WOODWARD, R.S.

...Report on astronomical work of 1889 and 1890.

DEPARTMENT OF THE INTERIOR

BULLETIN

OF THE

UNITED STATES

GEOLOGICAL SURVEY

No. 70

REPORT ON ASTRONOMICAL WORK OF 1889 AND 1890

WASHINGTON
GOVERNMENT PRINTING OFFICE
1890

LIBRARY CATALOGUE SLIPS.

Series title.

United States. *Department of the interior.* (*U. S. geological survey*).

Department of the interior | — | Bulletin | of the | United States | geological survey | no. 70 | [Seal of the department] |

Washington | government printing office | 1890

Second title: United States geological survey | J. W. Powell, director | — | Report | on | astronomical work | of | 1889 and 1890 | by | Robert Simpson Woodward | [Vignette] |

Washington | government printing office | 1890

8°. 79 pp.

Author title.

Woodward (Robert Simpson).

United States geological survey | J. W. Powell, director | — | Report | on | astronomical work | of | 1889 and 1890 | by | Robert Simpson Woodward | [Vignette] |

Washington | government printing office | 1890

8°. 79 pp.

[UNITED STATES. *Department of the interior.* (*U. S. geological survey*). Bulletin 70].

Title for subject entry.

United States geological survey | J. W. Powell, director | — | Report | on | astronomical work | of | 1889 and 1890 | by | Robert Simpson Woodward | [Vignette] |

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WASHINGTON, D. C., *November*, 1890.

DEPARTMENT OF THE INTERIOR

BULLETIN

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 70

WASHINGTON
GOVERNMENT PRINTING OFFICE
1890

UNITED STATES GEOLOGICAL SURVEY

J. W. POWELL, DIRECTOR

REPORT

ON

ASTRONOMICAL WORK

OF

1889 AND 1890

BY

ROBERT SIMPSON WOODWARD

WASHINGTON
GOVERNMENT PRINTING OFFICE
1890

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ILLUSTRATION.

LETTER OF TRANSMITTAL.

DEPARTMENT OF THE INTERIOR,
U. S. GEOLOGICAL SURVEY,
Washington, D. C., June 30, 1890.

SIR: I have the honor to submit herewith a report on certain astronomical positions determined in 1889 and 1890.

I desire in this connection to acknowledge my indebtedness to Prof. H. S. Pritchett, who made the observations at the base station, St. Louis, in the longitude work; to Messrs. H. L. Baldwin, jr., W. T. Griswold, R. U. Goode, and A. P. Davis, who assisted me in the field work; to Mr. S. S. Gannett, for assistance in the office computations; and to Mr. B. C. Washington, jr., for assistance in office computations and in the preparation of this report. The Survey is indebted to Prof. W. von Streeruwitz and his assistants, of the Texas Geological Survey, and to the officials of the Missouri River Commission for much valuable assistance, concerning which mention is made in the text. I desire also to acknowledge the uniform courtesy of the officials of the Western Union Telegraph Company, who granted the free use of their lines in exchanging clock signals.

Very respectfully,

R. S. WOODWARD,
Chief Geographer.

HON. J. W. POWELL,
Director U. S. Geological Survey.

REPORT ON ASTRONOMICAL WORK OF 1889 AND 1890.

BY R. S. WOODWARD.

ASTRONOMICAL POSITIONS DETERMINED.

(1) The astronomical positions which form the subject of the following report were determined in connection with the geographical work of the Geological Survey during the autumn of 1889 and the spring of 1890. The points determined are the following, the designations being those of the towns in or near which the astronomical observations were made: Spearville, Kansas; Boisé City, Idaho; and Cisco and Sierra Blanca, Texas.

The longitudes were all determined by the telegraphic method with reference to the observatory of Washington University, St. Louis, Missouri. The observations at this point were made by Prof. H. S. Pritchett, director of the observatory. The observations in the field were made chiefly by the writer. He was assisted at Spearville, Kansas, by Mr. H. L. Baldwin, jr., who observed one night for latitude; at Boisé City, Idaho, by Mr. W. T. Griswold; at Cisco, Texas, by Mr. R. U. Goode, who observed one night for latitude; and at Sierra Blanca, Texas, by Mr. A. P. Davis.

In connection with the astronomical work at Sierra Blanca, two points on the one hundred and fifth meridian were established in El Paso County, Texas. The intersection of this meridian with the Rio Grande River defines the common corner of El Paso, Jeff Davis, and Presidio Counties, and hence the location of this meridian on the ground is a matter of importance to those counties and to the State of Texas. The meridian being about twenty-one miles east of the astronomical station at Sierra Blanca, it was necessary to resort to geodetic operations in order to locate near the meridian a point from which the precise position of the meridian could be measured off on the ground. The details of these operations were designed and executed chiefly by Mr. A. P. Davis.

DESCRIPTION OF STATIONS.

(2) At each of the points named above a suitable pier was erected to support the meridian transit used in making the astronomical observations. All the piers are of one pattern. They consist of a foundation of one cubic yard of concrete well set in hydraulic cement. Centrally on the surface of the foundation, which rises to the level of the ground surface, a solid column of brick-work two by two and one-half bricklengths in cross-section rises to a height of about three feet. This column is capped by a dressed stone 6 by 19 by 24 inches.

At Spearville, Kansas, the pier is about 150 feet south of the Atchison, Topeka and Santa Fé Railway, and about 1,000 feet east of the railway station. It is the east end of a secondary base measured by Mr. H. L. Baldwin, jr., in 1889.

At Boisé City, Idaho, the pier is on the plain south of the city, about 1,000 feet southwest of the terminus (in 1889) of the Boisé branch of the Union Pacific Railway. It is near the road leading from this terminus across the irrigation ditch; it is south of and within 300 feet of the bridge across this ditch.

At Cisco, Texas, the pier is located on a hill near the intersection of Fourth street and Avenue F. It is 58.1 feet north and 16.2 feet west of a well-hole cased with iron tubing to a depth of 1,500 feet.

At Sierra Blanca, Texas, the pier is on the south side of and about 200 feet from the Southern Pacific Railway.

In all cases these piers are conspicuous objects and in localities where they are unlikely to be disturbed for a long time.

INSTRUMENTS AND INSTRUMENTAL CONSTANTS.

(3) The instruments used at St. Louis were a meridian transit by Fauth & Co., a chronograph by Bond & Sons, and a break-circuit sidereal clock, No. 214, by Howard. The constants of the transit instrument as used in 1889 are the same as those of 1884–'85, and published in Bulletin No. 49 of U. S. Geological Survey. During the winter of 1889–'90 the agate V's of this transit were replaced by brass V's, both of which were made immovable, and the pivots were at the same time repolished. These changes made the instrument somewhat more stable in azimuth and in inclination than it had been during the autumn of 1889. The inequality of pivots was also reduced to an inappreciable quantity.

The instruments used in the field were meridian transit No. 20 by Würdemann, a chronograph by Fauth & Co., and a break-circuit sidereal chronometer, No. 187, by Bond & Sons. The principal constants of this transit are given in Bulletin No. 49 of U. S. Geological Survey. Since the constants given in that publication were determined, however, the pivots have been turned again, a new glass diaphragm has been supplied, and additional data for the value of the zenith distance micrometer screw have been obtained. The new values for the constants used in the work to which this report relates are the following:

Equatorial intervals of diaphragm lines from mean of middle five lines.

Wire A_1	$+ 24^s.22$	Clamp west.
A_2	$+ 20\ .22$	
A_3	$+ 16\ .08$	
1	$+\ 8\ .07$	
2	$+\ 4\ .03$	
3	$+\ 0\ .05$	
4	$-\ 4\ .02$	
5	$-\ 8\ .12$	
B_1	$-16\ .09$	
B_2	$-20\ .13$	
B_3	$-24\ .17$	

Inequality of pivots = + $0^s.096$ for clamp west.

Value half revolution of micrometer screw = 40''.356.

The value of a half revolution of the micrometer screw determined in 1884 from transits of Polaris near its elongation, is 40''.381.[1] The value given above is a mean of this value (40''.381) and a value (40''.331) determined from a large number of observations made by Mr. B. C. Washington, jr., and Mr. S. S. Gannett on a graduated staff placed at a known distance from the transit.

LATITUDES.

(4) The latitudes of the piers were determined by Talcott's method. At each station a meridian mark, whose azimuth was accurately determined by the time observations, was used to keep the error of collimation small, and the line of collimation close to the meridian.

