the railroad at Green River, 6 feet from the northwest edge of an old abandoned cement-lined reservoir. The station is marked by a drill hole in a piece of sandstone.

Austin longitude (Lander County, Nev., C. H. S., 1889; 1898).—On the west side of the courthouse at Austin, on the south side of the main street of the town. The station is marked by the foundation of a pier.

Hot Spring (Mineral County, Nev., C. H. S., 1902).—South of the east end of a large soda and borax flat which marks an old lake bed, near a hot spring known as Woodruff's Hot Spring, which is at the northwest end of the oblique boundary line between Mineral and Nye Counties. The station is 4.5 meters southeast of the center of the spring and is marked by a drill hole in a hard rock 18 inches long, which projects 6 inches above the ground. The chimney of an old adobe ruin is west of the spring and 34 paces from the station, and the foundation of an old rock-grinding mill is just east of the spring and northeast of the station.

Miller (Mineral County, Nev., C. H. S., 1902).—On a small conical knoll about 75 feet high on the north side of the range, about 2 miles south of the soda and borax flat or old lake bed and about 2¼ miles southwest of Hot Spring. The station is marked by a drill hole and a cross in a fast rock which is cracked in several places, and by a pile of rocks about the foot of the signal pole.

Mount Annie (Nye County, Nev., C. H. S., 1902).—On the summit of Mount Annie. The station is marked by a cairn.

Hot Spring west base (Mineral County, Nev., C. H. S., 1902).—On the soda and borax flat or lake bed, about 2.1 miles northeast of Hot Spring and 1.6 miles due south of the old Eagle mill. The station is marked by a 2-inch iron pipe 30 inches long driven in the ground nearly flush with the surface.

Hot Spring east base (Mineral County, Nev., C. H. S., 1902).—On the soda and borax flat or old lake bed, about 1⅓ miles north-northwest from Hot Spring and 2 miles southeast of the old Eagle mill. The station is marked by a 1-inch iron pipe 2 feet long driven in the ground nearly flush with the surface.

Churchill (Mineral County, Nev., C. H. S., 1902).—About 7¾ miles northwest of the old Eagle mill, on the highest peak of the Sinkavata Hills. The station is marked by a large cairn.

Mount Grant highest peak (Mineral County, Nev., C. H. S., 1902).—On the highest and most southern one of tho three peaks which form the summit of Mount Grant, about 200 meters south of station *Mount Grant.* Tho station is marked hy a cairn.

Freel Peak (Eldorado County, Cal., W. B. F., 1893; 1897).—On Freel Peak, the more western one of two high, sharp peaks about 7 miles southeast of Lake Tahoe. The station is marked by a half-inch copper bolt in a drill hole in a rock and by a cairn, 6 feet high and 8 feet in diameter at the base, built around the foot of the signal pole.

Rose Knob (Washoe County, Nev., W. B. F., 1893).—On Rose Knoh, an isolated sharp conical peak of the Rose Mountain Range about 3 miles north of the north end of Lake Tahoe. The statiou is marked by a half-inch copper bolt in a drill hole in the solid rock at the top of tho peak.

Rubicon Point (Eldorado County, Cal., W. B. F., 1893).—On the northern one of two projections of a well-known bold rocky point, called Ruhicon Point, on the southwest shoro of Lake Tahoe. The station is on a ledgo which slopes from a height of about 10 feet down to the water's edge. Back of this ledge is a vertical cliff 50 feet high. The station is marked by a half-inch copper bolt in a drill hole in the solid rock ledge.

Observatory Point (Placer County, Cal., W. B. F., 1893).—On Observatory Point, a well-known point on the northwest shore of Lake Tahoe. The station is not on the highest part of the hill, which is heavily wooded, hut on the first rise or level above the lake, where most of tho heavy timber has heen cut. Tho station is marked by a half-inch copper bolt in a drill hole in a solid ledge of rock. Three hlazed trees are, respectively, about 20 meters southwest, 40 meters west, and 40 meters northwest.

Genoa Peak (Douglas County, Nev., C. H. S., 1893; 1897).—On a bare rocky summit of the mountain range along the east side of Lake Tahoe about 5 miles southeast of Glenbrook, 3½ miles east of Cave Rock, and just northwest of the town of Genoa, which it overlooks. The peak is very conspicuous from Carson Valley. The station is marked by a copper bolt in a loose stone at the center of tho haso of a pile of stones.

Hot Spring Mountain (Douglas County, Nev., C. H. S., 1897).—On the more westerly one of the two summits of Hot Spring Mountain, which derives its name from a hot spring at its hase on the southwest side. The station is marked hy a five-eighths inch drill hole in the outcropping ledge at the highest point of the peak and by a large pile of rocks about the hase of the signal pole.

Folsom Peak (Douglas County, Nev., C. H. S., 1893; 1897).—On the west side of the summit of Folsoms Knoh or Little Round Top, a symmetrical hill about 500 feet high, about three-fourths mile northwest of Hohart post office and a short distance north of Hobarts Wharf on Lake Tahoe. The station is marked by a five-eighths inch copper bolt inserted 3 inches in a drill hole in a rock.

Anderson (Douglas County, Nev., C. H. S., 1897).—On a foothill about one-fourth mile south of the road that hranches from the Anderson Ranch-Desert Station Road and heads nearly for Mineral Peak. The station is about 10 meters from the highest point of the hill and is marked hy a five-eighths inch drill hole in a granite bowlder and hy a pile of rocks about the base of the signal pole.

Deadman (Douglas County, Nev., W. B. F., 1893).—Just north of Glenhrook, on the highest part of a rough rocky point, known as Deadmans Point, on the east side of Lake Tahoe. The hill is about 800 feet above the level of the lake, and the top of it is composed of enormous granite bowlders. The station is on the highest part of the hill and is marked hy a half-inch copper bolt in a drill hole in the top of a large irregular granite bowlder about 10 by 15 feet in cross section and 25 feet high.

Tallac Peak (Eldorado County, Cal., C. H. S., 1893).—On Tallac Peak, about 7 miles hy trail south of Tallac Hotel, on the south shore of Lake Tahoe. The station is marked by a drill holo in tho rock at the top of the peak.

Sutro (Lyon County, Nev., C. H. S., 1897).—On the south end of a high ridgo northwest of the town of Sutro. The station is marked hy a three-fourths inch drill hole in the top of a pyramidal rock projecting about 1 foot above the ground, and hy a small pile of rocks around the base of the signal pole. A cairn of small rocks 4 feet in diameter and 4 feet high is about 10 meters northeast of the station.

Cedar Hill (Storey County, Nev., C. H. S., 1897).—On a reddish-colored hill, known as Cedar Hill, just north of Virginia City. The station is marked by a five-eighths inch drill hole in the most southern one of three outcropping ledges, each of which projects about 8 inches above the ground. There is a cairn around the base of the signal pole.

Overlook (Ormsby County, Nev., C. H. S., 1897).—On the second rocky point overlooking Carson City on a ridge projecting from Snow Valley Mountain. The station is marked hy a half-inch drill hole in a projecting rock ledge and by a cairn huilt around the base of the signal pole. There is a large pile of rocks about 5 meters back of tho station.

Mount Davidson flagstaff (Storey County, Nev., C. H. S., 1897).—A pointed iron mast about 15 meters high about 12 meters from the highest point of Mount Davidson.

Peavine (Washoe County, Nev., W. B. F., 1893; 1897).—On Peavine Mountain about 5 miles northeast of Reno. The station is marked hy a copper bolt in a drill hole in a solid rock ledge. A cairn 6 feet in diameter is about 3 meters west of the station.

Prison Hill (Ormsby County, Nev., C. H. S., 1897).—On the highest part of the hill about 2 miles back of the penitentiary at Carson City. The station is marked by a drill hole in a fast rock and hy a large pile of stones around the base of the signal pole.

East Peak (Douglas County, Nev., C. H. S., 1893; 1897).—The highest summit of the mountains duo east of the southeast end of Lake Tahoe. The station is marked by a drill hole in a rock at the highest point of the peak and by a pilo of rocks 5 feet high and 8 feet in diameter at the baso around the foot of the signal pole.

Virginia City astronomic (Storey County, Nev., C. H. S., 1889; 1897).—In the yard south of the office of the Consolidated California & Virginia Mines Co. and directly opposite the railroad station at Virginia City. The station is marked by a drill hole in the top of the pier used for supporting the transit. Due to mining operations the ground on which the whole of Virginia City is situated is moving slowly to the eastward and this station should be used with caution.

Verdi Peak (Sierra County, Cal., C. H. S., 1897).—The highest peak at the south end of the range of mountains west of the town of Verdi, Nev. It projects boldly above the timber and is also known locally as Bald Mountain. The station is marked by a drill hole in a fast rock, and by a pile of loose stones built around the base of the signal pole.

Ranch Hill (Washoe County, Nev., C. H. S., 1897).—On the south end and nearly the highest point of a ridge making out into the Truckee Valley just east of Robert's ranch. From the station the barns at Robert's ranch are nearly in range with the railroad bridge across the Truckee River. The station is marked by a five-eighths inch drill hole in a large bowlder and by a cairn built around the base of the signal pole.

Bender (Washoe County, Nev., C. H. S., 1897).—On a ridge about 3 miles southeast of Verdi, in the prolongation of the road running north from Christianson's ranch. The station is marked by a drill hole in a large rock and by a pile of rocks above it.

Verdi Bluff (Washoe County, Nev., G. D., 1872; 1897).—On the northeastern brow of the bluff which is south of Verdi and just south of the railroad track at a point 55 rails east of the water tank at Verdi. The station is marked by a half-inch drill hole in a reddish granite rock which projects but slightly above the surface of the ground. A large mass of granite rock projecting 6 feet above the ground is about 40 meters from the brow of the bluff and about 16 meters from the station in azimuth 355° (magnetic).

North Flat (Washoe County, Nev., G. D., 1872; 1897).—About 2 miles northeast of the water tank at Verdi, on a plateau on the north side of the Truckee River and about 200 meters north of the Henness Pass Road where it crosses a small stream. The station is about 30 meters south of the highest part of the plateau and about 5 feet lower and is marked by a drill hole in the top of a large irregular rock.

Point of Rocks (Washoe County, Nev., G. D., 1872).—On a steep hillside about 1 mile north of Verdi on the north side of the Truckee River and about 200 meters north of the Henness Pass wagon road. The station is marked by a half-inch drill hole in solid rock.

Verdi east base (Washoe County, Nev., G. D., 1872; 1897).—This station has been destroyed. It has been approximately recovered and re-marked by a drill hole in the top of a large, triangular, granite block, but the geodetic position of this new point has never been determined.

Verdi west base (Washoe County, Nev., G. D., 1872).—About three-fourths mile east of Verdi on the second rise or plateau south of the railroad about midway between the first cut east of Verdi and the next curve of the track east. The station is on the north slope of the plateau and about 125 meters west of a small arroyo. It is marked by a half-inch drill hole in the top of a granite bowlder 5 or 6 feet in diameter which projects about 2 feet above the surface of the ground. A blasted granite rock about 6 feet in diameter is about 9 meters from the station in azimuth 16° (magnetic).

California-Nevada iron monument (Sierra County, Cal., and Washoe County, Nev., C. H. S., 1897).—On the south side of the road leading from Verdi, Nev., to Truckee, Cal., and just southeast of three pine trees, the only trees in the vicinity. The monument is of cast iron with a flange at the bottom and is 6 inches square at the top, 12 inches square at the bottom, and 6 feet high above the ground. It is about 5 inches out of plumb to the eastward.

Verdi longitude (Washoe County, Nev., C. H. S., 1889; 1897).—About one-third mile east of the town of Verdi, on the slight elevation back of O. Lonkey's residence, about 40 meters north of a stone fence and directly opposite the water faucet in the garden. The station is marked by the remains of a brick and cement pier, projecting a few inches above the surface of the ground.

Cone Peak, white flag (Washoe County, Nev., G. D., 1872).—The highest point of a conical peak 5 or 6 miles south of Verdi and a little more than a mile southeast of the Truckee River.

Crystal Peak flagstaff (Sierra County, Cal., G. D., 1872).—A large unpainted flagstaff on the main street of Crystal Peak village, in front of Mr. Hollingshead's house.

Crystal Peak mountain top (Sierra County, Cal., G. D., 1872).—A sharp mountain peak about 5 or 6 miles to the westward of Crystal Peak village.

California-Nevada stone monument (Sierra County, Cal., and Washoe County, Nev., G. D., 1872).—West of the town of Crystal Peak near the base of the mountain range which in this locality is somewhat back from the Truckee River. The station is south of the Henness Pass Road along the south bank of the west branch of Dog Creek and is about 8 meters south of a large outcrop of fine dark sandstone beside the road. A similar outcrop of rock is about 120 meters east of the station on the north side of the road. The station is marked by a half-inch drill hole in the top of the lower part of a stone boundary monument the top of which has been broken of.

California-Nevada wood monument (Sierra County, Cal., and Washoe County, Nev., G. D., 1872).—On the slope south of *California-Nevada stone monument* (see above), 31 meters distant and 7.5 meters higher. The station is marked by a roughly squared log set in the ground and surrounded by a large cairn.

Lone tree (Washoe County, Nev., G. D., 1872).—A prominent lone tree on the Peavine Ridge about 5 miles in a northeasterly direction from Verdi.

Verdi meridian mark (Washoe County, Nev., G. D., 1872).—On a summit of Peavine ridge about 3 miles north-northeast of Verdi and about 40 meters northeast of the old Bull Ranch Road. About 300 meters southwest by west from the station is a point of rocks distinctly visible from the Henness Pass Road at the point where the ranch road mentioned above intersects it. The station is marked by a pile of rocks about the base of a 1-inch board used as a signal pole.

Verdi azimuth mark (Washoe County, Nev., G. D., 1872).—About 1½ miles northeast of Verdi and 1 mile north of the Truckee River on a black-topped hill between two branches of a small stream which flows to the southward. The station is marked by a half-inch drill hole in a rock and by a pile of rocks about the base of the signal pole.

VERTICAL CIRCLE.

The vertical circles in use by the United States Coast and Geodetic Survey for the trigonometric leveling and for some of the time determinations [1] are, in general form, like that shown in illustration No. 5.

The instrument is practically a theodolite with the graduated circle in a vertical position and its axis horizontal, with the telescope fastened rigidly to the alidade. The circle and alidade are fastened to a horizontal support, which rests upon the top of a vertical axis, the latter fitting into a stand. There is a counterpoise to the circle and alidade on the opposite side of the vertical axis. The stand has three leveling screws, and on some of the instruments there is a graduated circle near the base for measuring horizontal angles approximately.

Before starting observations the usual adjustments of the eyepiece and object glass should be made and the cross wires should be brought approximately into the center of the field. There is no adjustment for collimation in either the vertical or horizontal plane. A coarse stride level is used to make the horizontal axis of the circle approximately horizontal, and, consequently, the circle vertical, and a sensitive level is fastened to the circle and made parallel with it to define a horizontal line through the instrument. If, after leveling by the two levels, the instrument is rotated on its vertical axis through 180° and the bubbles remain on the graduated scales of the level vials, then the adjustments for level are satisfactory.

When making the observations on an object, its image is brought into the field of the telescope, the horizontal wire is placed on it, and readings are made of the bubble of the fixed level and of the verniers of the vertical circle. The telescope is then rotated on its horizontal axis and revolved 180° about the vertical axis of the instrument. A second observation is made on the object, and the level and vertical circles are again read. These observations constitute one complete determination of the double zenith distance, and are called a set.

If upon revolving the instrument through 180° in azimuth for the second reading on the object for any one set it is found that one end of the bubble extends beyond the graduations of the level vial, it may be brought back by the foot screws of the instrument. It should *never* be brought back to the graduations by moving the tangent screw, which controls the relation between the bubble and the graduations of the circle. In other words, the relation between the fixed level and the vertical circle of the instrument should remain undisturbed during a set. If the level is badly out of adjustment, it should be adjusted between sets.

COMPUTATION, ADJUSTMENT, AND ACCURACY OF THE ELEVATIONS.

The zenith distances directly observed at each station were first computed. These zenith distances were corrected for height of the object observed and of instrument so as to refer them all to the ground at each station or to the surface marks at the station.

The difference of elevation of each pair of stations in the main scheme was then computed from the observations over the line joining them by the formula

$$h_2-h_1=s \tan \tfrac{1}{2}\,(\zeta_2-\zeta_1)\left[1+\frac{h_2+h_1}{2\rho}+\frac{s^2}{12\rho^2}\right]$$

in which h_2 and h_1 are elevations of the stations, ζ_2 and ζ_1 are the measured zenith distances as corrected for height of instrument and of object observed, s is the horizontal distance between the stations, and ρ is the radius of curvature.

As there are always two or more lines to each new station, many rigid conditions exist between the observed difference of elevation, even if the connections with the precise leveling

[1] See p. 151, under the heading Astronomic azimuth.

VERTICAL CIRCLE USED IN TRIGONOMETRIC LEVELING AND FOR MAKING TIME OBSERVATIONS.

were ignored, and the least square adjustment furnishes the readiest accurate means of deriving the required elevations.