Pairs of stars were selected from Prof. Safford's catalogue of 2,018 stars.[2] In computing the apparent places of these stars, corrections for secular variation of precession were applied.

The computations for the latitudes of Spearville, Kansas; Boisé City, Idaho; and Cisco, Texas, were made chiefly by Mr. S. S. Gannett; those for the latitude of Sierra Blanca, Texas, were made chiefly by Mr. B. C. Washington, jr.

The details of the latitude work are given in Table I following, and the individual results, weights, etc., are given in Table II. The weights applied are the same as those given on page 32 of Bulletin No. 49 of U. S. Geological Survey.

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[1] Bulletin No. 49, U. S. Geological Survey, p. 12.

[2] Mean declinations of 2,018 stars between 0^h and 2^h and 12^h and 24^h right ascension, and 10° and 70° north declination, for January 1. 1875. Prepared under the direction of Lieut. George M. Wheeler, Corps Engineers, U. S. Army. Washington, Government Printing Office, 1879.

TABLE I.—*Details of latitude work: Station, Spearville.*

Date.	Star number.	δ_1	δ_2	$\frac{1}{2}(\delta_1+\delta_2)$	$\frac{1}{2}(Z_1-Z_2)$ Micrometer.	$\frac{1}{2}(Z_1-Z_2)$ Level.	Correction for refraction.	ϕ
1889.		° ′ ″	° ′ ″	° ′ ″	′ ″	″	″	° ′ ″
Oct. 25	1261 1274	45 43 37.06	29 45 47.72	37 44 42.39	+ 6 21.45	+ 0.47	+0.10	37 51 04.41
25	1287 1313	38 56 10.80	36 38 28.51	47 19.65	+ 3 43.45	+ 4.67	+0.06	07.83
25	1320 1326	23 09 30.21	52 28 36.56	49 03.39	+ 2 00.58	+ 1.52	+0.03	05.52
25	1359 1372	50 41 25.44	25 04 41.22	53 03.33	− 1 56.59	+ 0.10	−0.05	06.79
24	1424 1438	28 25 52.43	47 23 52.41	54 52.42	− 3 40.02	− 4.20	−0.06	08.14
25	....	52.53	52.56	54 52.54	− 3 45.63	+ 2.94	−0.06	09.79
24	1448 1475	34 03 50.17	41 31 31.54	47 40.85	+ 3 22.51	+ 3.88	+0.06	07.30
25	1450 1464	56 17 41.38	19 24 50.11	51 15.75	− 0 13.48	+ 1.57	0.00	03.84
25	1500 1502	19 39 49.86	56 03 27.31	51 38.58	− 0 37.21	+ 2.41	−0.01	03.77
23	1535 1539	29 52 33.11	45 38 17.60	45 25.35	+ 5 35.40	+ 5.56	+0.10	06.41
25	....	33.22	17.78	45 25.50	+ 5 39.23	+ 3.15	+0.10	07.98
24	1558 1559	39 47 29.46	35 45 55.71	46 42.58	+ 4 25.71	− 1.10	+0.08	07.27
25	....	29.61	55.84	46 42.72	+ 4 14.77	+10.29	+0.08	07.86
26	....	29.78	56.02	46 42.90	+ 4 20.82	+ 3.99	+0.08	07.79
25	1579 1598	49 27 19.90	26 15 13.48	51 16.69	− 0 12.79	+ 2.41	0.00	06.31
26	....	20.12	13.60	51 16.86	− 0 09.73	− 0.79	0.00	06.34
24	1608 1619	52 37 17.30	23 08 18.54	52 47.92	− 1 43.27	+ 4.09	−0.03	08.71
25	....	17.51	18.63	52 48.07	− 1 46.30	+ 5.09	−0.03	06.83
26	....	17.76	18.75	52 48.25	− 1 43.76	+ 1.36	−0.03	05.83
24	1645 1658	57 56 37.02	17 47 27.35	52 02.19	− 0 56.94	+ 0.16	−0.02	05.39
25	....	37.26	27.43	52 02.35	− 0 58.11	+ 0.89	−0.02	05.11
26	....	37.55	27.51	52 02.53	− 0 60.61	+ 3.41	−0.02	05.31
28	1683 1702	51 00 43.15	24 31 48.23	46 15.69	+ 4 48.95	+ 0.26	+0.09	04.99
24	1687 1694	18 30 33.50	56 53 16.55	41 55.02	+ 9 11.34	+ 0.37	+0.17	06.90
25	....	33.58	16.81	41 55.20	+ 9 12.77	− 3.83	+0.17	04.31
26	....	33.68	17.10	41 55.39	+ 9 13.36	− 3.67	+0.17	05.35
28	1692 1702	50 54 41.75	24 31 48.23	43 14.99	+ 7 49.58	+ 0.26	+0.14	04.97
25	1703 1707	49 49 41.58	26 18 27.16	38 04 04.37	−12 57.79	0.00	−0.22	06.36
24	1718 1727	57 55 11.56	17 36 00.52	37 45 36.04	+ 5 32.01	− 1.10	+0.10	07.05
25	....	11.82	00.60	36.21	+ 5 29.10	− 0.84	+0.10	04.57
26	....	12.13	00.68	36.40	+ 5 27.01	+ 1.47	+0.10	04.98
27	....	12.43	00.78	36.60	+ 5 30.23	− 2.10	+0.10	04.83
28	....	12.72	00.89	36.80	+ 5 29.87	− 1.00	+0.10	05.77
24	1744 1752	38 04 15.97	37 21 33.76	42 54.87	+ 8 13.15	0.00	+0.14	08.16
25	....	16.15	33.95	55.05	+ 8 09.68	+ 2.89	+0.14	07.76
27	....	16.56	34.35	55.45	+ 8 15.37	− 5.30	+0.14	05.66
28	....	16.77	34.57	55.67	+ 8 11.33	− 2.10	+0.14	05.04
24	1762 1782	56 10 18.48	19 41 16.96	37 55 47.72	− 4 39.75	− 1.26	−0.10	06.61
25	....	18.75	17.05	47.90	− 4 40.60	0.00	−0.10	07.20
26	....	19.05	17.15	48.10	− 4 38.09	− 1.42	−0.10	08.49
27	....	19.35	17.27	48.31	− 4 42.90	− 0.94	−0.10	04.37
24	1792 1801	26 38 53.17	48 44 58.91	37 41 56.04	+ 9 07.76	+ 0.84	+0.16	04.80
25	....	53.31	59.13	56.22	+ 9 04.93	+ 3.57	+0.16	04.88
27	....	53.60	59.67	56.63	+ 9 12.68	− 7.61	+0.16	01.86
28	1800 1814	28 42 51.87	47 15 40.92	37 59 16.39	− 8 08.15	− 1.31	−0.14	06.79
24	1824 1836	57 13 55.47	18 35 28.34	54 41.90	− 3 32.96	0.00	−0.07	08.87
25	....	55.74	28.42	42.08	− 3 39.13	+ 4.67	−0.07	07.55
26	....	56.04	28.51	42.27	− 3 31.99	− 3.20	−0.07	07.02
27	....	56.37	28.63	42.50	− 3 36.51	− 0.37	−0.07	05.55
28	1833 1853	50 58 22.53	24 41 58.98	50 10.75	+ 0 53.88	+ 0.26	+0.02	04.91
24	1850 1867	20 48 33.23	54 22 52.73	35 42.98	+15 24.12	+ 3.10	+0.26	10.46
25	....	33.30	52.93	43.11	+15 27.98	− 2.83	+0.26	08.52

TABLE I.—*Details of latitude work: Station, Spearville*—Continued.

Date.	Star number.	δ_1	δ_2	$\frac{1}{2}(\delta_1+\delta_2)$	$\frac{1}{2}(Z_1-Z_2)$ Micrometer.	Level.	Correction for refraction.	ϕ
1889.		° ′ ″	° ′ ″	° ′ ″	′ ″	″	″	° ′ ″
Oct. 27	1850 1867	20 48 33.55	54 22 53.38	37 35 43.46	+15 24.00	—5.14	+0.26	37 51 02.58
26	1859 1873	29 04 16.55	46 39 16.59	51 46.57	— 0 38.66	—1.31	—0.01	06.59
28	....	16.88	17.12	47.00	— 0 38.14	—2.00	—0.01	06.85
24	1883 1888	30 50 20.08	44 45 05.05	47 42.57	+ 3 18.56	+5.20	+0.06	06.39
25	....	20.21	05.27	42.74	+ 3 21.94	+1.21	+0.06	06.07
27	....	20.57	05.78	43.17	+ 3 18.76	+2.99	+0.06	04.98
28	....	20.76	06.05	43.40	+ 3 22.55	+0.58	+0.06	06.64
24	1909 1929	17 14 39.12	58 39 58.61	57 18.87	— 6 14.39	—0.42	—0.12	03.94
25	....	39.19	58.89	19.04	— 6 11.03	—0.26	—0.12	07.63
26	....	39.26	59.20	19.23	— 6 04.54	—8.77	—0.12	05.85
27	....	39.36	59.53	19.44	— 6 11.40	—0.42	—0.12	07.50
24	1937 1957	40 51 16.38	34 41 23.10	46 19.74	+ 4 51.17	—2.20	+0.08	08.79
25	....	16.58	23.26	19.92	+ 4 47.74	+2.68	+0.08	10.42
26	....	16.79	23.46	20.12	+ 4 42.33	+3.41	+0.08	05.94
27	....	17.03	23.67	20.35	+ 4 49.55	—4.09	+0.08	05.89
28	....	17.28	23.86	20.57	+ 4 40.72	+7.19	+0.08	08.56
24	1983 1996	29 02 30.86	46 33 25.25	47 58.05	+ 3 09.68	+0.89	+0.05	08.67
25	....	30.99	25.47	58.23	+ 3 08.18	+1.89	+0.05	08.35
26	....	31.14	25.72	58.43	+ 3 09.63	—1.10	+0.05	07.01
27	....	31.31	25.99	58.65	+ 3 09.59	—5.46	+0.05	02.83
24	2013 2018	17 43 25.31	57 53 53.22	48 39.26	+ 2 24.92	+2.36	+0.05	06.59
25	....	25.36	53.52	39.44	+ 2 23.95	+3.04	+0.05	06.48
26	....	25.44	53.82	39.63	+ 2 30.97	—6.77	+0.05	03.88
27	....	25.54	54.14	39.84	+ 2 25.93	+1.05	+0.05	06.87
28	....	25.63	54.46	40.04	+ 2 26.69	—1.05	+0.05	05.73

TABLE I—Continued.—*Details of latitude work: Station, Boisé City.*

Date.	Star number.	δ_1	δ_2	$\frac{1}{2}(\delta_1+\delta_2)$	$\frac{1}{2}(Z_1-Z_2)$ Micrometer.	Level.	Correction for refraction.	ϕ
1889.		° ′ ″	° ′ ″	° ′ ″	′ ″	″	″	° ′ ″
Nov. 14	1409 1417	61 01 24.00	26 18 10.98	43 39 47.49	— 3 46.12	—2.94	—0.07	43 35 58.36
14	1427 1431	62 35 15.13	24 48 32.91	41 54.02	— 5 53.84	—4.41	—0.11	55.66
14	1470 1473	59 35 54.93	27 46 40.46	41 17.70	— 5 16.39	—3.78	—0.12	57.49
14	(1)	63 00 55.86	24 01 18.08	31 06.97	+ 4 49.15	—0.84	+0.10	55.38
13	(2)	57 51 18.43	29 38 50.3	45 04.37	— 9 06.39	—1.26	—0.16	56.56
13	1581 1584	66 37 08.03	20 32 28.87	34 48.45	+ 1 09.33	—1.05	+0.02	56.75
14	....	08.14	28.85	48.50	+ 1 07.07	+2.89	+0.02	58.48
13	1615 1630	67 30 43.80	19 57 23.70	44 03.75	— 8 06.50	+1.36	—0.16	58.45
14	....	43.96	23.68	03.82	— 8 04.60	+0.31	—0.16	59.37
14	1647 1656	43 27 60.00	43 39 21.00	38 40.50	— 2 45.42	+4.41	—0.04	59.45
13	1647 1662	43 27 59.92	43 43 36.16	35 48.04	+ 0 07.75	+0.32	0.00	56.11
14	....	60.00	36.26	48.13	+ 0 05.69	+6.82	0.00	60.64
12	1669 1681	28 45 10.96	58 21 13.65	33 12.30	+ 2 44.61	+0.10	+0.04	57.05
13	....	11.03	13.84	12.43	+ 2 45.78	—0.79	+0.04	57.46
14	....	11.07	13.99	12.53	+ 2 44.33	+2.10	+0.04	59.00
14	1713 1719	26 30 01.77	60 42 12.20	36 06.98	— 0 10.94	+2.05	—0.00	58.09
13	1747 1758	36 10 34.41	51 24 42.65	47 38.53	—11 38.97	+0.79	—0.20	60.15
14	....	34.51	42.81	38.66	—11 42.24	+2.10	—0.20	58.32
13	1783 1798	27 40 21.85	59 43 15.85	41 48.85	— 5 52.67	+0.89	—0.10	56.97
14	....	21.92	16.06	48.99	— 5 53.56	—0.57	—0.10	54.76
14	1810 1815	40 05 17.82	47 40 60.05	53 08.93	—17 11.22	+2.00	—0.33	59.38
13	1821 1830	23 40 07.73	63 38 58.37	39 33.05	— 3 39.09	+3.78	—0.07	57.67
14	....	07.79	58.62	33.20	— 3 36.51	+1.26	—0.07	57.88
13	1834 1841	60 31 19.03	26 36 46.92	34 02.98	+ 1 54.89	—0.10	+0.03	57.80
14	....	19.25	46.99	03.12	+ 1 53.16	+0.10	+0.03	56.41
13	1871 1874	20 09 13.25	67 11 36.15	40 24.70	— 4 29.10	+0.79	—0.09	56.30
14	....	13.29	36.44	24.87	— 4 28.97	+1.42	—0.09	57.23
14	1885 1894	20 26 58.45	67 14 14.50	50 36.48	—14 32.71	—4.36	—0.29	59.12
13	1893 1906	42 21 36.59	44 57 09.67	39 23.13	— 3 26.74	+4.36	—0.06	60.69
13	1911 1915	42 53 14.89	44 50 20.12	51 47.50	—15 48.09	+1.42	—0.27	60.68
14	....	15.07	20.31	47.69	—15 51.81	+1.36	—0.27	56.97
13	1948 1960	67 29 12.35	19 43 59.69	36 36.02	— 0 35.96	—3.15	—0.01	56.90
14	....	12.65	59.75	36.20	— 0 38.50	—0.05	—0.01	57.74
13	1965 1984	19 32 00.38	68 08 41.42	50 20.85	—14 19.27	—2.05	—0.29	59.24
13	1993 2005	23 02 15.29	64 22 12.56	42 13.92	— 6 18.18	+3.10	—0.12	58.72
14	....	15.37	12.86	14.11	— 6 15.64	+1.42	—0.12	59.77
13	1993 2008	23 02 15.29	64 34 27.72	48 21.50	—12 26.55	+3.10	—0.24	57.81
14	....	15.37	28.00	21.68	—12 25.30	+1.78	—0.24	57.92
13	2001 2005	23 03 31.41	64 22 12.56	42 51.98	— 6 57.32	+3.57	—0.13	58.10
14	....	31.49	12.86	52.17	— 6 55.15	+2.62	—0.13	59.51
13	2001 2008	23 03 31.41	64 34 27.72	48 59.57	—13 05.69	+3.57	—0.25	57.20
14	....	31.49	28.00	59.75	—13 04.80	+2.99	—0.25	57.69

[1] 30 Cephei. μ Pegasi. [2] δ Cephei. η Pegasi.