The elevations of stations of the primary scheme from the thirty-ninth parallel triangulation to the Canada boundary were adjusted in two sets of equations. The solution of the first set fixed all the elevations of the primary stations between the thirty-ninth parallel and latitude 46°, and the solution of the second set fixed the elevations of the primary stations between latitude 46° and the Canada boundary.

In the first set the elevations of Pikes Peak and Divide, the stations of the thirty-ninth parallel triangulation, were held fixed at 4300.63 and 2259.46 meters, respectively.

These elevations differ slightly from the values published in Special Publication No. 4,[1] due to more recent leveling by the United States Geological Survey and to the 1913 level net adjustment.

In addition to these fixed elevations, seven other stations, determined by precise leveling and less accurate spirit leveling, were assumed to be fixed.

These stations are Watkins astronomic, Brighton B. M. eccentric, Dover B. M. eccentric, Whitaker, Provo east base, Provo west base, and Buffalo Springs. Their elevations are 1683.47, 1514.35, 1648.01, 2041.98, 1123.05, 1177.19, and 878.93 meters, respectively. The precise leveling by the base measuring party connected the ends of the Provo base with bench mark Provo 3708 DW, the elevation of which was adopted as 1130.93 meters.[2]

The elevation of the top of the rail at Buffalo Springs was adopted as 870.81 meters (2857.0 feet), as furnished by the engineers of the Chicago, Milwaukee & Puget Sound Railway Co.

The elevation of Whitaker was obtained from the bench mark, 6702 Denver, of the United States Geological Survey. The value 2042.136 meters (6699.909 feet) was adopted for the elevation of this bench mark.

The elevations of Watkins astronomic, Brighton B. M. eccentric, and Dover B. M. eccentric depend on the precise level bench marks G_2, R_2, and E_3, the elevations of which are published in Special Publication No. 18 as 1681.21, 1514.21, and 1648.19 meters, respectively.

The elevation of the 53 remaining stations connected by the observations are unknowns to be determined by the method of least squares from the 139 differences of elevations indicated below.

In the following tabulation there are shown the observed differences of elevation treated in the first set of equations, together with their adjusted values. The weight p, assigned to each observed difference of elevation, is inversely proportional to the square of the length, in meters, s, of the line between stations and is conveniently computed by the formula $\log p = 10 - 2 \log s$. The observed difference of elevation is given the sign of the elevation of the second station minus the elevation of the first. The quantity contained in the last column but one is the correction to be added to an observed difference of elevation to obtain the adjusted difference of elevation.

Station 1.	Station 2.	Weight, p.	Observed difference of elevation, h_2-h_1.	Adjusted difference of elevation, h_2-h_1.	Adjusted minus observed, v.	pvv.
			Meters.	*Meters.*	*Meters.*	
Pikes Peak	Divide	0.36	−2044.54	−2041.17	+3.37	....
Pikes Peak	Elbert	0.28	−2153.79	−2153.76	+0.03	0.000
Divide	Elbert	2.79	− 112.35	− 112.59	−0.24	0.161
Elbert	Hilltop	1.56	− 138.83	− 139.92	−1.09	1.853
Pikes Peak	Hilltop	0.17	−2296.63	−2293.68	+2.95	1.479
Pikes Peak	Morrison	0.12	−1898.65	−1899.47	−0.82	0.081
Elbert	Morrison	0.18	+ 248.43	+ 254.29	+5.86	6.181
Hilltop	Douglas	17.50	− 51.56	− 51.56	+0.00	0.000
Morrison	Douglas	0.40	− 445.39	− 445.77	−0.38	0.058
Morrison	Indian	0.34	− 553.57	− 553.09	+0.48	0.078
Douglas	Indian	3.71	− 107.28	− 107.32	−0.04	0.006
Hilltop	Indian	1.92	− 158.24	− 158.88	−0.64	0.786
Morrison	Boulder	0.92	+ 174.67	+ 174.71	+0.04	0.001
Indian	Boulder	0.21	+ 728.63	+ 727.80	−0.83	0.145
Indian	Watkins astronomic	9.66	− 164.41	− 164.60	−0.19	0.349

[1] See pp. 265 and 266.

[2] See Special Publication No. 18, p. 148.

Station 1.	Station 2.	Weight, *p*.	Observed difference of elevation, h_2-h_1.	Adjusted difference of elevation, h_2-h_1.	Adjusted minus observed, *v*.	*pvv*.
			Meters.	*Meters.*	*Meters.*	
Boulder	Watkins astronomic	0.25	− 888.21	− 892.40	−4.19	4.389
Boulder	Brighton	0.46	− 984.76	− 983.21	+1.55	1.105
Morrison	Brighton	0.32	− 809.66	− 808.50	+1.16	0.431
Indian	Brighton	0.52	− 257.00	− 255.41	+1.59	1.315
Brighton	Brighton B. M., ecc	29.05	− 78.41	− 78.31	+0.10	0.290
Boulder	Brighton B. M., ecc	0.59	−1061.28	−1061.52	−0.24	0.034
Morrison	Brighton B. M., ecc	0.39	− 888.22	− 886.81	+1.41	0.775
Brighton	Dewey	0.32	− 90.83	− 94.62	−3.79	4.621
Boulder	Dewey	0.13	−1077.64	−1077.83	−0.19	0.005
Dewey	Horsetooth	0.37	+ 714.88	+ 713.23	−1.65	1.007
Brighton	Horsetooth	0.22	+ 617.69	+ 618.61	+0.92	0.182
Boulder	Horsetooth	0.24	− 366.08	− 364.60	+1.48	0.519
Horsetooth	Dover B. M., ecc	0.57	− 562.37	− 563.26	−0.89	0.441
Dewey	Warren	0.25	+ 475.58	+ 472.74	−2.84	2.002
Horsetooth	Warren	0.28	− 238.55	− 240.49	−1.94	1.043
Warren	Twin	0.88	+ 512.73	+ 511.98	−0.75	0.508
Dover B. M., ecc	Twin	0.42	+ 832.09	+ 834.75	+2.66	2.949
Dewey	Twin	0.14	+ 984.15	+ 984.72	+0.57	0.045
Horsetooth	Twin	0.31	+ 268.29	+ 271.49	+3.20	3.174
Warren	Terry	1827.9	− 0.04	− 0.04	+0.00	0.000
Twin	Terry	0.90	− 512.52	− 512.02	+0.50	0.225
Warren	Colo.-Wyo. boundary monument	102.69	− 110.72	− 110.72	−0.00	0.002
Terry	Colo.-Wyo. boundary monument	81.72	− 110.69	− 110.68	+0.01	0.002
Warren	Wadill	1.38	+ 37.25	+ 36.62	−0.63	0.556
Terry	Wadill	1.46	+ 36.19	+ 36.65	+0.46	0.315
Twin	Wadill	0.83	− 478.55	− 475.36	+3.19	8.436
Warren	Russell	0.50	+ 536.74	+ 536.88	+0.14	0.010
Twin	Russell	2.20	+ 25.27	+ 24.90	−0.37	0.301
Russell	Greentop	6.34	− 35.29	− 35.41	−0.12	0.087
Twin	Greentop	0.87	− 9.63	− 10.51	−0.88	0.674
Wadill	Greentop	0.91	+ 464.16	+ 464.86	+0.70	0.446
Wadill	Ragged	0.67	+ 501.04	+ 501.29	+0.25	0.044
Greentop	Ragged	10.14	+ 36.39	+ 36.44	+0.05	0.024
Ragged	Whitaker	1.14	− 466.28	− 466.71	−0.43	0.211
Greentop	Whitaker	1.22	− 429.15	− 430.27	−1.12	1.533
Wadill	Whitaker	3.68	+ 34.14	+ 34.58	+0.44	0.729
Ragged	Chugwater	0.43	− 475.71	− 474.61	+1.10	0.520
Whitaker	Chugwater	0.50	− 9.39	− 7.90	+1.49	1.110
Chugwater	Notch	0.76	+ 381.17	+ 381.59	+0.42	0.134
Whitaker	Notch	0.17	+ 373.84	+ 373.69	−0.15	0.004
Ragged	Notch	0.22	− 96.14	− 93.02	+3.14	2.169
Chugwater	Coleman	0.25	− 343.44	− 340.89	+2.55	1.626
Notch	Coleman	0.61	− 723.57	− 722.48	+1.09	0.725
Coleman	Haystack	0.62	+ 30.17	+ 32.27	+2.10	2.734
Notch	Haystack	0.23	− 691.57	− 690.21	+1.36	0.425
Chugwater	Haystack	0.21	− 309.88	− 308.62	+1.26	0.333
Haystack	Hobbs	1.38	+ 132.18	+ 132.62	+0.44	0.267
Hobbs	Rawhide	16.95	− 11.54	− 11.53	+0.01	0.001
Haystack	Rawhide	1.14	+ 120.06	+ 121.09	+1.03	1.209
Coleman	Willow	0.13	+ 162.20	+ 162.19	−0.01	0.000
Haystack	Willow	0.23	+ 129.52	+ 129.92	+0.40	0.037
Hobbs	Willow	5.57	− 2.79	− 2.70	+0.09	0.043
Rawhide	Willow	3.11	+ 8.73	+ 8.83	+0.10	0.031
Willow	Manville	2.65	− 139.70	− 139.57	+0.13	0.046
Rawhide	Manville	1.11	− 131.30	− 130.74	+0.56	0.349
Manville	Kirtley	0.65	− 139.07	− 137.50	+1.57	1.592
Willow	Kirtley	0.40	− 279.24	− 277.07	+2.17	1.877
Rawhide	Kirtley	0.51	− 268.96	− 268.24	+0.72	0.261
Willow	Nebr.-Wyo. boundary monument, ecc.	0.38	− 295.51	− 296.36	−0.85	0.276
Kirtley	Nebr.-Wyo. boundary monument, ecc.	10.15	− 19.32	− 19.29	+0.03	0.010
Kirtley	Bluff	2.38	− 119.95	− 119.54	+0.41	0.394
Kirtley	S. Dak.-Nebr. boundary monument	3.27	− 388.11	− 387.07	+1.04	3.564
Bluff	S. Dak.-Nebr. boundary monument	3.37	− 266.51	− 267.52	−1.01	3.458
Kirtley	S. Dak.-Wyo. boundary monument	2.04	− 324.31	− 325.83	−1.52	4.707
Bluff	S. Dak.-Wyo. boundary monument	5.80	− 206.82	− 206.29	+0.53	1.654
Manville	Parker	0.11	− 244.73	− 240.57	+4.16	1.899
Kirtley	Parker	0.21	− 106.15	− 103.07	+3.08	1.992
Manville	Alkali	0.13	− 343.45	− 347.33	−3.88	1.958
Kirtley	Alkali	0.12	− 209.77	− 209.83	−0.06	0.000
Parker	Alkali	0.21	− 108.06	− 106.76	+1.30	0.357
Alkali	Elk	0.74	+ 357.64	+ 358.49	+0.85	0.530
Alkali	Sullivan	0.64	+ 141.85	+ 144.08	+2.23	3.191
Elk	Sullivan	4.14	− 214.32	− 214.40	−0.08	0.029
Parker	Sullivan	0.91	+ 38.52	+ 37.33	−1.19	1.295
Alkali	Cottonwood	0.36	− 51.44	− 54.23	−2.79	2.802
Parker	Cottonwood	0.73	− 160.05	− 160.99	−0.94	0.640
Cottonwood	Provo west base	3.28	− 136.70	− 137.06	−0.36	0.425
Parker	Provo west base	2.60	− 298.88	− 298.04	+0.84	1.826
Provo west base	Provo east base	4.72	− 54.39	− 54.15	+0.24	....
Cottonwood	Provo east base	1.14	− 191.76	− 191.20	+0.56	0.355

Station 1.	Station 2.	Weight, *p*.	Observed difference of elevation, h_2-h_1.	Adjusted difference of elevation, h_2-h_1.	Adjusted minus observed, *v*.	*pvv*.
			Meters.	*Meters.*	*Meters.*	
Parker	Provo east base	2.05	− 352.89	− 352.19	+0.70	1.010
Provo west base	Provo astronomic	17.25	− 29.22	− 29.26	−0.04	0.030
Cottonwood	Provo astronomic	1.88	− 165.71	− 166.32	−0.61	0.702
Parker	Provo astronomic	1.57	− 327.48	− 327.31	+0.17	0.030
Provo east base	Provo astronomic	20.30	+ 24.80	+ 24.88	+0.08	0.133
Alkali	Cambria	0.38	+ 595.88	+ 592.49	−3.39	4.357
Elk	Cambria	0.73	+ 232.68	+ 234.01	+1.33	1.287
Inyankara	Cambria	1.99	+ 21.43	+ 21.42	−0.01	0.000
Laird	Cambria	1.81	− 143.22	− 143.20	+0.02	0.001
Bluff	Parker	0.29	+ 12.04	+ 16.47	+4.43	5.699
Cambria	Crow	2.89	+ 186.96	+ 186.86	−0.10	0.030
Laird	Crow	3.25	+ 43.57	+ 43.66	+0.09	0.027
Laird	Inyankara	1.34	− 165.07	− 164.62	+0.45	0.276
Terry	Inyankara	0.54	− 213.33	− 213.54	−0.21	0.024
Sundance	Inyankara	1.07	− 88.88	− 89.36	−0.48	0.251
Terry	Laird	2.76	− 49.50	− 48.92	+0.58	0.916
Sundance	Laird	0.47	+ 76.61	+ 75.25	−1.36	0.868
Sundance	Mont., southeast corner, ecc	0.23	− 992.22	− 992.83	−0.61	0.084
Terry	Mont., southeast corner, ecc	0.17	−1117.82	−1117.00	+0.82	0.114
Castle	Terry	0.15	+1003.24	+1004.44	+1.20	0.217
Wymonkota	Terry	0.16	+1058.09	+1059.18	+1.09	0.191
Sundance	Terry	0.37	+ 120.77	+ 124.17	+3.40	4.290
Castle	Sundance	0.10	+ 875.45	+ 880.27	+4.82	2.320
Wymonkota	Sundance	0.23	+ 937.26	+ 935.00	−2.26	1.170
Castle	Wymonkota	0.40	− 53.98	− 54.74	−0.76	0.230
Moreau	Wymonkota	0.45	− 90.91	− 91.53	−0.62	0.171
Harding	Wymonkota	0.54	− 131.51	− 131.07	+0.44	0.104
Reva	Castle	0.23	+ 44.55	+ 44.01	−0.54	0.066
Moreau	Castle	0.55	− 36.87	− 36.79	+0.08	0.004
Harding	Castle	0.36	− 77.55	− 76.33	+1.22	0.532
Reva	Moreau	0.45	+ 82.32	+ 80.81	−1.51	1.029
Harding	Moreau	5.30	− 39.63	− 39.54	+0.09	0.038
Reva	Harding	0.30	+ 121.17	+ 120.35	−0.82	0.203
Lodge	Harding	0.14	+ 242.46	+ 242.80	+0.34	0.016
Table	Harding	0.27	+ 120.65	+ 125.55	+4.90	6.493
Lodge	Reva	0.96	+ 123.17	+ 122.45	−0.72	0.491
Table	Reva	0.41	+ 6.10	+ 5.21	−0.89	0.327
Table	N. Dak.-S. Dak., milepost 333, ecc	4.37	− 177.89	− 177.92	−0.03	0.004
Butte	N. Dak.-S. Dak., milepost 333, ecc	1.13	− 85.62	− 85.50	+0.12	0.016
Lodge	Table	0.49	+ 116.21	+ 117.25	+1.04	0.528
Butte	Table	0.62	+ 91.92	+ 92.42	+0.50	0.156
Whetstone	Lodge	0.57	+ 24.23	+ 24.20	−0.03	0.001
Butte	Lodge	0.47	− 24.59	− 24.83	−0.24	0.026
Whetstone	C. M. & P. S. Ry. B. M	2.06	− 79.09	− 79.06	+0.03	0.002
Butte	C. M. & P. S. Ry. B. M	6.32	− 128.02	− 128.08	−0.06	0.024
Butte	Whetstone	0.90	− 49.07	− 49.02	+0.05	0.002

The probable error of an observation of weight unity derived from the preceding adjustment is ±0.83 meter. In other words, the reciprocal observations over a line 31.7 kilometers (19.7 miles) long, this being the length of the line corresponding to unit weight, determined the difference of elevation of two points with such a degree of accuracy that it is an even chance whether the error is greater or less than 0.83 meter. The probable errors for other lines were assumed to be proportional to their lengths.

The probable errors of the elevations of the four stations fixed by precise leveling do not exceed ±0.05 meter. The probable errors of the elevations of the five other stations determined by spirit leveling may be estimated at about ±0.15 meter.

The probable error approaches this value for stations adjacent to those fixed by the spirit leveling and is greatest for the most remote stations. Station Terry, Wyo., was assumed to be the one least accurately determined, and its probable error was therefore computed as a limiting value. It was found to be ±0.98 meter from the vertical angles alone. When combined with the probable error of the elevation fixed by the spirit leveling, it is 0.99 meter.

In other words, for the least accurately determined station in the main scheme between the thirty-ninth parallel triangulation and latitude 46° there is an even chance that the elevation is correct within 1 meter (or 3.3 feet), and for most stations the accuracy is greater than this.

The results of the solution of the second set of equations, in which the stations concerned are those from the line Butte-Whetstone (latitude 46°) to the Canada boundary, are shown below in the form used for the first set:

Station 1.	Station 2.	Weight, p.	Observed difference of elevation, h_2-h_1.	Adjusted difference of elevation, h_2-h_1.	Adjusted minus observed, v.	pvv.
			Meters.	*Meters.*	*Meters.*	
Black	Whetstone	0.55	− 99.64	− 99.10	+0.54	0.162
Rainy	Whetstone	1.06	− 60.31	− 60.09	+0.22	0.051
Rainy	Butte	0.57	− 10.90	− 11.07	−0.17	0.017
Black	Butte	2.12	− 50.24	− 50.08	+0.16	0.054
Rainy	Black	0.89	+ 37.79	+ 39.01	+1.22	1.330
Badland	Black	0.83	+134.83	+134.08	−0.75	0.465
Sentinel	Black	0.28	+ 11.00	+ 11.62	+0.62	0.105
Sentinel	Rainy	0.18	− 29.83	− 27.39	+2.44	1.074
Saddle	Rainy	0.32	+149.74	+150.35	+0.61	0.122
Badland	Rainy	0.96	+ 94.47	+ 95.07	+0.60	0.348
Saddle	Badland	0.95	+ 56.01	+ 55.28	−0.73	0.504
Sentinel	Badland	0.55	−123.65	−122.46	+1.19	0.774
Sentinel	Saddle	0.44	−178.14	−177.74	+0.40	0.072
Hump	Saddle	0.53	−129.57	−130.01	−0.44	0.101
Cook	Saddle	0.54	+ 35.69	+ 34.90	−0.79	0.340
Blue	Sentinel	0.40	+107.98	+108.02	+0.04	0.001
Cook	Sentinel	0.95	+211.89	+212.64	+0.75	0.532
Hump	Sentinel	11.16	+ 47.67	+ 47.73	+0.06	0.042
Hump	Mont.-N. Dak. boundary monument, ecc.	0.85	−180.81	−179.91	+0.90	0.684
Blue	Mont.-N. Dak. boundary monument, ecc.	9.05	−119.53	−119.62	−0.09	0.702
Cook	Hump	1.88	+164.52	+164.91	+0.39	0.285
Blue	Hump	0.52	+ 59.31	+ 60.29	+0.98	0.500
Flat	Cook	0.95	− 13.74	− 13.45	+0.29	0.081
Trotter	Cook	2.47	− 0.69	− 0.32	+0.37	0.333
Blue	Cook	0.84	−104.40	−104.62	−0.22	0.040
Blue	Trotter	1.74	−104.64	−104.30	+0.34	0.201
Flat	Trotter	5.64	− 13.18	− 13.13	+0.05	0.015
Flat	Blue	1.09	+ 91.29	+ 91.17	−0.12	0.016
Sheep	Blue	0.40	+111.83	+112.52	+0.69	0.193
Lovering	Blue	0.36	+131.19	+131.29	+0.10	0.004
Sheep	Flat	1.99	+ 21.09	+ 21.35	+0.26	0.135
Lovering	Flat	0.43	+ 40.26	+ 40.12	−0.14	0.008
Sheep	Lovering	0.54	− 19.52	− 18.77	+0.75	0.300
Buford	Lovering	0.46	+ 50.47	+ 49.86	−0.61	0.171
Jackson	Lovering	1.74	+ 25.31	+ 25.22	−0.09	0.014
Buford	Sheep	0.43	+ 68.74	+ 68.63	−0.11	0.006
Montana	Sheep	0.42	+127.65	+128.84	+1.19	0.595
Jackson	Sheep	0.37	+ 41.96	+ 43.99	+2.03	1.522
Ferry	Missouri River Commission B. M. [illegible].	27.46	− 87.84	− 87.95	−0.11	0.326
Cutoff	Missouri River Commission B. M. [illegible].	21.47	−129.38	−129.32	+0.06	0.073
Mondak	Ferry	80.18	+ 86.71	+ 86.61	−0.10	0.839
Cutoff	Ferry	19.25	− 41.43	− 41.38	+0.05	0.058
Montana	Ferry	25.95	− 28.42	− 28.26	+0.16	0.664
Montana	Mondak	101.18	−114.79	−114.87	−0.08	0.647
Cutoff	Mondak	12.68	−127.97	−127.98	−0.01	0.002
Cutoff	Missouri River Commission B. M. [illegible].	17.72	−126.63	−126.58	+0.05	0.044
Lanark	Missouri River Commission B. M. [illegible].	12.40	−109.33	−109.40	−0.07	0.061
Jackson	Cutoff	4.78	− 71.83	− 71.73	+0.10	0.048
Lanark	Cutoff	5.91	+ 16.94	+ 17.18	+0.24	0.346
Montana	Cutoff	11.83	+ 13.02	+ 13.11	+0.09	0.100
Montana	Lanark	4.05	− 4.51	− 4.07	+0.44	0.783
Jackson	Lanark	2.24	− 88.40	− 88.91	−0.51	0.581
Jackson	Montana	1.80	− 84.29	− 84.85	−0.56	0.566
Buford	Montana	33.12	− 60.22	− 60.21	+0.01	0.004
Buford	Jackson	1.19	+ 25.01	+ 24.64	−0.37	0.163
Bainville	Jackson	0.98	+ 17.82	+ 17.42	−0.40	0.156
Snake	Jackson	0.65	− 30.11	− 30.46	−0.35	0.080
Williston	Buford	1.21	+ 33.38	+ 33.27	−0.11	0.014
Bull	Buford	0.95	− 35.15	− 35.52	−0.37	0.130
Snake	Buford	1.31	− 54.88	− 55.10	−0.22	0.064
Buford	Bainville	2.12	+ 7.41	+ 7.22	−0.19	0.074
Williston	Snake	1.04	+ 88.43	+ 88.37	−0.06	0.004
Bull	Snake	5.90	+ 19.66	+ 19.58	−0.08	0.036
Williston	Bull	1.92	+ 68.17	+ 68.79	+0.62	0.738
Bonetraill	Bull	3.30	+ 52.84	+ 52.63	−0.21	0.145
Gladys	Bull	3.78	+ 32.20	+ 31.86	−0.34	0.439
Marmon	Williston	1.43	+ 45.66	+ 45.04	−0.62	0.552
Bonetraill	Williston	2.75	− 16.33	− 16.15	+0.18	0.086
Gladys	Williston	1.79	− 37.70	− 36.92	+0.78	1.092
Marmon	Bonetraill	2.53	+ 61.57	+ 61.19	−0.38	0.361

Station 1.	Station 2.	Weight, p.	Observed difference of elevation, h_2-h_1.	Adjusted difference of elevation, h_2-h_1.	Adjusted minus observed, v.	pvv.
			Meters.	*Meters.*	*Meters.*	
Gladys	Bonetraill	3.65	− 20.97	− 20.77	+0.20	0.148
Marmon	Gladys	1.82	+ 81.96	+ 81.96	0.00	0.000
Howard	Gladys	2.08	+ 51.93	+ 52.33	+0.40	0.336
Muddy	Marmon	1.72	+ 1.91	+ 0.46	−1.45	3.610
Howard	Marmon	1.32	− 30.12	− 29.63	+0.49	0.318
Muddy	Howard	2.63	+ 30.14	+ 30.09	−0.05	0.007
Stady	Howard	2.25	− 3.75	− 3.46	+0.29	0.188
Crosby	Howard	1.02	− 22.51	− 22.19	+0.32	0.106
Norge	Howard	1.23	− 4.02	− 3.47	+0.55	0.374
Crosby	Muddy	2.36	− 52.23	− 52.27	−0.04	0.004
Stady	Muddy	4.97	− 33.04	− 33.55	−0.51	1.290
Crosby	Stady	9.68	− 18.46	− 18.73	−0.27	0.694
Norge	Stady	4.05	− 0.18	− 0.01	+0.17	0.116
Crosby	Norge	3.31	− 18.60	− 18.71	−0.11	0.042
Bowie	Norge	6.54	− 4.57	− 4.30	+0.27	0.472
Ambrose	Crosby	21.80	+ 31.80	+ 31.81	+0.01	0.002
Ambrose southwest base	Crosby	8.04	+ 79.33	+ 78.89	−0.44	1.562
Bowie	Crosby	2.46	+ 14.15	+ 14.41	+0.26	0.166
Bowie	Ambrose	2.88	− 17.28	− 17.40	−0.12	0.041
Ambrose southwest base	Ambrose	13.46	+ 47.13	+ 47.08	−0.05	0.033
Ambrose northeast base	Ambrose	12.90	+ 74.39	+ 74.48	+0.09	0.104
Ambrose northeast base	Ambrose southwest base	9.11	+ 28.15	+ 27.40		
Bowie	Ambrose southwest base	10.00	− 64.61	− 64.48		
Bowie	Ambrose northeast base	3.04	− 91.84	− 91.88		

In this second set of equations the elevations of six stations were taken as fixed. The elevations of Butte and Whetstone had been fixed by the solution of the first set as 1007.01 and 957.99 meters, respectively. The stations Ambrose southwest base, Ambrose northeast base, and Bowie were held fixed from the results of the spirit leveling by the United States and Canada Boundary Survey, their elevations being 650.920, 623.521, and 715.398 meters, respectively. Precise leveling by the Missouri River Commission fixed the elevation of two bench marks, which were made secondary stations of the triangulation and included in this adjustment, viz, Missouri River Commission B. Ms. $\frac{121}{2}$ and $\frac{122}{2}$. Their elevations were held fixed at 582.626 and 579.883 meters, respectively.

The elevations of the remaining 33 stations connected by the observations are the unknowns determined by the method of least squares from the 91 observed differences of elevation in the above table.

The probable error of an observation of weight unity derived from the adjustment is ±0.48 meter. Unit weight corresponds as in the first set to reciprocal observations over a line 31.7 kilometers (19.7 miles) long.

Station Cook may be assumed to be the station least accurately determined, and the probable error computed for its elevation is ±0.37 meter from the vertical angles alone. This probable error, combined with a probable error of ±0.15 meter, assumed for the stations fixed by spirit leveling, may be stated to be ±0.4 meter (1.3 feet).

Referring to the table where the 25 sections of vertical angle results of previous triangulation are assembled in order of their accuracy,[1] this section is exceeded in accuracy by only two sections.

The completion of the transcontinental line of precise levels since the publication of the transcontinental triangulation [2] gave a new elevation for the Salt Lake base. This new elevation differed 5.7 meters from the value obtained from the vertical angles alone, which had been assigned a probable error of ±2.5 meters.

The two adjustments set forth on pages 336 to 340 of Special Publication No. 4 were combined, therefore, and three additional fixed elevations introduced, viz, Salt Lake northwest base, Salt Lake southeast base, and the United States Engineers' Observatory near Ogden, their elevations being 1289.47, 1283.94, and 1332.70 meters, respectively.[3] The elevations of

[1] See Special Publication No. 13, p. 63. [2] Special Publication No. 4, 1900. [3] See Special Publication No. 18, p. 146.

Round Top (3165.6 meters) and Mount Lola (2786.8 meters) were held undisturbed. The precise level elevation for the top of the rail in front of the railroad station at Truckee is 1772.76 meters. This is nearly the same point from which Assistant J. J. Gilbert's levels of 1898 started. Applying the 1898 difference of elevation ($\triangle h = 1013.87$ meters), the new elevation of Mount Lola is 2786.63 meters.

The elevations of the three stations Divide, Pikes Peak, and Plateau were held fixed as 2259.46, 4300.63, and 1644.4 meters, respectively. New leveling by the United States Geological Survey changed the elevation published for Pikes Peak on page 266 of Special Publication No. 4. The amount of the correction, +0.4 meter, was applied to station Plateau, adjusted at the same time.

The probable error of an observation of unit weight is ±3.62 meters for this adjustment.

To get the probable error of an adjusted height, this quantity must be divided by the square root of the weight coefficient derived from the normal equation. Mount Waas was selected as the least accurately determined of any in the scheme, and its probable error was found to be ±1.02 meters from the vertical angle determination alone. This, combined with the uncertainty of the fixed elevations, would remain unchanged.

TABLE OF ELEVATIONS.

Thirty-ninth parallel to latitude 46°.

Station.	Point to which elevation refers.	Elevation.	
		Meters.	Feet.
Class 1.			
Watkins astronomic	Top of surface mark.	1683.47	5523.18
Brighton bench mark, ecc	do	1514.35	4968.32
Dover hench mark, ecc	do	1648.01	5406.84
Bench mark 6702 Denver	do	2042.14	6699.91
Whitaker	do	2041.98	6699.40
Provo astronomic bench mark 3708 DW.	do	1130.93	3710.39
Provo east base	do	1123.05	3684.54
Provo west base	do	1177.19	3862.16
Buffalo Springs	Top of rail	870.82	2857.02
Do	Top of surface mark.	878.93	2883.62
Class 2.			
Elbert	Top of surface mark.	2146.87	7043.5
Hilltop	do	2006.95	6584.5
Douglas	do	1955.39	6415.3
Indian	do	1848.07	6063.2
Morrison	do	2401.16	7877.8
Boulder	do	2575.87	8451.0
Brighton	do	1592.66	5225.3
Dewey	do	1498.04	4914.8
Horsetooth	do	2211.27	7254.8
Warren	do	1970.78	6465.8
Twin	do	2482.76	8145.5
Terry	do	1970.74	6465.7
Wadill	do	2007.40	6585.9
Greentop	do	2472.25	8111.0
Russell	do	2507.66	8227.2
Ragged	do	2508.69	8230.6
Cheyenne east base	do	2011.22	6598.5
Cheyenne west base	do	2074.20	6805.1
Chugwater	do	2034.08	6673.5
Notch	do	2415.67	7925.4
Coleman	do	1693.19	5555.1
Haystack	do	1725.46	5660.9
Colorado-Wyoming houndary monument.	do	1860.06	6102.5
Hobbs	do	1858.08	6096.1
Rawhide	do	1846.55	6058.2
Willow	do	1855.38	6082.2
Manville	do	1715.81	5629.3
Kirtley	do	1578.31	5178.2
Nebraska-Wyoming houndary monument, ecc.	do	1559.02	5114.9
Bluff	do	1458.76	4785.9
South Dakota-Wyoming boundary monument.	do	1252.48	4109.2
Alkali	do	1368.48	4489.8
South Dakota-Nebraska boundary monument.	do	1191.24	3908.3
Sullivan	do	1512.56	4962.5
Cottonwood	do	1314.25	4311.8
Provo astronomic	do	1147.93	3766.2
Parker	do	1475.24	4840.0
Elk	do	1726.97	5665.9
Cambria	do	1960.97	6433.6
Class 2—Continued.			
Inyankara	Top of surface mark.	1939.55	6363.3
Crow	do	2147.83	7046.7
Laird	do	2104.17	6903.4
Terry	do	2153.09	7063.9
Sundance	do	2028.92	6656.5
Wymonkota	do	1093.91	3588.9
Castle	do	1148.65	3768.5
Montana, southeast corner, ecc.	do	1036.09	3391.2
Harding	do	1224.99	4019.0
Moreau	do	1185.44	3889.2
Reva	do	1104.64	3624.1
Lodge	do	982.18	3222.4
Table	do	1099.43	3607.0
North Dakota-South Dakota, milepost 333, ecc.	do	921.51	3023.3
Butte	do	1007.01	3303.8
Whetstone	do	957.99	3143.0
Class 3.			
Daniels & Fisher's tower	Top of dome	1687.0	5535
Denver University observatory.	do	1656.9	5436
Denver State Capitol	Top of gilded dome	1672.9	5489
Denver county courthouse	do	1645.9	5400
Loretto Heights school	Top of belfry tower	1718.1	5637
Denver, Grant smelter	Top of chimney	1680.2	5512
Westminster schoolhouse	Top of belfry	1726.6	5665
Greeley tall tank	Top of tank	1466.3	4811
Greeley sugar factory	Top of chimney	1464.5	4805
La Salle, tank near coal chute.	Top of tank	1450.0	4757
Eaton sugar factory	Top of chimney	1513.6	4966
Loveland red-brick chimney	do	1554.1	5099
Loveland tall white chimney	do	1563.0	5128
Cheyenne State Capitol	Top of small dome	1900.0	6234
Fort D. A. Russell water tank	Eaves	1908.0	6260
Otto, U. P. Ry., black water tank.	Top of tank	2131.9	6994
Ritzke's windmill	Center of wheel	2001.9	6568
Kipp's, William, square house.	Top of chimney	1999.9	6561
Hollingswood's harn	West gable	2029.4	6658
Tall new house	do	2083.9	6837
Jirch College	Top of cupola	1656.3	5434
Manville Congregational Church.	Ground	1603.1	5260
Manville, C. & N. W. Ry. water tank.	Top of tank	1613.0	5292
Bear Lodge Mountain	Highest peak	2030.2	6661
Peak south of Terry	do	2074.0	6804
Haystack Butte	Highest point	1128.7	3703
East Deer Ear Butte	do	1047.3	3436
West Deer Ear Butte	do	1050.7	3447
Wheatland standpipe	Top	1500.9	4924
Eagles Nest Butte	Top of cairn	1003.4	3292

TABLE OF ELEVATIONS—Continued.