TABLE I—Continued.—*Details of latitude work: Station, Cisco.*

Date.	Star number.	δ_1	δ_2	$\frac{1}{2}(\delta_1+\delta_2)$	$\frac{1}{2}(Z_1-Z_2)$ Micrometer.	$\frac{1}{2}(Z_1-Z_2)$ Level.	Correction for refraction.	ϕ
1889.		° ′ ″	° ′ ″	° ′ ″	′ ″	″	″	° ′ ″
Dec. 4	1510 1519	50 58 47.63	13 58 13.89	32 28 30.76	− 5 03.56	+2.10	−0.10	32 23 29.20
5	....	47.61	13.82	30.71	− 5 02.35	+2.47	−0.10	30.73
4	1531 1537	41 14 38.65	22 59 15.15	06 56.90	+16 30.58	+3.15	+0.28	30.91
5	....	38.62	15.10	56.86	+16 36.18	−2.57	+0.28	30.75
3	1541 1544	24 01 17.65	41 22 22.90	41 50.27	−18 19.54	+2.89	−0.33	33.34
4	....	17.60	22.87	50.23	−18 22.33	+1.47	−0.33	29.04
5	....	17.55	22.85	50.20	−18 15.72	−2.73	−0.33	31.47
4	1557 1562	44 09 59.74	20 10 46.32	10 23.03	+13 05.49	+3.62	+0.23	32.37
5	....	59.74	46.27	23.00	+13 07.07	+0.47	+0.23	30.77
3	1562 1568	20 10 46.38	44 47 12.99	28 59.68	− 5 31.57	+0.63	−0.10	28.64
3	1571 1579	15 38 25.18	49 27 23.54	32 54.36	− 9 24.99	+0.52	−0.17	29.72
4	....	25.12	23.53	54.32	− 9 24.99	+4.15	−0.17	33.31
5	....	25.07	23.54	54.30	− 9 25.95	+0.94	−0.17	29.12
3	1588 1601	45 47 44.13	19 02 01.50	24 52.81	− 1 25.56	+1.36	−0.03	28.58
4	....	44.10	01.43	52.76	− 1 21.03	+2.00	−0.03	33.70
5	....	44.10	01.39	52.74	− 1 28.38	+5.25	−0.03	29.58
5	1609 1629	44 34 03.26	20 13 35.50	23 49.38	− 0 20.30	+3.15	−0.01	32.22
3	1618 1619	41 28 40.43	23 08 19.30	18 29.87	+ 5 03.40	−1.26	+0.09	32.10
4	....	40.44	19.30	29.87	+ 4 57.30	+5.25	+0.09	32.52
4	1636 1652	31 46 54.97	32 53 23.92	20 09.45	+ 3 20.21	+3.31	+0.06	33.03
3	1637 1640	22 47 56.25	42 18 30.17	33 13.21	− 9 44.20	+1.05	−0.17	29.89
5	....	56.18	30.18	13.18	− 9 32.69	−6.77	−0.17	33.55
3	1655 1663	16 12 59.29	48 54 19.53	33 39.41	−10 04.58	−3.99	−0.19	30.65
4	....	59.25	19.58	39.41	−10 08.13	−1.57	−0.19	29.52
3	1693 1707	38 40 15.53	26 18 29.22	29 22.38	− 5 52.47	+0.31	−0.10	30.12
4	....	15.54	29.19	22.37	− 5 56.62	+6.40	−0.10	32.05
5	....	15.56	29.19	22.38	− 5 52.07	+0.42	−0.10	30.63
3	1732 1740	45 27 42.94	19 35 42.14	31 42.24	− 8 13.20	−0.21	−0.14	28.99
4	....	42.99	42.09	42.54	− 8 07.94	−4.67	−0.14	29.79
5	....	43.04	42.08	42.56	− 8 10.25	−1.00	−0.14	31.17
3	1765 1766	49 22 43.87	15 24 56.62	23 50.25	− 0 19.53	−1.00	−0.01	29.71
5	....	44.02	56.54	50.28	− 0 21.11	+1.42	−0.01	30.59
3	1797 1802	34 47 44.11	30 15 35.10	31 39.60	− 8 04.35	−2.62	−0.13	32.50
4	....	44.14	35.20	39.67	− 8 08.55	+1.15	−0.13	32.14
5	....	44.17	35.20	39.69	− 8 08.84	+3.36	−0.13	34.08
3	1831 1844	27 06 42.16	37 54 13.60	30 27.88	− 6 58.98	+1.84	−0.12	30.62
4	....	42.15	13.60	27.87	− 6 57.16	+0.94	−0.12	31.53
2	1875 1886	35 02 17.50	29 30 23.38	16 20.44	+ 7 19.04	−6.56	+0.13	33.07
3	....	17.60	23.38	20.49	+ 7 10.12	+1.36	+0.13	32.10
4	....	17.60	23.41	20.51	+ 7 10.32	+5.98	+0.13	36.94
5	....	17.70	23.44	20.57	+ 7 24.24	−8.56	+0.13	36.38
2	1897 1903	36 48 29.42	28 09 48.44	29 08.93	− 5 38.42	+1.68	−0.09	32.10
3	....	29.46	48.45	08.96	− 5 39.55	+0.21	−0.09	29.53
4	....	29.53	48.46	09.00	− 5 37.74	+0.26	−0.09	31.43
5	....	29.58	48.48	09.03	− 5 40.28	+4.09	−0.10	32.74
4	1917 1934	16 30 34.51	48 09 44.26	20 09.39	+ 3 25.05	−1.36	+0.06	33.14
5	....	34.49	44.38	09.44	+ 3 23.37	−0.21	+0.06	32.56
4	1917 1939	16 30 34.51	48 04 19.40	17 26.95	+ 6 07.56	−2.41	+0.11	32.21
5	....	34.49	19.30	26.90	+ 6 05.34	+0.05	+0.11	32.40
4	1927 1934	16 23 07.10	48 09 44.26	16 25.68	+ 7 07.29	−1.26	+0.13	31.84
5	....	07.08	44.38	25.73	+ 7 04.87	+0.26	+0.13	30.99

TABLE I.—*Details of latitude work: Station, Cisco*—Continued.

Date.	Star number.		δ_1	δ_2	$\frac{1}{2}(\delta_1-\delta_2)$	$\frac{1}{2}(Z_1+Z_2)$ Micrometer.	$\frac{1}{2}(Z_1+Z_2)$ Level.	Correction for refraction.	ϕ
1889.			° ′ ″	° ′ ″	° ′ ″	′ ″	″	″	° ′ ″
Dec. 4	1927	1939	16 23 07.10	48 04 19.4*	32 13 43.25	+ 9 49.81	—2.31	+0.18	32 23 30.93
5	....		07.08	19.3	43.19	+ 9 46.93	+0.52	+0.18	30.82
3	1936	1939	16 52 10.96	48 04 19.6	28 15.28	— 4 47.34	+2.99	—0.09	30.84
4	1950	1955	40 01 14.81	25 11 23.98	36 19.40	—12 52.38	+5.83	—0.23	32.63
5	....		14.88	24.00	19.44	—12 48.74	+0.05	—0.23	30.52
5	1964	1965	45 35 18.32	19 32 00.75	33 39.53	—10 06.92	+0.10	—0.19	32.52
5	1969	1976	10 17 36.76	54 36 14.29	26 55.53	— 3 26.34	+0.84	—0.07	30.10
4	1976	1978	54 36 14.13	10 29 50.82	33 02.48	— 9 28.38	—3.04	—0.18	30.88
5	....		14.29	50.78	02.53	— 9 32.49	+0.21	—0.18	30.13
2	1993	2010	23 02 16.20	41 48 08.5*	25 12.35	— 1 38.55	—3.20	—0.03	30.57
3	....		16.19	08.6	12.40	— 1 42.87	+1.73	—0.03	31.23
4	....		16.20	08.7	12.45	— 1 41.25	+0.05	—0.03	31.22
5	....		16.20	08.9	12.55	— 1 42.10	+0.31	—0.03	30.96
2	2010	(1)	41 48 08.5*	22 56 30.8*	22 19.65	+ 1 11.47	0.00	+0.02	31.14
3	....		08.6	30.9	19.75	+ 1 12.00	+0.63	+0.02	32.40
4	....		08.7	30.9	19.80	+ 1 09.17	+1.57	+0.02	30.56
5	....		08.9	31.0	19.95	+ 1 09.21	+2.57	+0.02	31.75

[1] α Arietis.
* Declinations taken from Berliner Jahrbuch.