Thirty-ninth parallel to latitude 46°—Continued.

Station.	Point to which elevation refers.	Elevation. Meters.	Elevation. Feet.
Class 3—Continued.			
Section 33, T. 17 N., R. 68 W., southwest corner.	Top of stone post	2035.1	6677
Crows Nest (U. S. G. S.)	Top of mark	2147.8	7047
Sullivan (U. S. G. S.)	do	1513.0	4964
Elk (U. S. G. S.)	do	1727.0	5666
North Dakota-South Dakota, milepost 333.	Top of post	907.3	2977
Section 36, T. 4 S., R. 65 W., southeast corner.	X on stone	1843.3	6048
Dover B. M., reference mark	Top of mark	1648.5	5408
Class 3—Continued.			
East Twin	Top of mark	2481.4	8141
Nebraska-Wyoming boundary moumment 123.	Top of stone	1558.6	5114
Alkali (U. S. G. S.)	Top of mark	1368.3	4489
Wyoming, northeast corner, ecc.	do	1052.2	3452
Wyoming, northeast corner, monument.	Top of red granite	1051.6	3450
Montana, southeast corner, monument.	Top of mark	1027.0	3369

Latitude 46° to Canada.

Station.	Point to which elevation refers.	Elevation. Meters.	Elevation. Feet.
Class 1.			
Bench mark $\frac{131}{3}$, Missouri River Commission.	Top of cap	582.81	1912.10
Bench mark $\frac{121}{2}$, Missouri River Commission.	do	582.63	1911.51
Bench mark $\frac{122}{2}$, Missouri River Commission.	do	579.88	1902.49
Ambrose southwest base	Top of surface mark	650.92	2135.56
Ambrose northeast base	do	623.52	2045.67
Bowio	do	715.40	2347.11
Class 2.			
Black	Top of surface mark	1057.09	3468.1
Rainy	do	1018.08	3340.2
Badland	do	923.01	3028.2
Saddle	do	867.73	2846.9
Sentinel	do	1045.47	3430.0
Hump	do	997.74	3273.4
Cook	do	832.83	2732.4
Trotter	do	833.15	2733.4
Montana-North Dakota boundary monument, ecc.	do	817.83	2683.2
Blue	do	937.45	3075.6
Flat	do	846.28	2776.5
Lovering	do	806.16	2644.9
Sheep	do	824.93	2706.5
Jackson	do	780.94	2562.1
Mondak	do	581.22	1906.9
Ferry	do	667.83	2191.0
Cutoff	do	709.21	2326.8
Buford	do	756.30	2481.3
Lanark	do	692.02	2270.4
Montana	do	696.09	2283.8
Class 2—Continued.			
Bainville	Top of surface mark	763.52	2505.0
Snake	do	811.40	2662.1
Williston	do	723.03	2372.1
Bull	do	791.82	2597.8
Bonetraill	do	739.19	2425.2
Gladys	do	759.95	2493.3
Marmon	do	677.99	2224.4
Howard	do	707.62	2321.6
Muddy	do	677.53	2222.9
Stady	do	711.08	2332.9
Norge	do	711.09	2333.0
Crosby	do	729.81	2394.4
Ambrose	do	698.00	2290.0
Bilby	do	695.2	2281
Jasper	do	712.8	2339
Class 3.			
Sentinel Butte public school	Base of flagstaff	845.6	2774
Beach Catholic Church	Cross	866.5	2843
Schoolhouse, 6 miles north of Hump.	Top of chimney	849.2	2786
Bainville Catholic Church	Tip of highest spire	628.5	2062
Snowden water tank	Top	592.6	1944
Steihl's house	Top of chimney	596.8	1958
Ambrose Presbyterian Church	Top of flat steeple	645.8	2119
Bonetraill schoolhouse belfry	Base of flagstaff	741.5	2433
Bowman water tank	Top	945.9	3103
Section 22, T. 17 N., R. 60 E., southeast corner.	Top of mark	816.1	2677
Section 7, T. 143 N., R. 105 W., southwest corner.	do	817.2	2681

Thirty-ninth parallel, east of Pikes Peak.

Station.	Point to which elevation refers.	Elevation. Meters.	Elevation. Feet.
Class 1.			
First View	Top of surface mark	1400.48	4594.74
Kit Carson	do	1345.67	4414.92
Hugo	do	1625.54	5333.13
Divide	do	2259.46	7412.91
El Paso west base	Top of monument	2167.03	7109.66
Do	Top of surface mark	2165.98	7106.22
El Paso east base	do	1993.94	6541.78
Pikes Peak	do	4300.63	14109.65
Class 2.			
Landsman	Top of surface mark	1418.1	4652.5
Class 2—Continued.			
Eureka	Top of surface mark	1442.5	4732.6
Overland	do	1609.4	5280.2
Aroya	do	1495.9	4907.8
Adobe	do	1575.6	5169.3
Holt	do	1868.4	6129.9
Square Bluffs	do	1711.9	5616.5
Cramer Gulch	do	1605.4	5267.0
Dry Camp	do	1705.0	5593.8
Corral Bluffs	do	2070.4	6792.6
Plateau	do	1644.4	5395.0
Big Springs	do	1903.6	6245.4
Holcolm Hills	do	2138.9	7017.4

TABLE OF ELEVATIONS—Continued.

Thirty-ninth parallel, Pikes Peak to California.

Station.	Point to which elevation refers.	Elevation.	
		Meters.	Feet.
Class 1.			
Salt Lake northwest base	Top of surface mark.	1289.47	4230.54
Salt Lake southeast base	do	1283.94	4212.39
Ogden longitude	Top of west pier	1332.70	4372.37
Class 2.			
Round Top	Top of surface mark.	3165.6	10385.8
Mount Lola	do	2786.8	9143.0
Mount Como	do	2747.9	9015.4
Pah Rah	do	2513.2	8245.4
Mount Grant	do	3427.4	11244.7
Carson Sink	do	2680.0	8792.6
Toiyabe Dome	do	3589.0	11774.9
Lone Mountain	do	2775.5	9106.0
Mount Callahan	do	3109.7	10202.4
Diamond Peak	do	3238.9	10626.3
White Pine	do	3434.6	11268.4
Wheeler Peak	do	3976.7	13046.9
Pioche	do	2675.8	8778.9
Ibepah	do	3684.3	12087.6
Tushar	do	3697.8	12131.9
Mount Nebo	do	3618.2	11870.7
Deseret	do	3362.2	11030.8
Scipio	do	2962.4	9719.1
Wasatch	do	3393.3	11132.9
Patmos Head	do	2999.5	9840.9
Mount Ellen	do	3496.9	11472.7
Mount Waas	do	3752.3	12310.7
Tavaputs	do	2677.8	8785.4
Mesa	do	3046.0	9993.4
Uncompahgro	do	4354.5	14286.4
Gunnison azimuth	do	2342.2	7684.4
Treasury Mountain	do	4097.1	13441.9
Mount Ouray	do	4253.5	13955.0
Mount Elbert	do	4395.1	14419.6
Bison	do	3787.8	12427.1
Pilot Peak	do	3262.5	10703.7
Ogden Peak	do	2918.4	9574.8
Antelope	do	2010.3	6595.5
Promontory	do	2008.5	6589.6
Waddoup	do	1302.4	4273.0
City Creek	do	1876.4	6156.2
Chiquita	do	2603.7	8542.3
Grand Junction standpipe	Top of pipe	1403.3	4604.0
Class 3.			
Sanpete	Ground at station	3376.8	11079
Oquirrh	do	2853.6	9362
Mooseneah	do	3348.5	10986
Mount Hilgard	do	3536.4	11602
Monroe	do	[1]3417.8	11213
Delano	do	[1]3707.3	12163
San Rafael Knob	do	[1]2418.2	7934
Mount Alice	do	3513.5	11527
Desert Peak	Top of peak	2128.6	6984
Fremont Island	Top of cairn	1522.4	4995
Francis Peak	Top of peak	2823.7	9264
Class 3—Continued.			
Bountiful Peak or Francis Peak.	Base of cairn	2889.8	9481
Temple, east spire	Center of figure Gabriel.	1385.1	4544
North Ogden Peak	Ground at station	2961.8	9717
Desatoiya	do	3040.6	9976
Monitor	do	3309.0	10856
Onaqui	do	2787.0	9144
Salt Creek	do	3045.4	9991
Lone Tree	Tangent to summit	3068.5	10067
South Scipio	Ground at station	[1]2813.5	9231
Harriman	do	3226.2	10585
Lone Peak	do	3430.3	11254
Springville Peak	Top of peak	3369.2	11054
Draper	do	2840.5	9319
Frisco Mount	do	2946.7	9668
Sawtooth Peak or Sevier Mountain.	do	2942.6	9654
Beaver	Top of signal	3679.2	12064
Indian Peak	Top of peak	2981.9	9783
Antelope Mountain or Swasey Peak.	do	2950.3	9679
Volcano	do	[1]2876.2	9436
Crestone Peak	do	4355.9	14291
Sierra Blanca	do	4377.7	14363
Antero	do	4037.0	13245
Rito Alto	do	4137.2	13573
East Spanish Peak	Highest point	3865.8	12683
Mount Harvard	Top of peak	4388.9	14399
Mount Yale	do	4319.7	14172
Mount Princeton	do	4321.3	14177
Monte Rosa	do	3506.4	11504
Mount Shavano	do	4321.9	14179
Mount Massive	do	4390.2	14404
Augusta	do	[1]3041.6	9979
Fairview	do	2532.1	8307
Mount Lincoln	do	[1]2615.7	8582
Star Peak	do	[1]2997.7	9835
Lyon South Summit	do	2794.8	9169
Montezuma Peak	do	[1]2552.0	8373
Shoshone Peak, north	do	3146.0	10322
Bunker Hill	do	3498.2	11477
Shoshone Peak, south	do	[1]3069.8	10072
Sharp Peak	do	3078.1	10099
Mount Hamilton	do	3273.9	10741
Prospect Peak	do	[1]2918.0	9573
Duckwater	do	3503.0	11493
Broken Back	do	3190.0	10466
Ward	do	3331.3	10929
Mount Lewis	do	[1]2951.6	9684
Granite Peak	do	[1]2980.7	9779
Mount Moriah	do	3672.6	12049
Pioche Peak	Signal	[1]2225.7	7302
Highland Peak	Top of peak	[1]2843.9	9330
White Rock	Stone monument	[1]2714.3	8905
Mount Grafton	Top of peak	3347.7	10983
Mount Jefferson	Base of monument	[1]3598.7	11807
South Promontory	Base of peak	[1]2156.6	7075

[1] No check on this elevation.

DETERMINATION OF ASTRONOMIC LONGITUDE.

The astronomic longitudes of five triangulation stations along the one hundred and fourth meridian were determined in 1912 by the observing parties under Assistants H. A. Seran and G. D. Cowie. Each of those stations was connected by wire telegraph with the old longitude station in Omaha, at which Mr. Cowie made the time observations. Mr Seran observed time at the new stations and exchanged time signals with Mr. Cowie. The transits used were equipped with the self-registering micrometers. The methods and instruments are described in the astronomic manual (Special Publication No. 14 of the Coast and Geodetic Survey).

The descriptions of the new longitude stations and the data connected with each of the five determinations of the difference in longitude are given on the following pages:

Summary of the determination of the differences of longitude.

Station.		Date of exchange of time signals.	Difference of longitude $\Delta\lambda$.	v.	Transmission time.
Eastern.	Western.				
		1912.	m s	s	s
Omaha, Nebr.....	Mondak longitude, Mont..	Sept. 6	32 24.761	+0.034	0.156
Do.............	.....do...................	Sept. 7	24.803	− .008	.151
Do.............	.....do...................	Sept. 8	24.821	− .026	.162
Mean......	....	....	32 24.795	± .012	....

At Omaha the transit was mounted on the same pier used in 1907. This pier is 89.896 meters west and 39.315 meters north of the old longitude station of 1882, reference to which may be found on pages 218 and 254 of Appendix No. 2, Report for 1897. The adjusted longitude of the 1882 station is $6^h\ 23^m\ 46^s.087$, and the 1907 pier is $0^s.257$ west of it, making the longitude of the 1907 pier $6^h\ 23^m\ 46^s.344 = 95°\ 56'\ 35''.16$.

At Mondak the transit was mounted on a temporary wooden pier 3.995 meters north and 0.250 meter east of the triangulation station *Mondak*. (See description on p. 123.) The longitude station, not marked, is $32^m\ 24^s.795 = 8°\ 06'\ 11''.93$ west of the Omaha longitude station of 1907. The longitude of the temporary station is therefore 104° 02′ 47″.09 and the longitude of the triangulation station Mondak is 0.01″ greater or 104° 02′ 47″.10.

Station.		Date of exchange of time signals.	Difference of longitude $\Delta\lambda$.	v.	Transmission time.
Eastern.	Western.				
		1912.	m s	s	s
Omaha, Nebr.....	Bowman longitude, N. Dak.	Sept. 18	29 50.060	+0.036	0.118
Do.............	.....do...................	Sept. 28	50.084	+ .012	.117
Do.............	.....do...................	Sept. 29	50.147	− .051	.109
Do.............	.....do...................	Sept. 30	50.095	+ .001	.111
Mean......	....	....	29 50.096	± .012	....

At Bowman the transit was mounted on a concrete pier 12.018 meters west and 8.219 meters north of *Bowman water tank*. The pier is $29^m\ 50^s.096 = 7°\ 27'\ 31''.44$ west of the Omaha longitude station of 1907 (see above). The longitude of the Bowman longitude station is therefore 103° 24′ 06″.60.

Station.		Date of exchange of time signals.	Difference of longitude $\Delta\lambda$.	v.	Transmission time.
Eastern.	Western.				
		1912.	m s	s	s
Omaha, Nebr.....	Provo longitude, S. Dak...	Oct. 11	31 32.210	−0.038	0.050
Do.............	.....do...................	Oct. 12	32.127	+ .045	.043
Do.............	.....do...................	Oct. 13	32.178	− .006	.046
Mean......	....	....	31 32.172	± .016	....

At Provo the transit was mounted on a temporary wooden pier 12.355 meters north and 1.404 meters west of *Provo astronomic* station. (See description on p. 119.) The longitude station, not marked, is $31^m\ 32^s.172 = 7°\ 53'\ 02''.58$ west of Omaha longitude station of 1907 (see above) and its longitude is therefore 103° 49′ 37″.74. *Provo astronomic* station is 0″.06 east of the longitude station and its longitude is therefore 103° 49′ 37″.68.

Station.		Date of exchange of time signals.	Difference of longitude $\Delta\lambda$.	v.	Transmission time.
Eastern.	Western.				
		1912.	m s	s	s
Omaha, Nebr.....	Wheatland longitude, Wyo.	Oct. 19	36 02.296	+0.009	0.069
Do.............	.....do...................	Oct. 22	02.385	− .080	.079
Do.............	.....do...................	Oct. 24	02.299	+ .006	.078
Do.............	.....do...................	Oct. 25	02.240	+ .065	.077
Mean......	....	....	36 02.305	± .021	....

At Wheatland the transit was mounted on a temporary wooden pier 25.21 meters east and 6.41 meters north of *Wheatland standpipe*. (See description on p. 125.) The longitude station not marked, is $36^m\ 02^s.305 = 9°\ 00'\ 34''.58$ west of Omaha longitude station of 1907 (see above), and its longitude is therefore 104° 57′ 09″.74. *Wheatland standpipe* is 1″.09 west of the temporary station, and its longitude is therefore 104° 57′ 10″.83.

Station.		Date of exchange of time signals.	Difference of longitude $\Delta\lambda$.	v.	Transmission time.
Eastern.	Western.				
		1912.	m s	s	s
Omaha, Nebr.....	Watkins longitude, Colo...	Nov. 1	34 38.536	+0.027	0.061
Do..........	.....do....................	Nov. 7	38.628	− .065	.064
Do..........	.....do....................	Nov. 8	38.524	+ .039	.066
Mean.......			34 38.563	±0.022	

At Watkins the transit was mounted on a temporary wooden pier 4.60 meters east and 48.64 meters south of *Watkins astronomic* station. (See description on p. 116.) The longitude station, not marked, is $34^m\ 38^s.563 = 8°\ 39'\ 38''.45$ west of Omaha longitude station of 1907 (see above), and its longitude is therefore 104° 36′ 13″.61. *Watkins astronomic* station is 0″.19 west of the temporary longitude station, and its longitude is therefore 104° 36′ 13″.80.

The following table gives for each longitude station on the one hundred and fourth meridian the name of the station, the geodetic latitude and longitude, the astronomic longitude, the difference between the astronomic and geodetic longitude (A − G), the cosine of the latitude, and finally the deflection in the prime vertical. The table is arranged like that shown on page 152, except that the cosine of the latitude is the factor for reducing the difference between the astronomic and geodetic longitudes to the prime vertical, while the negative of the cotangent of the latitude is used in the latter table to reduce the difference in azimuths to the prime vertical.

The astronomic longitudes have not been corrected for the variation of latitude.

Deflections in prime vertical.

Station.	Geodetic latitude.	Geodetic longitude.	Astronomic longitude.	A−G.	cos ϕ'.	A−G (P. V.).
	° ′ ″	° ′ ″	″	″		″
Watkins astronomic, Colo...	39 44 43.813	104 36 18.915	13.80	− 5.12	0.7689	− 3.94
Wheatland standpipe, Wyo.	42 02 43.815	104 57 26.898	10.83	−16.07	0.7426	−11.93
Provo astronomic, S. Dak..	43 11 44.159	103 49 41.058	37.68	− 3.38	0.7290	− 2.46
Bowman longitude, N. Dak.	46 10 57.528	103 24 11.012	06.60	− 4.41	0.6924	− 3.05
Mondak, Mont.............	48 00 10.435	104 02 48.867	47.10	− 1.77	0.6691	− 1.18

At each of three of the stations the astronomic longitude and azimuth were determined. The Laplace azimuths computed at these stations are undoubtedly more accurate than the geodetic azimuths computed through the triangulation, and therefore the former were considered as being free from error. The discrepancies between the Laplace and the geodetic azimuths were considered as deviations of the triangulation in azimuth. In the adjustment the attempt was made to hold the Laplace azimuths as absolute by means of azimuth equations. If the adjustment had been rigid, the deflections in the prime vertical from the differences between the astronomic and geodetic longitudes would have been identical with those from the azimuths. The largest outstanding discrepancy is 0″.57 at Provo, and this was considered too small to necessitate a further adjustment to completely eliminate it. This is within the limit allowable when the probable error of the Laplace azimuth is taken into consideration.

ZENITH TELESCOPE USED FOR LATITUDE OBSERVATIONS.

ASTRONOMIC AZIMUTHS.

All except two of the astronomic azimuths on the one hundred and fourth meridian triangulation were observed in 1912 by the triangulation parties. Those two were observed in 1913 by the latitude party. The methods described in the publication of the United States Coast and Geodetic Survey entitled "The determination of time, longitude, latitude, and azimuth, Special Publication No. 14," were employed on this work. At the Laplace stations, Mondak, Provo, and Watkins, observations on more than one night and an accuracy of the azimuth as great as that represented by a probable error of ±0″.30 were required. At the other stations one night's observations were considered sufficient, provided the probable error of the result was not greater than ±0″.50, and observations in at least ten positions of the horizontal circle had been obtained.

The instrument used in the azimuth work was the 12-inch theodolite shown in illustration No. 2 and described briefly on page 30. The error and weight of the chronometer used were determined by observations made with the vertical circle. See page 140.

The following table shows for the azimuths observed by the party of Assistant C. V. Hodgson, the name of the station occupied, the dates on which observations were made, the number of positions, and the probable error of the result:

Program of occupation of azimuth stations by party of Assistant C. V. Hodgson.

Station.	Date of occupation.	Number of positions.	Probable error of result.	Station.	Date of occupation.	Number of positions.	Probable error of result.
	1912.		″		1912.		″
Ragged, Wyo	June 4	16	±0.31	Willow, Wyo	Oct. 15	16	±0.24
Twin, Wyo	June 25	16	±0.21				
Dewey, Colo	July 10	16	±0.34		1913.		
Boulder, Colo	Aug. 1	16	±0.22	Alkali, Wyo	Sept. 9	14	±0.38
Watkins astronomic, Colo	Aug. 11, 13	32	±0.18	Cambria, Wyo	Sept. 12	14	±0.29
Provo astronomic, S. Dak	Oct. 6, 7	24	±0.36				

The following table gives data, similar to that contained in the one above, for the azimuths observed by the party of Assistant E. H. Pagenhart:

Program of occupation of azimuth stations by party of Assistant E. H. Pagenhart.

Station.	Date of occupation.	Number of positions.	Probable error of result.	Station.	Date of occupation.	Number of positions.	Probable error of result.
	1912.		″		1912.		″
Bowie, N. Dak	June 4, 5	16	±0.53	Saddle, N. Dak	Sept. 5	16	±0.20
Gladys, N. Dak	June 22	16	±0.40	Reva, S. Dak	Oct. 7	16	±0.35
Mondak, Mont	July 24, 25	24	±0.20	Wymonkota, Mont	Oct. 20	16	±0.36
Blue, Mont	Aug. 20	16	±0.24				

The table below gives for each azimuth station its geographic position, the geodetic azimuth of a line of the main scheme of the triangulation, the astronomic azimuth, the difference between the astronomic and geodetic azimuths (A—G), the negative cotangent of the latitude of the occupied station ($-\cot \varphi'$), and finally the value of "A—G" as the deflection in the prime vertical (P. V.). The table is arranged like those shown in the two publications of the United States Coast and Geodetic Survey on the figure of the earth.[1]

In each case the azimuth and triangulation stations are coincident. The mark used was the signal lamp accurately centered over the triangulation station at the distant end of the line of triangulation for which the azimuth is given.

The astronomic azimuths have been corrected for the elevation of the station sighted upon, but not for the variation of latitude.

[1] "The Figure of the Earth and Isostasy from Measurements in the United States" and "Supplementary Investigation in 1909 of the Figure of the Earth and Isostasy."

Deflections in prime vertical.

Station.	Geodetic latitude.	Geodetic longitude.	Geodetic azimuth.	To station—	Astronomic azimuth.	A−G.	−cot φ′.	A−G (P. V.).
	° ′ ″	° ′ ″	° ′ ″		″	″		″
Watkins astronomic, Colo	39 44 43.813	104 36 18.915	350 08 03.53	Indian	06.88	+ 3.25	−1.2026	− 4.03
Boulder, Colo	39 57 37.355	105 17 40.611	348 40 25.56	Morrison	48.59	+23.03	−1.1934	−27.48
Dewey, Colo	40 30 25.868	104 33 16.100	94 00 17.52	Horsetooth	19.08	+ 1.56	−1.1706	− 1.83
Twin, Wyo	41 02 54.064	105 16 02.530	353 54 24.76	Horsetooth	38.82	+14.06	−1.1484	−16.15
Ragged, Wyo	41 26 20.835	105 20 39.192	212 56 23.95	Chugwater	35.45	+11.50	−1.1327	−13.03
Willow, Wyo	42 41 10.995	104 39 50.037	46 48 49.49	Coleman	47.56	− 1.93	−1.0842	+ 2.09
Provo astronomic, S. Dak	43 11 44.159	103 49 41.058	70 55 53.73	Provo west base	56.62	+ 2.89	−1.0651	− 3.08
Alkali, Wyo	43 38 12.937	104 29 11.373	207 19 16.05	Cambria	14.82	− 1.23	−1.0488	+ 1.29
Cambria, Wyo	44 02 43.952	104 11 36.919	27 31 26.43	Alkali	18.95	− 7.48	−1.0339	+ 7.73
Wymonkota, Mont	45 00 35.551	104 05 07.832	201 17 14.73	Harding	21.73	+ 7.00	−0.9997	− 7.00
Reva, S. Dak	45 34 51.060	103 12 44.169	135 35 35.72	Table	39.48	+ 3.76	−0.9799	− 3.68
Saddle, N. Dak	46 58 57.890	103 13 42.639	116 42 16.19	Cook	17.99	+ 1.80	−0.9331	− 1.68
Blue, Mont	47 15 22.033	104 10 00.510	229 07 14.56	Flat	15.44	+ 0.88	−0.9242	− 0.81
Mondak, Mont	48 00 10.435	104 02 48.867	171 45 17.45	Montana	18.75	+ 1.30	−0.9003	− 1.17
Gladys, N. Dak	48 26 45 434	103 53 03.761	192 15 02.79	Howard	59.64	− 3.15	−0.8864	+ 2.79
Bowie, N. Dak	48 59 56.626	103 44 00.295	273 03 40.65	Ambrose northeast base.	43.87	+ 3.22	−0.8693	− 2.80

ASTRONOMIC LATITUDES.

In July, 1913, a party under the direction of Assistant C. V. Hodgson began the observations for latitude at stations of the one hundred and fourth meridian primary triangulation. The work was interrupted while the party was engaged in measuring the Cheyenne base and in making the necessary horizontal observations to connect the base with the main scheme of triangulation. (See p. 22.) The party consisted of two men besides the chief, who was also the observer. The means of transportation was a White automobile truck of 1½ tons carrying capacity, with a 30-horsepower gasoline engine. The truck was provided with the necessary tanks for carrying gasoline for the engine and water for cooking and drinking purposes. The outfit comprised two tents, cots and bedding for three persons, a small mess outfit, a box of tools, a portable wooden tripod for the latitude instrument, a few short boards of which a platform was made for the observer, an 8 by 8 foot observing tent, a zenith telescope, and a chronometer. Besides the above-mentioned articles, there were a few small instruments for use when connecting the astronomic and triangulation stations. as well as lamps, lanterns, and other small articles of outfit.

The truck is shown in illustration No. 6c. The zenith telescope is shown in illustration No. 6a, and the wooden stand, which had legs capable of adjustment to various heights, is shown in illustration No. 6b. The observing tent used by the party is like that shown in illustration No. 17 of Special Publication No. 14. That the truck was a much more economical means of transportation than teams is clearly shown by a statement in Mr. Hodgson's season's report, which reads:

> During the 2.2 months spent on latitude we accomplished what would have taken seven months to complete with teams, while the cost per station was reduced from $212 to $119. Counting in the entire cost of the truck on this season's work, brings the cost per station to only $199, so that the truck more than paid for itself in 2.2 months.

The truck could be run at a maximum rate of 25 miles per hour.

The wooden stand was very satisfactory, in the opinion of Mr. Hodgson, and the accuracy of the results proves that it must have been very stable.

The chief of party followed the methods given in Special Publication No. 14 of the Coast and Geodetic Survey, entitled "The determination of time, longitude, latitude, and azimuth."

The accuracy desired was that represented by a probable error of the result at a station of about ±0″.10. The observer was permitted to complete the observations in one night, if it was found practicable to do so. He was directed to make computations of the latitude at the first few stations, but, after ascertaining the number of pairs necessary to give the desired accuracy, he was not to make any further computations in the field. After computations were made in the field at three stations it was found that, in general, 18 pairs would give the accuracy required. That this was a satisfactory number was proved by the probable errors

PORTABLE WOODEN SUPPORT WITH ADJUSTABLE LEGS FOR THE ZENITH TELESCOPE.

MOTOR TRUCK USED BY LATITUDE PARTY.

of the results, only one station having a probable error greater than ±0″.10, and that one only ±0″.11.

The program of the occupation of the stations is given in the following table. The Cheyenne base was measured between the occupation of stations Morrison and Whitaker. The astronomic azimuth of a line of the triangulation was observed at stations Alkali and Cambria.

Program of occupation of latitude stations.

Station.	Date of occupation.	Pairs observed.	Probable error of result.	Station.	Date of occupation.	Pairs observed.	Probable error of result.
	1913.		″		1913.		″
Elbert, Colo	July 30, 31	17	±0.10	Alkali, Wyo	Sept. 9	17	±0.08
Morrison, Colo	Aug. 2, 3	18	±0.07	Cambria, Wyo	Sept. 13	19	±0.05
Whitaker, Wyo	Aug. 12	16	±0.05	Sundance, Wyo	Sept. 17	18	±0.07
Loveland tall white chimney, Colo.	Aug. 14, 15	15	±0.11	Wyoming, northeast corner eccentric.	Sept. 19	18	±0.05
Brighton bench mark eccentric, Colo.	Aug. 16, 17	18	±0.06	Harding, S. Dak	Sept. 21	18	±0.08
Dewey, Colo	Aug. 20	18	±0.08	Reva, S. Dak	Sept. 25	17	±0.08
Colorado-Wyoming boundary monument 44.	Aug. 22	18	±0.08	Bowman longitude, N. Dak	Sept. 27	18	±0.08
Wheatland standpipe, Wyo	Aug. 23	18	±0.07	Badland, N. Dak	Sept. 30	17	±0.06
Coleman, Wyo	Aug. 28	17	±0.08	North Dakota-Montana, boundary monument eccentric.	Oct. 2	17	±0.08
Jireh College, Wyo	Aug. 31	17	±0.10	Sheep, N. Dak	Oct. 6	17	±0.10
Kirtley, Wyo	Sept. 3, 4	18	±0.05	Mondak, Mont	Oct. 8, 10, 11	17	±0.07
Provo astronomic, S. Dak	Sept. 5	18	±0.10	Bonetraill, N. Dak	Oct. 13	18	±0.07
				Ambrose northeast base, N. Dak	Oct. 14	17	±0.08

In every case the astronomic station was referred to the triangulation station and in the table given below the geodetic and astronomic latitudes refer to the triangulation stations whose geodetic positions are shown also on pages 88 to 94. Descriptions of the stations are given on pages 115 to 126, unless the name of the station is sufficient for its identification.

The following table gives the names of the latitude stations, their geodetic latitudes and longitudes, their astronomic latitudes reduced to sea level, and the values of A—G, the astronomic minus the geodetic latitude. The astronomic values have not been reduced for variation of the pole.

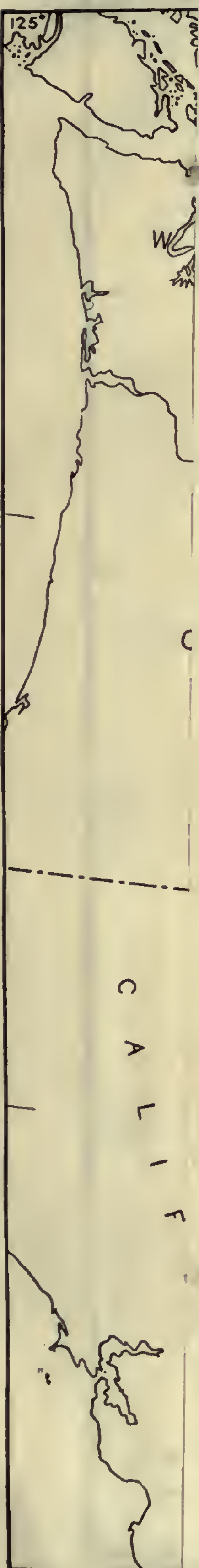
Deflections in the meridian.