TABLE I—Continued.—*Details of latitude work: Station, Sierra Blanca.*

Date.	Star number.		δ_1	δ_2	$\frac{1}{2}(\delta_1+\delta_2)$	$\frac{1}{2}(Z_1-Z_2)$ Micrometer.	$\frac{1}{2}(Z_1-Z_2)$ Level.	Correction for refraction.	ϕ
1890.			° ′ ″	° ′ ″	° ′ ″	′ ″	″	″	° ′ ″
May 17	8	13	21 09 18.50	41 16 28.28	31 12 53.39	− 2 26.41	+0.58	−0.05	31 10 27.51
18	....		18.62	28.45	12 53.54	− 2 26.01	+0.42	−0.05	27.90
18	19	23	23 38 46.87	38 30 53.85	04 50.36	+ 5 37.98	−1.37	+0.14	27.23
17	56	66	25 10 33.68	37 01 59.77	06 16.72	+ 4 09.00	−0.37	+0.08	25.43
18	....		33.87	59.95	06 16.91	+ 4 10.73	+1.42	+0.09	29.15
17	68	79	17 41 44.81	44.42 26.38	12 05.60	− 1 37.30	+0.84	−0.03	29.11
18	....		44.91	26.57	12 05.74	− 1 33.46	−4.41	−0.03	27.84
17	92	102	49 04 07.12	13 00 58.45	02 32.78	+ 7.53.38	−1.00	+0.18	25.34
18	....		07.32	58.56	02 32.94	+ 7 54.63	−0.16	+0.18	27.59
17	109	112	44 08 56.39	18 00 09.73	04 33.06	+ 5 53.84	+2.47	+0.13	29.50
18	....		56.58	09.86	04 33.22	+ 5 54.37	−2.10	+0.13	25.62
17	122	132	24 25 04.43	38 00 38.45	12 51.44	− 2 26.09	0.00	−0.05	25.30
18	....		04.57	38.63	12 51.65	− 2 26.09	−0.74	−0.05	24.77
17	142	152	12 08 27.87	50 15 45.28	12 06.58	− 1 42.58	+3.10	−0.03	27.07
18	....		27.98	45.52	12 06.75	− 1 40.81	−0.53	−0.03	25.38
17	173	175	24 55 06.36	37 44 49.11	19 57.74	− 9 32.37	+1.68	−0.21	26.84
18	....		06.52	49.33	19 57.92	− 9 30.71	+1.68	−0.21	28.68
18	184	186	51 16 35.72	11 18 16.87	17 26.30	− 6 58.53	−2.68	−0.15	24.94
17	197	201	23 15 19.52	39 03 20.43	09 19.98	+ 1 08.89	+0.58	+0.02	29.47
18	....		19.70	20.66	09 20.18	+ 1 08.20	+1.00	+0.02	29.40
17	197	205	23 15 19.52	39 05 39.56	10 29.54	− 0 01.41	+0.58	0.00	28.71
17	207	220	49 51 50.00	12 42 30.80	17 10.40	− 6 40.74	−0.16	−0.13	29.37
18	....		50.23	30.93	17 10.58	− 6 46.34	+4.78	−0.14	28.88
17	226	233	40 52 53.01	21 29 31.74	11 12.38	− 0 45.88	0.00	−0.02	26.48
18	....		53.26	31.91	11 12.58	− 0 45.76	+0.11	−0.02	27.15
17	240	252	18 12 13.23	44 22 43.47	17 28.35	− 6 59.95	+2.52	−0.18	30.74
18	....		13.39	43.72	17 28.56	− 6 57.16	+0.37	−0.15	31.62
17	257	262	32 48 48.43	29 37 11.64	13 00.04	− 2 31.61	+0.32	−0.07	28.68
18	....		48.65	11.85	13 00.25	− 2 31.58	−2.42	−0.05	26.20
18	272	273	15 46 18.95	46 35 40.39	10 59.67	− 0 35.11	+3.26	−0.01	28.02
17	287	293	19 43 17.25	42 17 35.02	26.14	+10 01.26	−0.42	+0.23	27.21
18	....		17.43	35.29	26.36	+10 01.34	+0.32	+0.23	28.25
17	312	323	44 52 47.77	17 25 47.20	09 17.48	+ 1 08.44	+0.32	+0.02	26.26
18	....		48.05	47.38	09 17.76	+ 1 11.07	−0.95	+0.02	27.90
17	344	346	40 04 53.52	22 28 51.13	16 52.32	− 6 25.36	+1.00	−0.14	27.82
18	....		53.79	51.34	16 52.56	− 6 25.80	−1.05	−0.14	25.69
17	349	359	25 26 32.93	36 52 43.19	09 38.06	+ 0 50.93	+0.53	+0.02	29.61
18	....		33.17	43.46	09 38.32	+ 0 50.28	+0.11	+0.02	29.29
17	367	373	19 23 21.61	42 34 50.95	30 59 06.28	+11 19.15	+1.05	+0.26	26.74
18	....		21.81	51.24	30 59 06.52	+11 18.42	+2.57	+0.26	27.77
17	423	431	15 27 52.66	47 09 35.42	31 18 44.04	− 8 17.79	+3.99	−0.18	30.06
18	....		52.86	35.73	18 44.30	− 8 21.42	+2.31	−0.19	25.00
17	456	460	26 24 15.21	35 59 52.01	12 03.61	− 1 38.23	+3.99	−0.03	29.34
18	....		15.47	52.29	12 03.88	− 1 36.29	−0.42	−0.03	27.14
17	469	484	16 01 11.24	46 20 27.89	10 49.56	− 0 23.20	+0.48	−0.01	26.83
18	....		11.44	28.20	10 49.82	− 0 24.29	+2.36	−0.01	27.88
17	495	496	45 13 20.55	16 56 57.48	05 09.02	+ 5 16.11	+2.99	+0.12	28.24
18	....		20.87	57.68	05 09.28	+ 5 19.50	−1.58	+0.11	27.52
18	503	520	42 39 19.42	19 24 37.74	01 58.58	+ 8 28.60	−0.89	+0.19	26.48
17	509	524	29 25 16.57	32 35 19.54	18.06	+10 10.95	−0.16	+0.23	29.08

TABLE II.—*Results for latitude. Station, Spearville, Kansas.*

Star numbers and class.		Individual results. Oct. 24.	Oct. 25.	Oct. 26.	Oct. 27.	Oct. 28.	Mean.	Weight.
		° ′ ″	″	″	″	″	″	
1261A	1274A	37 51	04.41	....	....	....	04.41	0.9
1287A	1313A	....	07.83	....	....	....	07.83	0.9
1320A	1326C	....	05.52	....	....	....	05.52	0.8
1359A	1372A	....	06.79	....	....	....	06.79	0.9
1424A	1438C	08.14	09.79	....	....	....	08.96	1.3
1448B	1475C	07.30	....	....	....	....	07.30	0.8
1450B	1464C	....	03.84	....	....	....	03.84	0.8
1500A	1502B	....	03.77	....	....	....	03.77	0.9
1535B	1539B	06.41	07.98	....	....	....	07.19	1.5
1558B	1559C	07.27	07.86	07.79	....	....	07.64	1.5
1579A	1598A	....	06.31	06.34	....	....	06.32	1.7
1608A	1619A	08.71	06.83	05.83	....	....	07.12	2.4
1645B	1658A	05.39	05.11	05.31	....	....	05.27	2.2
1683B	1702A	....	....	....	....	04.99	04.99	0.9
1687AA	1694A	06.90	04.31	05.35	....	....	05.52	2.6
1692B	1702A	....	....	....	....	04.97	04.97	0.9
1703C	1707A	....	06.36	....	....	....	06.36	0.8
1718A	1727B	07.05	04.57	04.98	04.83	05.77	05.44	3.1
1744A	1752A	08.16	07.76	....	05.66	05.04	06.65	3.0
1762C	1782A	06.61	07.20	08.49	04.37	....	06.67	1.9
1792C	1801B	04.80	04.88	....	01.86	....	03.85	1.5
1800AA	1814A	....	....	....	....	06.79	06.79	1.0
1824A	1836A	08.87	07.55	07.02	05.55	....	07.25	3.0
1833B	1853B	....	....	....	....	04.91	04.91	0.9
1850C	1867A	10.46	08.52	....	02.58	....	07.19	1.6
1859B	1873B	....	....	06.59	....	06.85	06.72	1.5
1883B	1888B	06.39	06.07	....	04.98	06.64	06.02	2.5
1909A	1929C	03.94	07.63	05.85	07.50	....	06.23	1.9
1937B	1957A	08.79	10.42	05.94	05.89	08.56	07.92	3.1
1983A	1996C	08.67	08.35	07.01	02.83	....	06.72	1.9
2013A	2018C	06.59	06.48	03.88	06.87	05.73	05.91	2.1