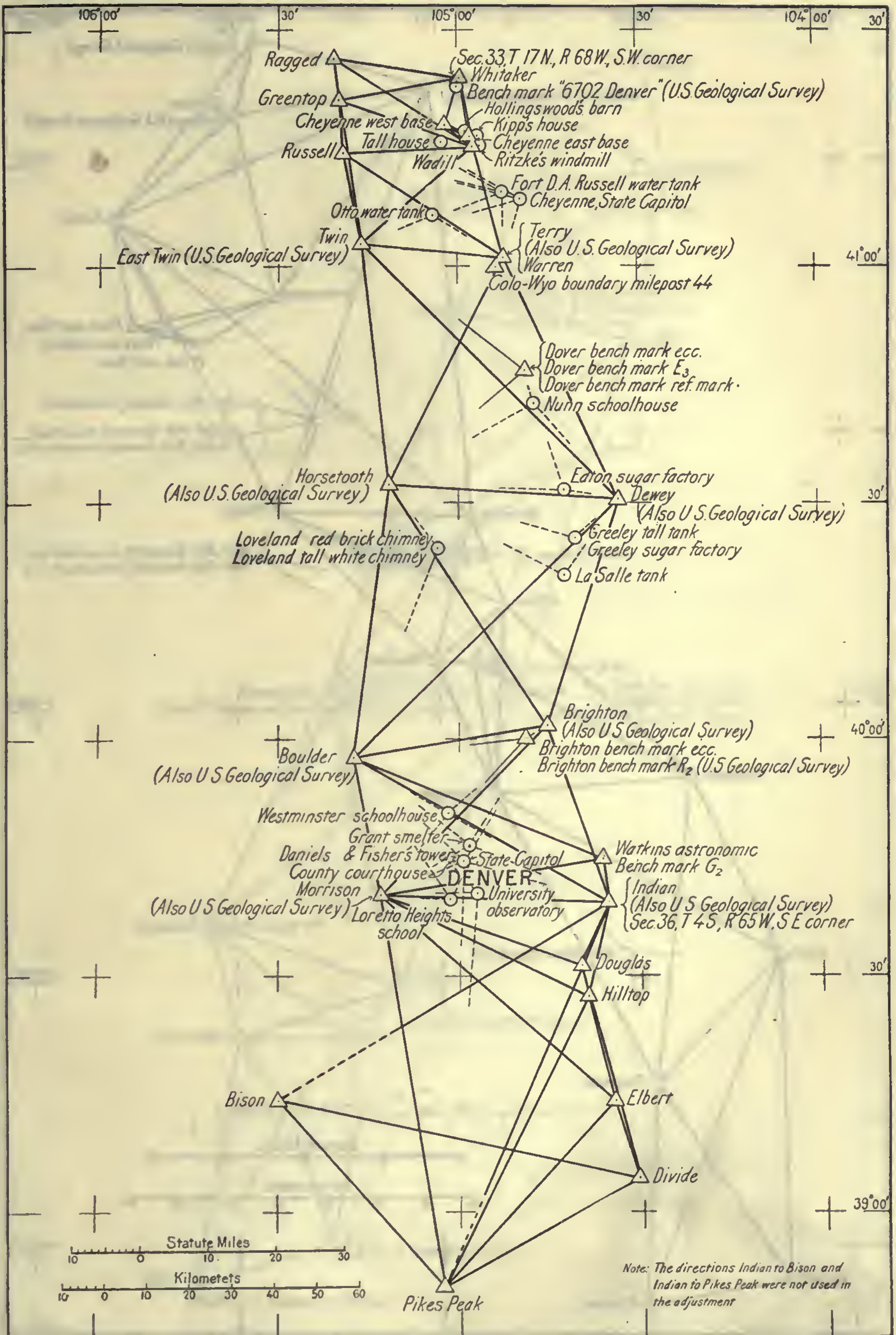
Station.	Geodetic latitude.	Geodetic longitude.	Astronomic latitude.	A—G.
	° ′ ″	° ′ ″	″	″
Elbert, Colo	39 14 02.936	104 34 33.167	2.40	−0.54
Morrison, Colo	39 40 09.669	105 13 09.104	11.77	+2.10
Whitaker, Wyo	41 23 56.362	104 59 38.801	53.00	−3.36
Loveland tall white chimney, Colo	40 24 10.770	105 03 35.817	4.62	−6.15
Brighton bench mark eccentric, Colo	40 00 01.626	104 48 58.148	3.40	+1.77
Dewey, Colo	40 30 25.868	104 33 16.100	19.53	−6.34
Colorado-Wyoming boundary monument 44	40 59 54.156	104 53 33.575	49.74	−4.42
Wheatland standpipe, Wyo	42 02 43.815	104 57 26.898	42.33	−1.49
Coleman, Wyo	42 22 03.568	105 07 13.823	5.98	+2.41
Jireh College, Wyo	42 46 29.82	104 42 34.38	32.52	+2.70
Kirtley, Wyo	42 51 44.682	104 06 00.914	43.70	−0.98
Provo astronomic, S. Dak	43 11 44.159	103 49 41.058	40.07	−4.09
Alkali, Wyo	43 38 12.937	104 29 11.373	7.79	−5.15
Cambria, Wyo	44 02 43.952	104 11 36.919	41.76	−2.19
Sundance, Wyo	44 28 44.696	104 27 02.821	45.35	+0.65
Wyoming northeast corner eccentric	44 59 59.117	104 03 18.515	60.39	+1.27
Harding, S. Dak	45 22 14.317	103 53 09.605	12.95	−1.37
Reva, S. Dak	45 34 51.060	103 12 44.169	49.54	−1.52
Bowman longitude, N. Dak	46 10 57.528	103 24 11.012	56.96	−0.57
Badland, N. Dak	46 42 00.620	103 19 59.087	.87	+0.25
North Dakota-Montana boundary monument eccentric	47 12 42.065	104 02 39.376	44.39	+2.33
Sheep, N. Dak	47 37 50.103	103 47 39.515	51.93	+1.83
Mondak, Mont	48 00 10.435	104 02 48.867	11.99	+1.55
Bonetraill, N. Dak	48 25 00.000	103 49 44.219	.73	+0.73
Ambrose northeast base, N. Dak	48 59 24.331	103 29 09.836	26.47	+2.14

It was not found to be practicable before the manuscript of this report went to press to correct the observed deflections for the effect of the topography and isostatic compensation. It seems to be reasonably certain from an inspection of the topographic maps in Colorado that these corrections will reduce many of the observed deflections. This seems to be the case especially with the deflection of the vertical in the prime vertical at station Boulder (latitude 39° 57′ and longitude 105° 18′). The observed deflection in this case was 27″.48, the nadir being drawn toward the west. The mountains just west of the station rise to an elevation of more than 13 000 feet (4000 meters).

NO. 7.

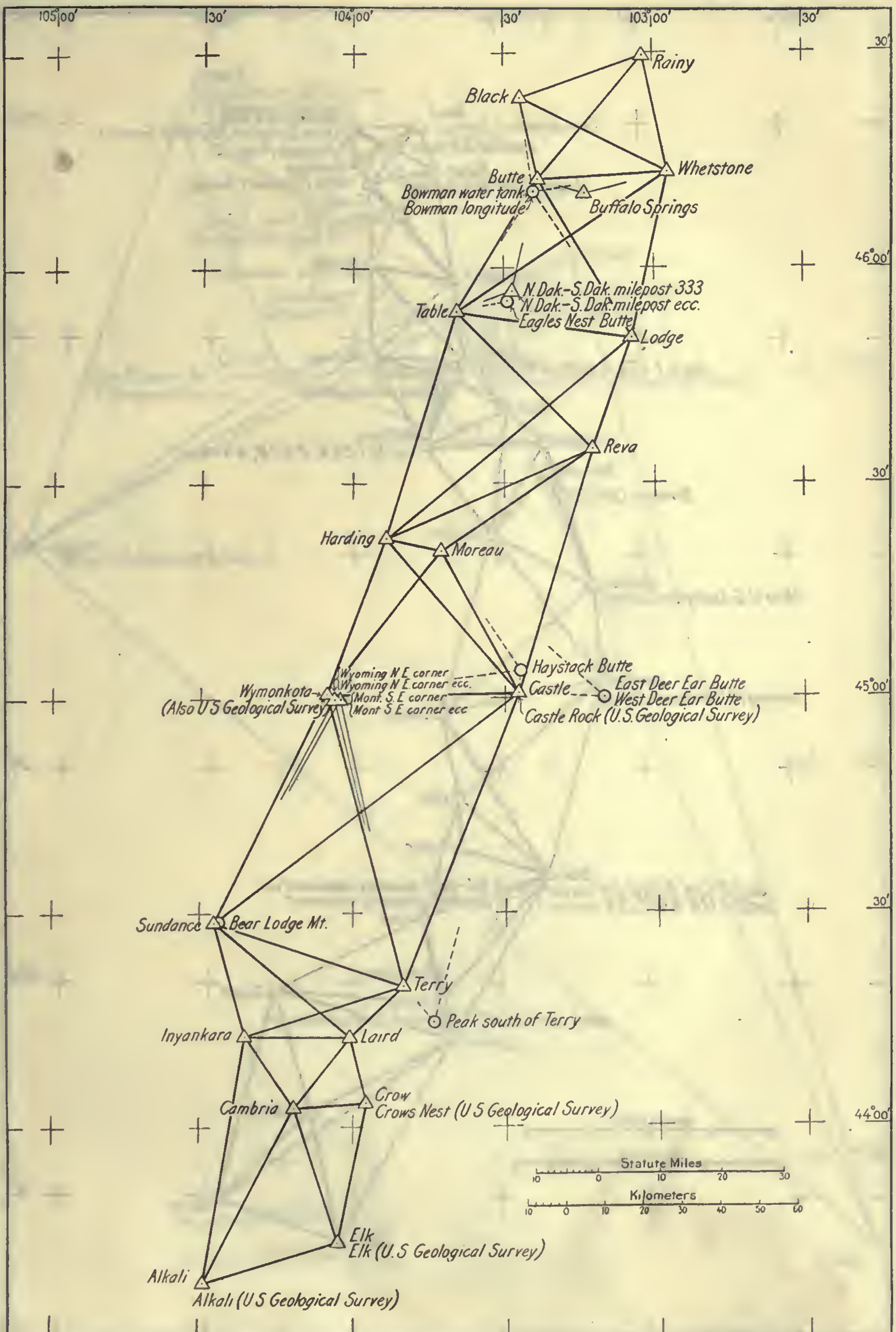
INDEX MAP SHOWING AREAS COVERED BY PUBLISHED TRIANGULATION WHICH HAS BEEN RIGIDLY COMPUTED ON THE NORTH AMERICAN DATUM.


125°
C A L I F

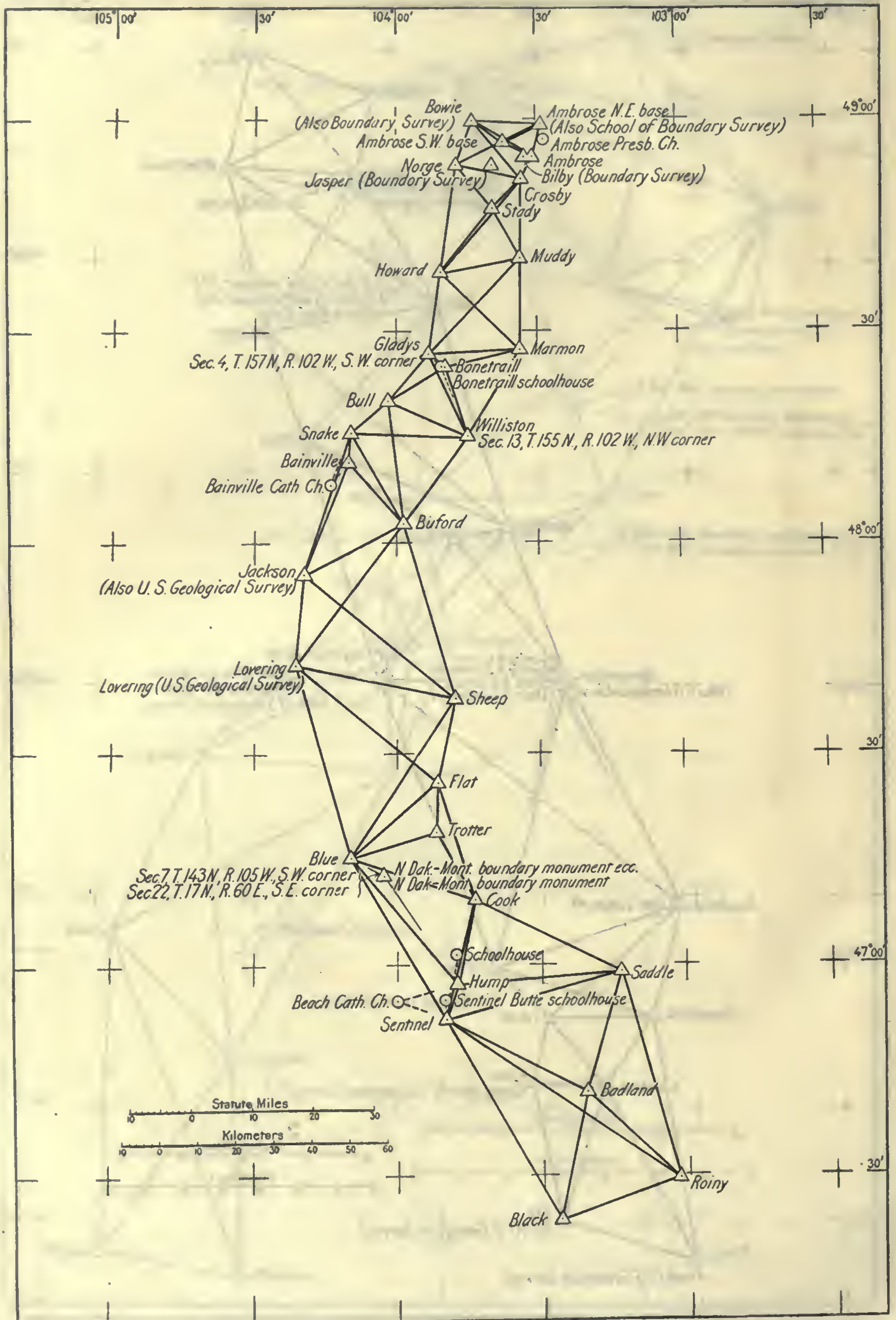


TRIANGULATION, ONE HUNDRED AND FOURTH MERIDIAN, STATIONS PIKES PEAK AND DIVIDE TO RAGGED AND WHITAKER.

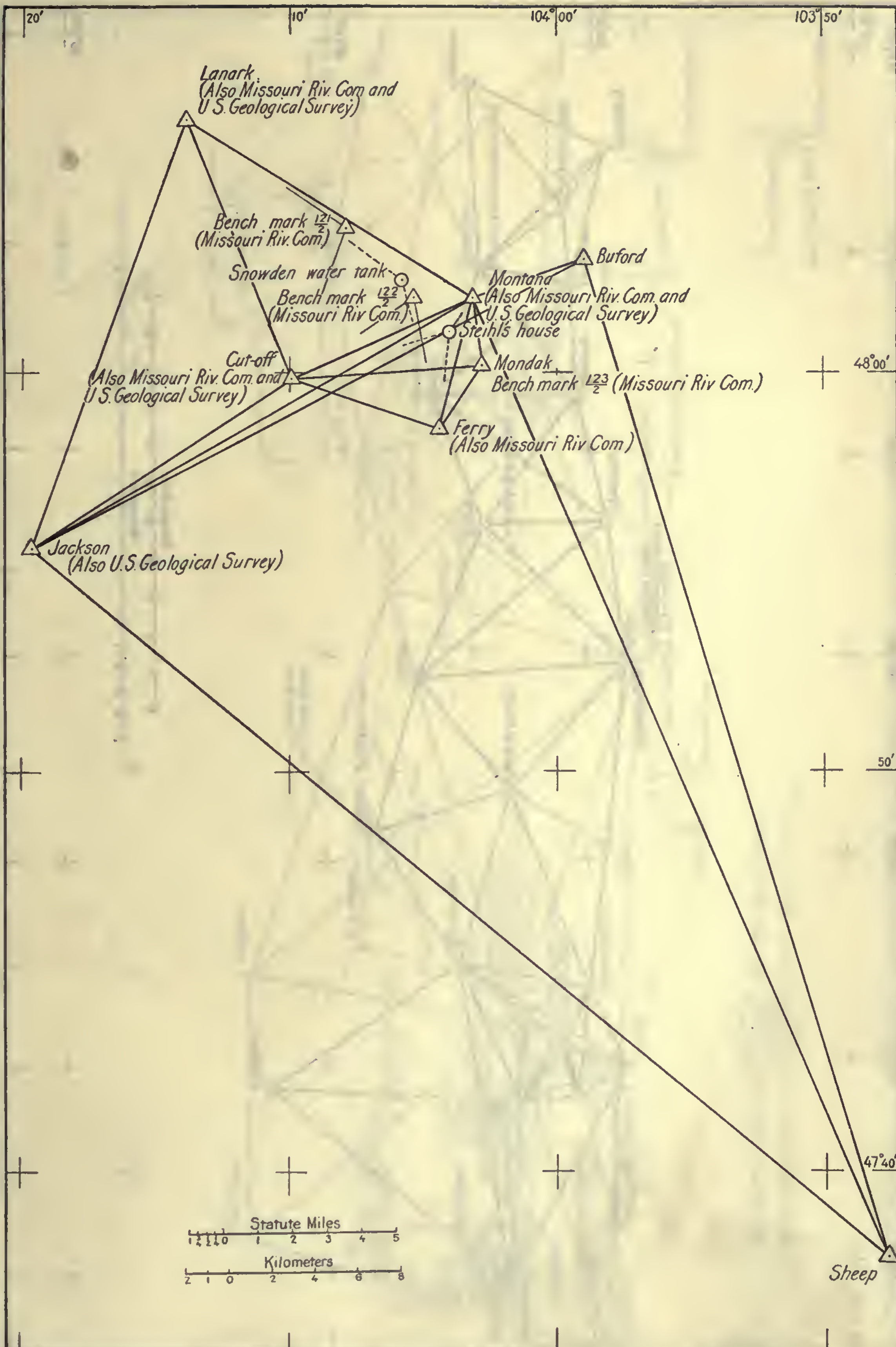
TRIANGULATION, ONE HUNDRED AND FOURTH MERIDIAN, STATIONS RAGGED AND WHITAKER TO ALKALI AND ELK.