Weighted mean, **37° 51′ 06″.34 ± 0″.14.**

TABLE II—Continued.—*Results for latitude: Station, Boisé City, Idaho.*

Star numbers and class.		Individual results.			Mean.	Weight.
		Nov. 12.	Nov. 13.	Nov. 14.		
		° ′ ″	″	″	′ ″	
1409A	1417C	43 35	....	58.36	58.36	0.8
1427B	1431A	....	....	55.66	55.66	0.9
1470B	1473A	....	....	57.49	57.49	0.9
30 Cephei AA	μ Pegasi AA	....	....	55.38	55.38	1.0
δ Cephei AA	η Pegasi AA	....	56.56	....	56.56	1.0
1581A	1584C	....	56.75	58.48	57.62	1.3
1615A	1630A	....	58.45	59.37	58.91	1.7
1647C	1656B	....	....	59.45	59.45	0.8
1647C	1662A	....	56.11	60.64	58.47	1.3
1669A	1681B	57.05	57.46	59.00	57.84	2.2
1713A	1719B	....	....	58.09	58.09	0.9
1747A	1758B	....	60.15	58.32	59.24	1.6
1783B	1798B	....	56.97	54.76	55.87	1.5
1810B	1815A	....	....	59.38	59.38	0.9
1821A	1830A	....	57.67	57.88	57.77	1.7
1834A	1841A	....	57.80	56.41	57.10	1.7
1871B	1874B	....	56.30	57.23	56.77	1.5
1885B	1894B	....	....	59.12	59.12	0.9
1893C	1906A	....	60.69	....	60.69	0.8
1911B	1915B	....	60.68	56.97	58.83	1.5
1948A	1960B	....	56.90	57.74	57.32	1.6
1965B	1984A	....	....	59.24	59.24	0.9
1993A	2005A	....	58.72	59.77	59.25	1.7
1993A	2008B	....	57.81	57.92	57.86	1.6
2001A	2005A	....	58.10	59.51	58.80	1.7
2001A	2008B	....	57.20	57.69	57.45	1.6

Weighted mean, **43° 35′ 57″.98±0″.16.**

TABLE II—Continued.—*Results for latitude: Station, Cisco, Texas.*

Star numbers and class.		Individual results.				Mean.	Weight.
		Dec. 2.	Dec. 3.	Dec. 4.	Dec. 5.		
		° ′ ″	″	″	″	″	
1510B	1519C	32 23	....	29.20	30.73	29.97	1.2
1531A	1537A	....	....	30.91	30.75	30.83	1.7
1541A	1544C	....	33.34	29.04	31.47	31.28	1.6
1557B	1562A	....	....	32.37	30.77	31.57	1.6
1562A	1568C	....	28.64	....	....	28.64	0.8
1571C	1579A	....	29.72	33.21	29.12	30.68	1.6
1588B	1601C	....	28.58	33.70	29.58	30.62	1.5
1609C	1629B	....	....	....	32.22	32.22	0.8
1618A	1619A	....	32.10	32.52	....	32.31	1.7
1636A	1652A	....	....	33.03	....	33.03	0.9
1637A	1640B	....	29.89	....	33.55	31.72	1.6
1655A	1663C	....	30.65	29.52	....	30.08	1.3
1693C	1707A	....	30.12	32.05	30.63	30.93	1.6
1732A	1740AA	....	28.99	29.79	31.17	29.98	2.6
1765B	1766A	....	29.71	....	30.59	30.15	1.6
1797A	1802A	....	32.50	32.14	34.08	32.91	2.4
1831A	1844AA	....	30.62	31.53	....	31.15	1.8
1875AA	1886A	33.07	32.10	36.94	36.38	34.62	3.2
1897C	1903A	32.10	29.53	31.43	32.74	31.45	1.9
1917B	1934B	....	....	33.14	32.56	32.85	1.5
1917B	1939AA	....	....	32.21	32.40	32.30	1.7
1927A	1934B	....	....	31.84	30.99	31.42	1.6
1927A	1939AA	....	....	30.93	30.82	30.88	1.8
1936B	1939AA	....	30.84	....	....	30.84	0.9
1950A	1955C	....	....	32.63	30.52	31.58	1.3
1964C	1965B	....	....	....	32.52	32.52	0.8
1969C	1976C	....	....	....	30.10	30.10	0.7
1976C	1978A	....	....	30.88	30.13	30.50	1.3
1993A	2010AA	30.57	31.23	31.22	30.96	30.99	3.2
2010AA	(1)	31.14	32.40	30.56	31.75	31.46	3.5

[1] α Arietis AA.

Weighted mean, 32° 23′ 31″.45±0″.15.

TABLE II—Continued.—*Results for latitude: Station, Sierra Blanca, Texas.*

Star numbers and class.		Individual results.		Mean.	Weight.
		May 17.	May 13.		
		° ′ ″	″	″	
8A	13A	31 10 27.51	27.90	27.70	1.7
19A	23C	....	27.23	27.23	0.8
56A	66B	25.43	29.15	27.29	1.6
68A	79B	29.11	27.84	28.47	1.6
92B	102A	25.34	27.59	26.46	1.6
109C	112A	29.50	25.62	27.56	1.3
122B	132A	25.30	24.77	25.04	1.6
142B	152B	27.07	25.38	26.22	1.5
173B	175A	26.84	28.68	27.76	1.6
184C	186B	....	24.94	24.94	0.8
197A	201C	29.47	29.40	29.44	1.3
197A	205C	28.71	....	28.71	0.9
207AA	220B	29.37	28.88	29.12	1.7
226C	233C	26.48	27.15	26.82	1.0
240C	252A	30.74	31.62	31.18	1.3
257A	262B	28.68	26.20	27.44	1.6
272C	273A	....	28.02	28.02	0.8
287A	293A	27.21	28.25	27.73	1.7
312A	323B	26.26	27.90	27.08	1.6
344A	346B	27.82	25.69	26.75	1.6
349B	359C	29.61	29.29	29.45	1.2
367B	373B	26.74	27.77	27.26	1.5
423A	431B	30.06	25.00	27.53	1.6
456A	460A	29.34	27.14	28.24	1.7
469A	484A	26.83	27.88	27.36	1.7
495A	496B	28.24	27.52	27.88	1.6
503B	520AA	....	26.48	26.48	0.9
509A	524A	29.08	....	29.08	0.9

Weighted mean, **31° 10′ 27″.64±0″.16.**

LONGITUDES.

(5) The methods of observation and computation adopted in the time work were substantially the same as those followed by Prof. Pritchett and myself in 1884–'85, and described at length in Bulletin No. 49 of U. S. Geological Survey. In the work of 1889–'90, however, equal weights were given to the mean transits of the stars. Nearly all of the stars observed fell in declination between —20° and +65°; so that the theoretical inequality in weights would be slight, while experience seems to justify the conclusion that in a well arranged time determination the application of weights is an illusory refinement.

In 1889 Prof. Pritchett observed, in general, transits on five lines of the diaphragm. In 1890 he observed, in general, on seven lines. At all the field stations and in the personal equation work at St. Louis, the writer observed, as a rule, on five lines. Departures from this rule occurred only when transits were broken by clouds or rendered uncertain by atmospheric unsteadiness. It would appear that, under ordinarily favorable conditions, the advantages of the use of a greater number of lines than five are inappreciable.

The details of the time work are given in Table III following. The first column in these tables gives the name of the star observed; the second, the position of the clamp; the third, the azimuth factor; the fourth, the collimation factor; the fifth gives the observed time t of transit of the star, corrected for inclination of horizontal axis and for daily aberration; and the last column gives the residuals v resulting from the substitution of the derived clock correction, azimuth, and collimation in the observation equations.

The right ascensions used were taken either directly from the Berliner Jahrbuch or reduced to the Jahrbuch system.

Along with each of the Tables III are given the normal equation for the clock correction, the resulting clock correction with the corresponding epoch, and the adopted azimuths and collimation.

A preliminary computation of the results from Prof. Pritchett's observations in 1889 was made by him during the course of the work. This computation was revised and checked during the winter of 1889–'90 by Mr. S. S. Gannett. The observations made by Prof. Prichett for the determination of Sierra Blanca, Texas, were completely reduced by him, all computations and readings of chronograph sheets being carefully checked. The results from my time observations were computed during the progress of the work and subsequently revised also by me.

(6) *Personal equation work.*—In the work of 1889, observations for personal equation were made at the observatory at St. Louis on two nights after the observations at the field stations were completed. The transits were set up on piers 4.2 feet apart and the difference in longitude of these observed, each observer using his own transit, transit key, chronograph, and electric apparatus, precisely as in the longitude work. For the longitude of Sierra Blanca in 1890, the same method of determining personal equation was adopted; and observations were made on three nights before and on four nights after the work at Sierra Blanca. The details of the time work for personal equation are given along with the other time work at St. Louis.

TABLE III.—*Details of time work.*

[Spearville, Kansas, October 27, 1889. Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ν Aquarii	W.	+0.7788	+1.022	21 03 23.32	+.02
ζ Cygni		+0.1618	1.152	08 42.66	+.02
α Equulei		+0.5474	1.004	10 21.81	—.04
α Cephei		—0.8791	2.139	17 32.44	—.05
ζ Capricorni	W.	+0.9470	+1.086	19 59.64	+.11
β Cephei	E.	—1.5654	—2.935	29 35.66	—.05
74 Cygni		—0.0471	1.308	33 14.03	—.14
ε Pegasi		+0.4833	1.013	38 54.19	+.01
δ Capricorni		+0.8494	1.044	40 41.71	+.11
π² Cygni	E.	—0.2885	—1.518	43 41.48	+.05

Normal equation, $10\Delta t + 1.5559a_w - 0.5683a_e - 1.413c + 328^s.98 = 0$

Adopted $a_w = +64^s.48$ $a_e = +64^s.35$ $c = +0^s.25$

Chronometer fast $39^s.23$ at $21^h.41$.

[Spearville, Kansas, October 27. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
7 Lacertæ	E.	—0.3181	—1.547	22 27 45.54	+.20
η Aquarii		+0.6231	1.000	29 40.75	+.14
ζ Pegasi		+0.4707	1.016	36 06.95	+.12
η Pegasi		+0.1642	1.150	38 18.73	—.29
ι Cephei	E.	—1.1290	—2.422	47 38.75	—.20
o Androm	W.	—0.0908	+1.340	57 35.99	+.04
α Pegasi		+0.4077	1.033	59 28.83	—.02
π Cephei		—2.2914	3.813	23 07 31.81	—.04
τ Pegasi		+0.2762	1.087	15 32.08	—.03
κ Piscium	W.	+0.6046	+1.000	21 16.98	+.06

Normal equation, $10\Delta t - 1.0937a_w - 0.1891a_e + 1.138c + 474^s.58 = 0$

Adopted $a_w = +64^s.29$ $a_e = +64^s.29$ $c = +0^s.24$

Chronometer fast $39^s.24$ at $22^h.87$.

TABLE III.—*Details of time work*—Continued.

[Spearville, Kansas, October 28, 1889. Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ν Aquarii	W.	+0.78	+1.02	21 04 13.41	−.03
ζ Cygni		+0.16	1.15	08 53.41	+.05
α Equulei		+0.53	1.00	10 57.13	.00
α Cephei		−0.88	2.14	15 36.72	−.02
ζ Capricorni	W.	+0.95	+1.09	21 00.36	−.08
β Cephei	E.	−1.56	−2.93	27 55.73	+.04
74 Cygni		−0.05	1.30	33 11.30	+.03
ε Pegasi		+0.50	1.01	39 25.17	+.04
δ Capricorni		+0.85	1.04	41 35.89	−.02
π² Cygni	E.	−0.29	−1.52	43 23.05	−.04

Normal equation, $10\Delta t + 1.54a_w - 0.55a_e - 1.40c + 4^s.51 = 0$

Adopted $a_w = +0^s.55$ $a_e = +0^s.55$ $c = +0^s.135$

Chronometer fast $39^s.49$ at $21^h.41$.

[Spearville, Kansas, October 28, 1889. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
7 Lacertæ	E.	−0.31	−1.55	22 27 25.14	−.10
η Aquarii		+0.62	1.00	30 20.40	.00
ζ Pegasi		+0.47	1.02	36 36.97	+.03
η Pegasi		+0.16	1.15	38 29.61	−.01
ι Cephei	E.	−1.13	−2.42	46 27.30	+.09
δ Aquarii	W.	+0.85	+1.04	49 26.45	−.09
o Androm		−0.09	1.34	57 30.73	+.06
α Pegasi		+0.41	1.03	59 55.21	.00
π Cephei		−2.29	3.81	23 04 06.87	−.07
τ Pegasi	W.	+0.28	+1.09	15 50.12	+.03

Normal equation, $10\Delta t - 0.84a_w - 0.19a_e + 1.17c + 6^s.29 = 0$

Adopted $a_w = +0^s.74$ $a_e = +0^s.74$ $c = +0^s.12$

Chronometer fast $39^s.57$ at $22^h.81$.

TABLE III.—*Details of time work*—Continued.

[Spearville, Kansas, November 2, 1889. Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
β Aquarii	W.	+0.70	+1.01	21 26 23.29	—.01
β Cephei		—1.56	2.93	28 03.05	—.09
ε Pegasi		+0.50	1.01	39 25.34	+.07
π^2 Cygni		—0.29	1.52	43 26.07	.00
16 Pegasi	W.	+0.24	+1.11	48 43.06	+.03
θ Pegasi	E.	+0.54	—1.00	22 05 17.18	—.01
2 Cephei		—1.79	3.20	08 31.77	+.18
θ Aquarii		+0.73	1.01	11 38.93	—.07
ν Aquarii		+0.64	1.00	16 36.18	+.01
7 Lacertæ	E.	—0.31	—1.55	27 27.97	—.11

Normal equation, $10\Delta t - 0.60a - 0.18c + 119^s.29 = 0$
Adopted $a_w = +4^s.30$ $a_e = +4^s.30$ $c = -0^s.04$
Chronometer fast $41^s.67$ at $21^h.93$

[Spearville, Kansas, November 2, 1889. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
o Androm	E.	—0.09	—1.34	22 57 32.98	—.08
α Pegasi		+0.41	1.03	59 55.78	—.01
π Cephei		—2.29	3.81	23 05 17.37	+.04
γ Piscium	E.	+0.58	—1.00	12 05.98	+.06
τ Pegasi	W.	+0.28	+1.09	15 51.29	+.01
4 Cassiopeæ		—0.85	2.11	20 43.01	+.09
70 Pegasi		+0.44	1.02	24 14.42	—.02
72 Pegasi		+0.14	1.16	29 10.17	—.06
γ Cephei	W.	—2.81	+4.45	35 46.99	—.01

Normal equation, $9\Delta t - 4.19a + 2.65c + 123^s.24 = 0$
Adopted $a_w = +4^s.38$ $a_e = +4^s.38$ $c = -0^s.05$
Chronometer fast $41^s.64$ at $23^h.26$.

TABLE III.—*Details of time work*—Continued.

[Boisé City, Idaho, November 15, 1889. Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
α Aquarii	W.	+0.70	+1.00	22 00 41.48	+.04
θ Pegasi		+0.62	1.01	05 12.68	—.06
ζ Cephei		—0.45	1.87	07 39.09	+.10
3 Lacertæ	W.	—0.23	+1.61	19 50.15	—.11
7 Lacertæ	E.	—0.16	—1.55	27 22.36	+.06
η Aquarii		+0.70	1.00	30 16.34	+.10
ζ Pegasi		+0.56	1.02	36 32.99	—.02
λ Pegasi		+0.38	1.09	41 48.94	—.07
ι Cephei	E.	—0.91	—2.42	46 25.20	—.08

Normal equation, $9\Delta t+1.21a-1.59c+58^s.30=0$

Adopted $a_w=+2^s.43$ $a_e=+2^s.43$ $c=+0^s.22$

Chronometer fast $36^s.77$ at $22^h.40$.

[Boisé City, Idaho, November 15, 1889. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ω Piscium	E.	+0.61	—1.01	23 54 14.45	+.06
β Cassiopeæ		—0.49	1.92	0 03 56.86	+.04
γ Pegasi		+0.50	1.03	08 09.26	—.03
ι Ceti	E.	+0.81	—1.01	14 23.66	+.01
12 Ceti	W.	+0.75	+1.00	24 59.60	+.09
ζ Cassiopeæ		—0.28	1.67	31 27.59	+.05
δ Androm.		+0.27	1.16	34 02.05	—.01
21 Cassiopeæ		—1.90	3.71	39 05.43	—.14
ζ Androm.	W.	+0.37	+1.09	42 05.43	—.06

Normal equation, $9\Delta t+0.64a+3.66c+57^s.72=0$

Adopted $a_w=+2^s.37$ $a_e=+2^s.37$ $c=+0^s.22$

Chronometer fast $36^s.68$ at $0^h.35$.

TABLE III.—*Details of time work*—Continued.

[Boisé City, Idaho, November 23, 1889. Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
θ Pegasi	W.	+0.62	+1.01	22 05 18.65	—.04
θ Aquarii		+0.80	1.01	11 41.41	+.12
γ Aquarii		+0.71	1.00	16 38.02	—.07
3 Lacertæ		—0.23	1.61	19 54.46	—.07
δ Cephei	W.	—0.46	+1.88	25 45.95	+.06
10 Lacertæ	E.	+0.11	—1.28	34 59.00	—.07
ζ Pegasi		+0.56	1.02	36 37.89	—.04
η Pegasi		+0.28	1.15	38 30.19	—.03
λ Pegasi		+0.38	1.09	41 53.46	+.07
ι Cephei		—0.91	2.42	46 26.15	+.15
π Cephei	E.	—1.97	—3.81	23 05 04.69	—.19

Normal equation, $11\Delta t+1.44\,a_w-1.55\,a_e-4.26c+449^s.64=0$

Adopted $a_w=+0^s.26$ $a_e=+0^s.26$ $c=-0^s.27$

Chronometer fast $40^s.98$ at $22^h.52$.