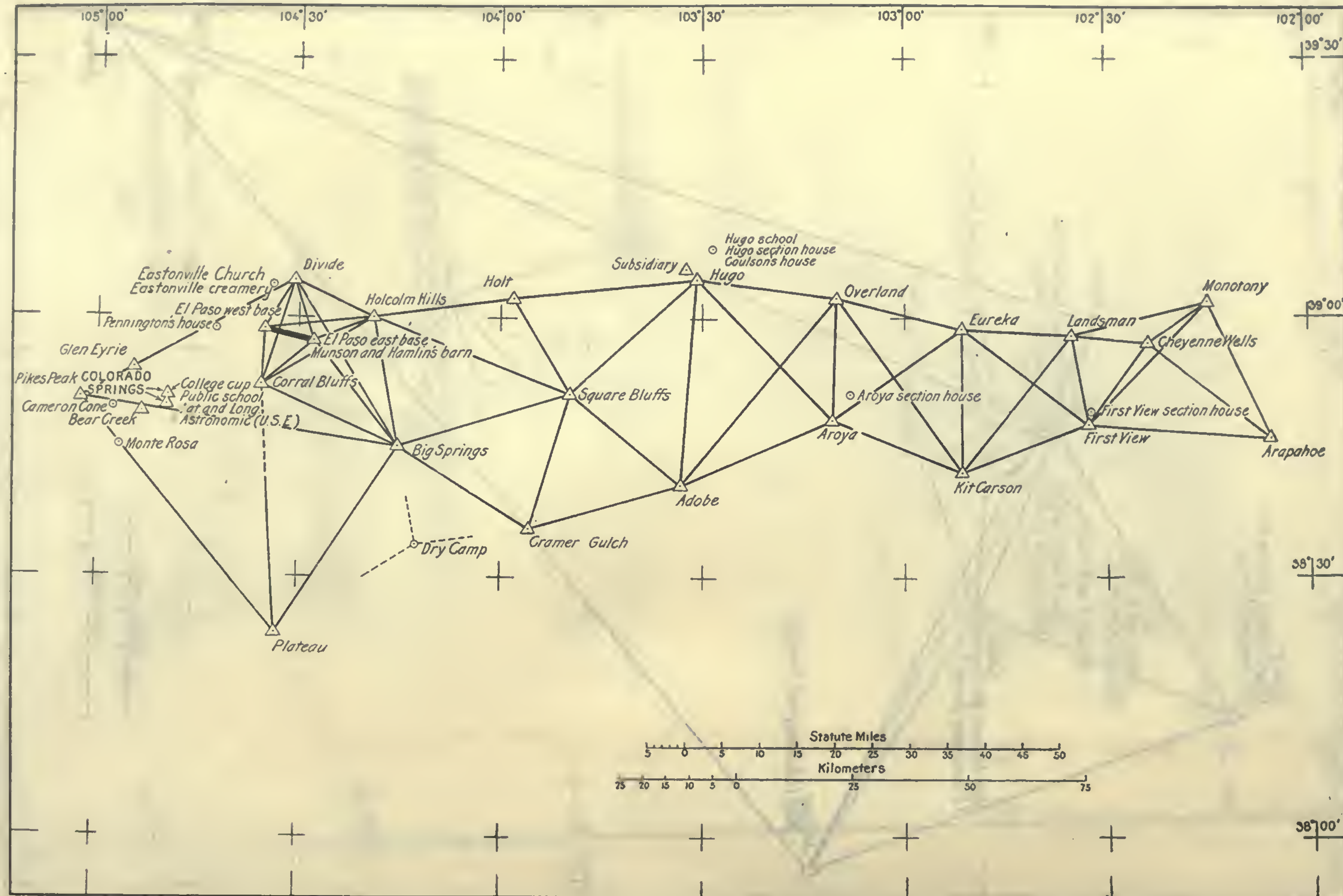
TRIANGULATION, ONE HUNDRED AND FOURTH MERIDIAN, STATIONS ALKALI AND ELK TO BLACK AND RAINY.



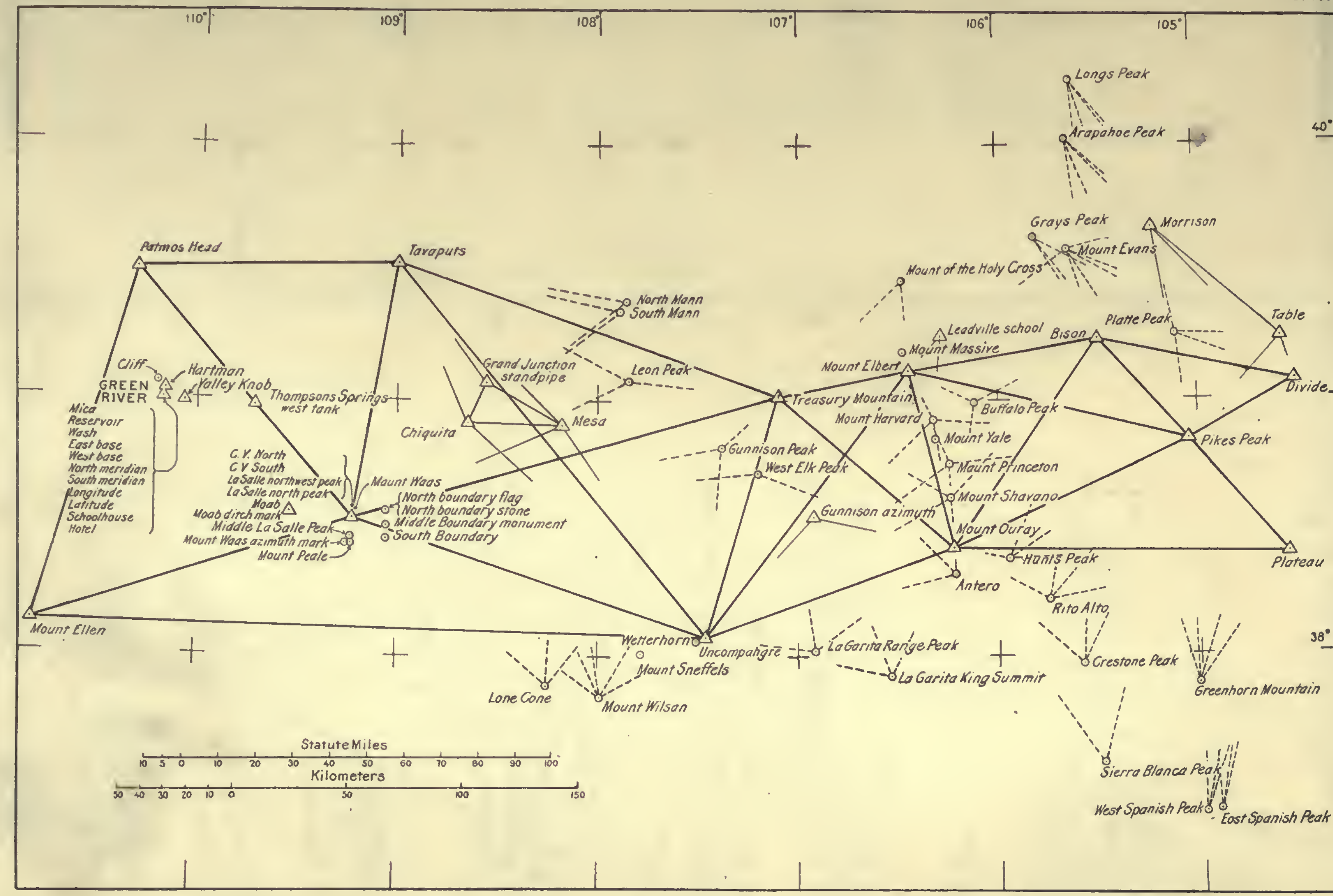
TRIANGULATION, ONE HUNDRED AND FOURTH MERIDIAN, STATIONS BLACK AND RAINY TO CANADA BOUNDARY.



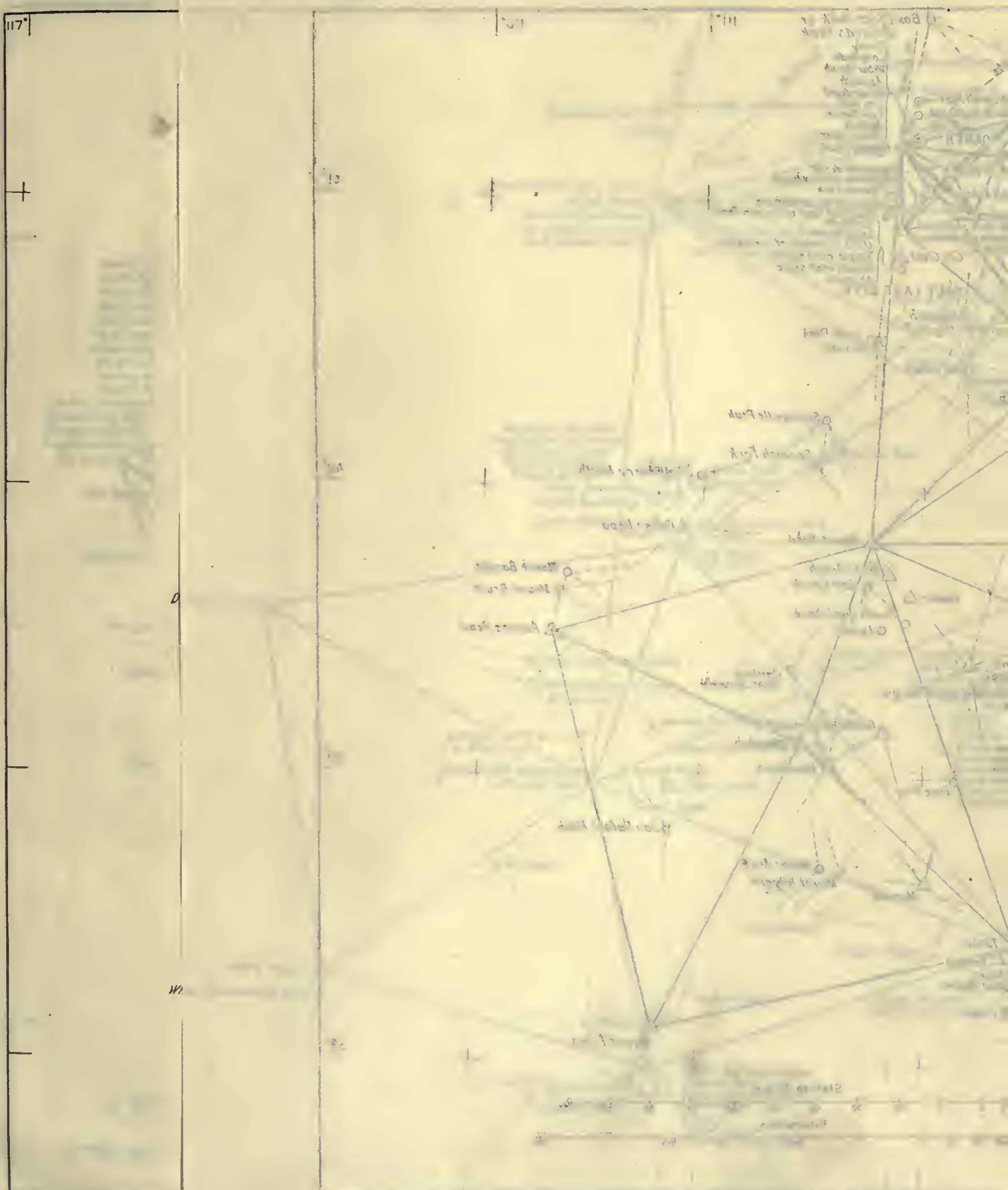
TRIANGULATION, ONE HUNDRED AND FOURTH MERIDIAN, MISSOURI RIVER CONNECTION.



TRIANGULATION, THIRTY-NINTH PARALLEL, KANSAS AND COLORADO BOUNDARY TO STATIONS DIVIDE, PIKES PEAK, AND PLATEAU.



TRIANGULATION, THIRTY-NINTH PARALLEL, STATIONS DIVIDE, PIKES PEAK, AND PLATEAU TO PATMOS HEAD AND MOUNT ELLEN.


117°

INDEX TO POSITIONS, DESCRIPTIONS, ELEVATIONS, AND SKETCHES.

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Mark, Ibepah	105	......	......	16
Mark, Verdi	114	140	......	17
Ogden	104	......	......	16
Salt Lake City	104	......	......	16
Badland	90	121	147	12
Bainville	90	123	147	12
Bainville Catholic Church, highest spire	94	......	147	12
Basalt or Pilot Cone, cairn	111	137	......	17
Beach Catholic Church, cross	94	......	147	12
Bear Creek	97	133	......	14
Bear Lodge Mountain, highest peak	93	......	146	11
Beaver	103	......	148	16
Beaver flagstaff	103	......	......	16
Beaver meetinghouse	103	......	......	16
Bench	106	......	......	16
Bench mark 121/2	94	126	147	13
Bench mark 122/2	94	126	147	13
Bench mark 123/2	94	......	147	13
Bench mark "6702 Denver"	92	......	146	9
Bench mark G_3	92	......	......	9
Bender	113	139	......	17
Big Springs	95	128	147	14
Bilby	94	126	147	12
Birch Creek, cairn	103	......	......	16
Bison	95	129	148	9, 15
Black	90	121	147	11, 12
Black boundary stake	105	......	......	16
Blanco	102	135	......	16
Blue	90	121	147	12
Bluff	93	125	146	10
Bonetraill	91	123	147	12
Bonetraill schoolhouse belfry	94	......	147	12
Booker	109	136	......	17
Boulder	88	116	146	9
Boundary stake No. 1	107	......	......	16
Boundary stake No. 2	107	......	......	16
Bountiful Peak or Francis Peak, cairn	104	......	148	16
Bowie	91	124	147	12
Bowman longitude	94	126	......	11
Bowman water tank	94	......	147	11
Box Elder Peak or Willards Peak, cairn	105	......	......	16
Bradford	109	136	......	17
Brighton	88	116	146	9
Brighton bench mark, eccentric	92	......	146	9
Brighton bench mark R_3	92	124	......	9
Broken Back, king summit monument	108	......	148	17
Buffalo Peak	98	......	......	15
Buffalo Springs	94	126	146	11
Buford	90	122	147	12, 13
Bull	91	123	147	12
Bullwhacker	108	135	......	17
Bunker Hill, cairn	110	......	148	17
Butler	109	136	......	17
Butte	106	......	......	16
Butte	105	......	......	16
Butte	90	120	146	11
Cache	105	......	......	16
California-Nevada, iron monument	113	139	......	17
California-Nevada, stone monument	114	139	......	17
California-Nevada, wood monument	114	139	......	17
Camara	102	135	......	16
Cambria	89	119	146	11
Camerons Cone	98	......	......	14
Camp stake	105	......	......	16
Canovas	102	135	......	16
Canyon Peak	106	......	......	16
Carson, capitol dome	113	......	......	17
Carson Sink	97	132	148	17
Carson Table, summit	111	......	......	17
Castle	89	120	146	11
Castle Rock (U. S. G. S.)	93	......	......	11
Catholic Church, Eureka	108	136	......	17
Catholic Church spire, Austin	110	......	......	17
Cedar	101	134	......	16
Cedar Hill	113	138	......	17
Cedar Spur	107	......	......	16
Cervera	102	135	......	16
Cheyenne east base	88	117	146	9
Cheyenne, State capitol dome	92	......	146	9

Station.	Position.	Description.	Elevation.	Sketch.
	Page.	*Page.*	*Page.*	*Number.*
Cheyenne Wells	95	127		14
Cheyenne west base	88	117	146	9
Chiquita	99	133	148	15
Chugwater	88	117	146	10
Churchill, cairn	111	137		17
City Creek	103	135	148	16
City Hall, Ogden	104			16
Cliff	101	134		15
Cliff, flag	105			16
Coleman	88	118	146	10
College cupola, Colorado Springs	97			14
Colorado Springs:				
College cupola	97			14
Latitude and longitude	97	133		14
Public schoolhouse, flagstaff on clock tower	98			14
United States Engineers, astronomic	97	133		14
Colorado-Utah:				
Middle boundary monument	100			15
North boundary flag	100			15
North boundary stone	100			15
South boundary	100			15
Colorado-Wyoming boundary monument, milepost 44	92	125	146	9
Cone Peak, white flag	114	139		17
Cook	90	121	147	12
Corral Bluffs	95	128	147	14
Cory Peak, or Mount Hull, summit	112			17
Cottonwood	89	119	146	10
Coulson's house, main chimney	97			14
County courthouse dome, Denver	91		146	9
Courthouse, Eureka	108	135		17
Courthouse flagstaff, Austin	110			17
Courthouse flagstaff, Ogden	104			16
Cramer Gulch	95	128	147	14
Crest	109	136		17
Crestone Peak	98		148	15
Crosby	91	124	147	12
Crow	89	119	146	11
Crows Nest (U. S. G. S.)	93		147	11
Crystal Peak, flagstaff	114	139		17
Crystal Peak, mountain top	114	139		17
Cutoff	90	122	147	13
Cutting	109	136		17
C. V. North, cairn	100			15
C. V. South, cairn	100			15
Daniels & Fisher's tower, gilded dome, Denver	91		146	9
Davis	109	136		17
Deadman	113	138		17
Delano, cairn	103		148	16
Denver:				
County courthouse dome	91		146	9
Daniels & Fisher's tower, gilded dome	91		146	9
Grant smelter, chimney	91		146	9
Loretto Heights school, belfry	91		146	9
State capitol dome	91		146	9
University, observatory dome	91		146	9
Desatoiya	111		148	17
Desatoiya, north twin	111			17
Deseret	96	131	148	16
Deseret magnetic	103			16

Station.	Position.	Description.	Elevation.	Sketch.
	Page.	*Page.*	*Page.*	*Number*
Desert	108	135		17
Desert Peak, cairn	105		148	16
Devine's granary	106			16
Dewey	88	116	146	9
Diamond Peak	96	132	148	16, 17
Divide	95	128	147	9, 14, 15
Douglas	109	136		17
Douglas	88	116	146	9
Dover bench mark E_3	92	124		9
Dover bench mark, eccentric	92		146	9
Dover bench mark, reference mark	92		147	9
Draper	103		148	16
Dry Camp	97		147	14
Duckwater, cairn	108		148	17
Eagles Nest Butte, cairn	93		146	11
East base, Green River	100	134		15
East base, Verdi	113	139		17
East Deer Ear Butte	93		146	11
Eastonville church spire	97			14
Eastonville creamery tower	97			14
East Peak	113	138		17
East Peninsula Peak	105			16
East Ridge	106			16
East Spanish Peak	98		148	15
East Twin	92		147	9
Eaton sugar factory, chimney	92		146	9
Elbert	88	115	146	9
Elephant, or Mucca Peak	112			17
Elk	89	119	146	10, 11
Elk (U. S. G. S.)	93		147	10, 11
El Paso east base	95	128	147	14
El Paso west base	95	128	147	14
Episcopal church spire, Austin	110			17
Esmeralda County, corner stone	109	137		17
Eureka	95	127	147	14
Eureka:				
Catholic church	108	136		17
Courthouse	108	135		17
Longitude	108	136		17
Fairview, cairn	111		148	17
Farmington courthouse spire	104			16
Ferry	90	123	147	13
First View	95	127	147	14
First View section-house chimney	97			14
Flag	105			16
Flag in flat	103			16
Flat	90	122	147	12
Folsom Peak	112	138		17
Fort D. A. Russell water tank	92		146	9
Francis Peak	104		148	16
Francis Peak, or Bountiful Peak, cairn	104		148	16
Freel Peak	112	138		17
Fremont Island, cairn	104		148	16
Frisco Mount, tree	106		148	16
Galena saddle	112			17
Genoa flagstaff	113			17
Genoa Peak	112	138		17
Gladys	91	123	147	12
Glen Eyrie	97	133		14
Golden	109	136		17
Grand Junction standpipe	99	134	148	15
Granite Peak	106		148	16

Station.	Position.	Description.	Elevation.	Sketch.
	Page.	*Page.*	*Page.*	*Number.*
Granite Peak, summit, south end	110			17
Grant smelter chimney, Denver	91		146	9
Grantsville flagstaff	103			16
Grassy, cairn	105			16
Grays Peak, summit	98			15
Greeley sugar-factory chimney	92		146	9
Greeley tall tank	92		146	9
Greenhorn Mountain, cairn	98			15
Green River:				
East base	100	134		15
Hotel flagstaff	101	134		15
Latitude	101	134		15
Longitude	101	134		15
North meridian	101	134		15
Schoolhouse flagstaff	101	134		15
South meridian	101	134		15
West base	100	134		15
Greentop	88	117	146	9
Gunnison astronomic	101			16
Gunnison azimuth	99		148	15
Gunnison Peak, cairn	99			15
Harding	89	120	146	11
Hartman	100	134		15
Haystack	88	118	146	10
Haystack Butte, highest point	93		146	11
Herriman	103		148	16
Highland Peak, summit	107		148	16
Hill, flag	103			16
Hilltop	88	115	146	9
Hobbs	88	118	146	10
Holcolm Hills	95	128	147	14
Hollingswood's, Glen, new barn, west gable.	92		146	9
Holt	95	128	147	14
Horsetooth	88	116	146	9
Hot Creek, north summit	108			17
Hotel flagstaff, Green River	101	134		15
Hot Spring	111	137		17
Hot Spring east base	111	137		17
Hot Spring Mountain	112	138		17
Hot Spring west base	111	137		17
Howard	91	123	147	12
Hugo	95	127	147	14
Hugo schoolhouse chimney	97			14
Hugo section-house chimney	97			14
Hump	90	121	147	12
Hunts Peak	98			15
Ibepah	96	130	148	16
Ibepah:				
Azimuth mark	105			16
Post office eccentric	106			16
Post office southeast corner	106			16
Telegraph office chimney	106			16
Telegraph office flag	106			16
Indian	88	116	146	9
Indian Head, summit	102			16
Indian Peak	106		148	16
Inyankara	89	119	146	11
Iron monument, California-Nevada	113	139		17
Jackson	90	122	147	12, 13
Jasper	94	126	147	12
Jireh College cupola	93	125	146	10

Station.	Position.	Description.	Elevation.	Sketch.
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Kawich Peak	109			17
Kaysville meeting-house spire	104			16
Kaysville R. G. W. depot, chimney	104			16
Kipp's, William, square house chimney	92		146	9
Kirtley	89	118	146	10
Kit Carson	95	127	147	14
La Garita king summit	99			15
La Garita range peak	99			15
Laird	89	119	146	11
Lake Park pavilion, flag	104			16
Lake Shore Bench	103			16
Lanark	90	122	147	13
Lander Hill or Mount Prometheus	110	137		17
Landsman	95	127	147	14
La Salle, north peak, cairn	100			15
La Salle, northwest peak, cairn	100			15
La Salle, tank near coal chute	92		146	9
Latitude and longitude, Colorado Springs	97	133		14
Latitude, Green River	101	134		15
Latitude, Salt Lake City	104	135		16
Leadville, Ninth Street schoolhouse cupola	99			15
Leo	108	135		17
Leon Peak, low cairn	99			15
Levan	101	134		16
Lodge	90	120	146	11
Lone Cone	99			15
Lone Mountain	97	132	148	17
Lone Peak, needle	103		148	16
Lone tree	114	139	148	17
Lone tree, cairn	102			16
Longitude:				
Austin	110	137		17
Eccentric, Austin	110			17
Eureka	108	136		17
Green River	101	134		15
Ogden	104	135	148	16
Salt Lake City	104	135		16
Verdi	114	139		17
Longs Peak	98			15
Loretto Heights school belfry, Denver	91		146	9
Lothrop	109	136		17
Loveland, red brick chimney	92		146	9
Loveland, tall white chimney	92	124	146	9
Lovering	90	122	147	12
Lovering (U. S. G. S.)	94			12
Lyon, south summit	109		148	17
Manterola	102	135		16
Manville	89	118	146	10
Manville, C. & N. W. Ry. water tank	93		146	10
Manville, Congregational Church steeple	93		146	10
Marmon	91	123	147	12
Meridian mark, Verdi	114	139		17
Mesa	99	133	148	15
Methodist Church, Ogden	104			16
Methodist Church spire, Austin	110			17
Mica	100	134		15
Middle boundary	106			16
Middle boundary monument, Colorado-Utah	100			15
Middle La Salle Peak	100			15
Middle Promontory, cairn	104			16

Station.	Position.	Description.	Elevation.	Sketch.
	Page.	*Page.*	*Page.*	*Number.*
Milford Needle	103			16
Mill	111	137		17
Miller	111	137		17
Moab ditch mark	100			15
Moab (Warner's ranch)	100			15
Mondak	90	123	147	13
Monitor	108		148	17
Monotony	95	126		14
Monroe	101		148	16
Montana	90	122	147	13
Montana-North Dakota boundary monument	94	126		12
Montana-North Dakota boundary monument eccentric	94	126	147	12
Montana southeast corner eccentric	93	125	146	11
Montana southeast corner monument	93		147	11
Monte Rosa	98		148	14
Montezuma Peak	109		148	17
Montijo	102	135		16
Mooseneah	101		148	16
Moreau	89	120	146	11
Morrison	88	116	146	9, 15
Mount Alice, cairn	101		148	16
Mount Annie, cairn	111	137		17
Mount Bartles, summit	102			16
Mount Bruin, summit	102			16
Mount Callahan	97	132	148	17
Mount Como	97	133	148	17
Mount Conness	97	133		17
Mount Davidson, flagstaff	112	138		17
Mount Elbert	96	129	148	15
Mount Ellen	96	130	148	15, 16
Mount Evans	98			15
Mount Grafton, summit	107		148	16
Mount Grant	97	132	148	17
Mount Grant, highest peak	111	138		17
Mount Hamilton	108		148	17
Mount Harvard, cairn	99		148	15
Mount Hilgard, cairn	101		148	16
Mount Hull or Cory Peak, summit	112			17
Mount Irish	108			16
Mount Jefferson, middle summit	108			17
Mount Jefferson, north summit monument	108		148	17
Mount Jefferson, south summit	108			17
Mount Lewis	110		148	17
Mount Lincoln, peak	111		148	17
Mount Lola	97	133	148	17
Mount Massive, cairn	99		148	15
Mount Moriah, cairn	107		148	16
Mount Nebo	96	130	148	16
Mount of the Holy Cross, cairn	99			15
Mount Ouray	95	129	148	15
Mount Pealo	100			15
Mount Princeton, cairn	99		148	15
Mount Prometheus or Lander Hill	110	137		17
Mount Rose or Washoe Peak	112			17
Mount Shavano	98		148	15
Mount Sneffels, cairn	99			15
Mount Waas	96	129	148	15
Mount Waas azimuth mark, cairn	100			15
Mount Wilson	99			15
Mount Yale	99		148	15
Mucca or Elephant Peak	112			17
Muddy	91	123	147	12
Munson and Hamlin's barn, west gable	97			14

Station.	Position.	Description.	Elevation.	Sketch.
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Nebraska-South Dakota boundary monument	93	125	146	10
Nebraska-South Dakota boundary monument eccentric	93	125		10
Nebraska-Wyoming boundary monument 123	93	125	147	10
Nebraska-Wyoming boundary monument eccentric	93	125	146	10
Nephi Bench	101			16
Nevada-California, iron monument	113	139		17
Nevada-California, stone monument	114	139		17
Nevada-California, wood monument	114	139		17
Nevada-Utah boundary monument	107			16
Nevada-Utah boundary monument	105			16
Nevada-Utah boundary stake	105			16
Norge	91	124	147	12
North Augusta	111			17
North boundary flag	106			16
North boundary flag, Colorado-Utah	100			15
North boundary signal	106			15
North boundary stone, Colorado-Utah	100			16
North Dakota-Montana boundary monument	94	126		12
North Dakota-Montana boundary monument eccentric	94	126	147	12
North Dakota-South Dakota milepost 333	93	126	147	11
North Dakota-South Dakota milepost 333 eccentric	93	126	146	11
Northeast base, Oasis	102	135		16
Northeast corner, Wyoming, eccentric	93	125	147	11
Northeast corner, Wyoming, monument	93	125	147	11
North Flat	113	139		17
North Hill	110	137		17
North Maan, cairn	99			15
North meridian, Green River	101	134		15
North meridian, Oasis	102	135		16
North meridian, Tonopah	109	136		17
North Ogden Peak	105		148	16
North Ogden, public school	105			16
North Peak, tree, east prong	106			16
North Promontory, cairn	104			16
Northwest base, Tonopah	109	136		17
Notch	88	118	146	10
Nunn schoolhouse, belfry	92			9
Oasis:				
Astronomic	102	135		16
Northeast base	102	135		16
North meridian	102	135		16
Schoolhouse tower	103	135		16
South meridian	102	135		16
Southwest base	102	135		16
Observatory Point	112	138		17
Oddie	109	136		17
Ogden:				
Azimuth	104			16
City Hall	104			16
Courthouse flagstaff	104			16
Longitude	104	135	148	16
Methodist Church	104			16
Reform School	104			16
Union depot	104			16
Ogden Peak	96	131	148	16
Onaqui	103		148	16
Oquirrh	103		148	16

Station.	Position.	Description.	Elevation.	Sketch.
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Otto, U. P. Ry., black water tank	92		146	9
Overland	95	127	147	14
Overlook	112	138		17
Oxford	105			16
Pah Rah	97	133	148	17
Paradise Peak, cairn	111			17
Parker	89	119	146	10
Patmos Head	96	130	148	15, 16
Peak south of Terry	93		146	11
Peavine	112	138		17
Peavine east, cairn	114			17
Pennington's large white house, center chimney	97			14
Pikes Peak	95	129	147	9, 14, 15
Pilot Cone or Basalt, cairn	111	137		17
Pilot Peak	96	131	148	16
Pilot Peak azimuth mark	105			16
Pine Hill	107			16
Pioche	96	132	148	16
Pioche Peak, monument	107		148	16
Plateau	95	128	147	14, 15
Platte Peak	98			15
Point of Rocks	113	139		17
Pond Summit, monument	112			17
Post office eccentric, Ibepah	106			16
Post office southeast corner, Ibepah	106			16
Prison Hill	113	138		17
Promontory	96	131	148	16
Prospect Peak	108	136	148	17
Provo astronomic	89	119	146	10
Provo astronomic bench mark 3708D W			146	
Provo east base	89	119	146	10
Provo west base	89	119	146	10
Public schoolhouse, flagstaff on clock tower, Colorado Springs	98			14
Ragged	88	117	146	9, 10
Railway whistle post	114			17
Rainy	90	121	147	11, 12
Ralston	109	136		17
Ranch Hill	113	139		17
Rawhide	89	118	146	10
Red Chief, cairn	105			16
Red Squaw, cairn	105			16
Reform School, Ogden	104			16
Reno Congregational Church spire	114			17
Reservoir	110	137		17
Reservoir	100	134		15
Reva	89	120	146	11
Richmond	108	135		17
Rito Alto, cairn	98		148	15
Ritzke's windmill, center	92		146	9
Road summit	106			16
Roberts Creek	110			17
Rose Knob	112	138		17
Round Top	97	133	148	17
Rubicon Point	112	138		17
Russell	88	117	146	9
Saddle	90	121	147	12
Sagasta	102			16
Sage	112			17
Salt Creek, cairn	101		148	16
Salt Lake City:				
Azimuth	104			16
Latitude	104	135		16
Longitude	104	135		16
Temple east spire	103		148	16
Temple west spire	103			16
U. S. Land Survey standard meridian	104			16
Salt Lake northwest base	96	131	148	16
Salt Lake southeast base	96	131	148	16
Sandy	105			16
Sanpete	101	134	148	16
San Rafael Knob	101		148	16
Sawtooth Peak or Sevier Mountain	106		148	16
Schoolhouse flagstaff, Green River	101	134		15
Schoolhouse north of Hump, chimney	94		147	12
Schoolhouse tower, Oasis	103	135		16
School (U. S. & C., B. S.) or Ambrose northeast base	91	124	147	12
Scipio	102	134	148	16
Section 4, T. 157 N., R. 102 W., southwest corner	94			12
Section 7, T. 143 N., R. 105 W., southwest corner	94		147	12
Section 13, T. 155 N., R. 102 W., northwest corner	94			12
Section 22, T. 17 N., R. 60 E., southeast corner	94		147	12
Section 33, T. 17 N., R. 68 W., stone post, southwest corner	92		147	9
Section 36, T. 4 S., R. 65 W., southeast corner stone	91		147	9
Sentinel	90	121	147	12
Sentinel Butte schoolhouse, flagpole	94		147	12
Sevier Mountain or Sawtooth Peak	106		148	16
Sharp Peak	108		148	17
Sheep	90	122	147	12, 13
Shell Creek, north peak	107			16
Shell Creek, south peak	107			16
Sherman Peak	111			17
Short	109	136		17
Shoshone Peak, north	110		148	17
Shoshone Peak, south	110		148	17
Sierra Blanca, peak	98		148	15
Smoky Valley, northeast summit	108			17
Smoky Valley, southwest summit	108			17
Snake	90	123	147	12
Snake Creek	107			16
Snowden water tank	94		147	13
South Antelope 1, cairn	104			16
South Antelope 2	104			16
South boundary, Colorado-Utah	100			15
South boundary flag	106			16
South Dakota-Nebraska boundary monument	93	125	146	10
South Dakota-Nebraska boundary monument eccentric	93	125		10
South Dakota-North Dakota milepost 333	93	126	147	11
South Dakota-North Dakota milepost 333 eccentric	93	126	146	11
South Dakota-Wyoming boundary monument	93	125	146	10
Southeast base, Tonopah	109	136		17
Southeast corner, Montana, eccentric	93	125	146	11
Southeast corner, Montana, monument	93		147	11

Station.	Position.	Description.	Elevation.	Sketch.
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South Juah hase	101	......	......	16
South Mann, cairn	99	......	......	15
South meridian, Green River	101	134	......	15
South meridian, Oasis	102	135	......	16
South Peak, middle tree	106	......	......	16
South Promontory, cairn	104	......	148	16
South Scipio, cairn	102	......	148	16
Southwest base, Oasis	102	135	......	16
Spanish Fork, cairn	102	......	......	16
Springville Peak, monument	102	......	148	16
Square Bluffs	95	128	147	14
Stady	91	124	147	12
Star Peak	110	......	148	17
State Capitol domo, Denver	91	......	146	9
Steihl's house, chimney	94	......	147	13
Stone monument, California-Nevada	114	139	......	17
Strawberry North, summit	102	......	......	16
Subsidiary	97	......	......	14
Sullivan	89	119	146	10
Sullivan (U. S. G. S.)	93	......	......	10
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