[Boisé City, Idaho, November 23, 1889. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
α Androm	E.	+0.30	—1.14	00 03 21.80	—.10
γ Pegasi		+0.50	1.03	08 14.00	—.01
ι Ceti		+0.81	1.01	14 29.15	+.12
ζ Cassiopeæ	E.	—0.28	—1.67	31 31.01	+.02
δ Androm	W.	+0.27	+1.16	34 07.50	+.08
21 Cassiopeæ		—1.90	3.72	39 07.38	+.07
ζ Androm		+0.37	1.09	42 11.12	+.10
γ Cassiopeæ		—0.57	2.01	50 45.95	—.13
ε Piscium		+0.60	1.01	57 54.50	—.04
β Androm	W.	+0 18	+1.22	1 04 15.12	—.12

Normal equation, $10\Delta t+0.28a+5.36c+410^s.98=0$

Adopted $a_w=+0^s.28$ $a_e=+0^s.29$ $c=-0^s.29$

Chronometer fast $40^s.95$ at $0^h.57$.

TABLE III.—*Details of time work*—Continued.

[Boisé City, Idaho, November 24, 1889. Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
7 Lacertæ	W.	−0.16	+1.55	22 27 25.88	+.10
η Aquarii		+0.70	1.00	30 21.73	+.04
ζ Pegasi		+0.56	1.02	36 38.13	−.02
λ Pegasi		+0.38	1.09	41 53.74	.00
ι Cephei	W.	−0.91	+2.42	46 26.92	−.09
β Pegasi	E.	+0.31	−1.13	59 05.82	−.09
π Cephei		−1.97	3.81	23 05 04.95	+.05
τ Pegasi		+0.38	1.09	15 50.98	−.02
4 Cassiopeæ		−0.65	2.11	20 37.24	−.07
70 Pegasi	E.	+0.53	−1.02	24 14.92	+.05

Normal equation, $10\Delta t + 0.57a_w - 1.40a_e - 2.08c + 407^s.96 = 0$

Adopted $a_w = +0^s.29$ $a_e = +0^s.31$ $c = -0^s.23$

Chronometer fast $40^s.82$ at $22^h.91$.

[Boisé City, Idaho, November 24, 1889. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
α Androm	E.	+0.30	−1.14	0 03 21.72	−.05
γ Pegasi		+0.50	1.03	08 13.91	+.01
ι Ceti		+0.81	1.01	14 28.98	+.03
ζ Cassiopeæ	E.	−0.28	−1.67	31 30.80	+.01
21 Cassiopeæ	W.	−1.90	+3.71	39 07.10	−.01
ζ Androm		+0.37	1.09	42 10.82	+.08
γ Cassiopeæ		−0.57	2.01	50 45.78	−.02
ε Piscium	W.	+0.60	+1.01	57 54.18	−.06

Normal equation, $8\Delta t - 1.50a_w + 1.33a_e + 2.97c + 326^s.96 = 0$

Adopted $a_w = +0^s.36$ $a_e = +0^s.16$ $c = -0^s.25$

Chronometer fast $40^s.74$ at $0^h.51$.

TABLE III.—*Details of time work*—Continued.

[Cisco, Texas, December 8, 1889. Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
τ Pegasi	W.	+0.1763	+1.09	23 15 12.64	—.03
70 Pegasi		+0.3513	1.02	21 39.52	+.10
41 H. Cephei		—1.4729	2.58	42 14.27	+.05
φ Pegasi		+0.2530	1.05	46 56.15	+.14
ω Piscium		+0.4432	1.01	53 45.34	.00
β Cassiopeæ		—0.8446	1.92	0 03 03.60	—.19
γ Pegasi	W.	+0.3162	+1.03	07 37.83	—.09
12 Ceti	E.	+0.6032	—1.00	24 33.86	+.07
ζ Cassiopeæ		—0.5969	1.67	29 39.69	+.03
α Cassiopeæ		—0.7132	1.78	34 03.14	+.02
β Ceti		+0.8198	1.05	38 15.87	—.14
ζ Androm	E.	+0.1656	—1.09	41 31.74	+.01

Normal equation, $12\Delta t—0.7775a_w+0.2785a_e+3.11c—15^s.31=0$

Adopted $a_w=—16^s.20$ $a_e=—16^s.31$ $c=—0^s.07$

Chronometer slow $0^s.62$ at $0^h.08$.

[Cisco, Texas, December 8, 1889. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ε Cassiopeæ	E.	—1.1309	—2.21	1 46 10.07	+.02
β Arietis		+0.2239	1.07	48 36.31	—.02
υ Ceti		+0.8703	1.07	55 02.70	+.10
τ Androm		—0.2194	1.34	57 04.32	+.02
α Arietis	E.	+0.1783	—1.08	2 01 00.06	—.12
67 Ceti	W.	+0.6383	+1.01	11 39.51	+.02
ξ² Ceti		+0.4175	1.01	22 24.62	—.12
36 H. Cassiopeæ		—2.1162	3.30	27 01.55	—.06
ν Arietis		+0.2033	1.07	32 36.98	+.17
θ Persei	W.	—0.4276	+1.52	36 33.87	—.02

Normal equation, $10\Delta t—1.2847a_w—0.0778a_e+1.14c—27^s.52=0$

Adopted $a_w=—16^s.33$ $a_e=—16^s.33$ $c=—0^s.11$

Chronometer slow $0^s.54$ at $2^h.17$.

TABLE III—*Details of time work.*—Continued.

[Cisco, Texas, December 10, 1889. Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
φ Pegasi	W.	+0.26	+1.06	23 46 54.79	+.11
ω Piscium		+0.45	1.01	53 41.01	—.01
β Cassiopeæ		—0.84	1.92	0 03 19.70	.00
γ Pegasi	W.	+0.32	1.03	07 35.54	—.07
ι Ceti		+0.68	+1.01	13 50.86	+.01
12 Ceti	E.	+0.61	—1.00	24 27.11	+.06
ζ Cassiopeæ		—0.59	1.67	30 51.90	—.05
α Cassiopeæ		—0.70	1.78	34 17.37	.00
β Ceti		+0.82	1.06	38 05.74	—.07
ζ Androm		+0.17	1.09	41 31.89	—.07
γ Cassiopeæ		—0.92	2.01	50 05.89	+.10
ε Piscium	E.	+0.43	—1.01	57 15.73	+.04

Normal equation, $12\Delta t + 0.85a_w - 0.18a_e - 3.59\,c + 26^s.31 = 0$
Adopted $a_w = -0^s.40$ $a_e = -0^s.40$ $c = +0^s.02$
Chronometer fast $2^s.17$ at $0^h.39$.

[Cisco, Texas, December 10, 1889. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
φ Persei	E.	—0.47	—1.56	1 36 47.78	—.03
o Piscium		+0.41	1.06	39 36.95	—.02
ε Cassiopeæ		—1.12	2.21	46 31.29	+.05
β Arietis		+0.23	1.07	48 35.65	—.05
υ Ceti	E.	+0.87	—1.08	54 51.63	+.07
γ Androm	W.	—0.21	+1.34	56 11.08	+.12
α Arietis		+0.18	1.09	2 01 00.59	+.13
67 Ceti		+0.64	1.01	11 32.23	+.05
ξ Ceti		+0.42	1.01	22 20.79	—.10
36 H. Cassiopeæ		—2.10	3.30	27 38.06	—.07
ν Arietis	W.	+0.21	+1.08	32 36.33	—.11

Normal equation, $11\Delta t - 0.08a_e - 0.86a + 1.96c + 26^s.13 = 0$
Adopted $a_w = -0^s.36$ $a_e = -0^s.24$ $c = -0^s.07$
Chronometer fast $2^s.39$ at $2^h.03$

TABLE III.—*Details of time work*—Continued.

[Cisco, Texas, December 11, 1889: Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
β Cassiopeæ	W.	−0.84	+1.92	0 03 20.69	+.07
γ Pegasi		+0.32	1.03	07 36.33	−.04
ι Ceti		+0.68	1.01	13 51.63	+.06
12 Ceti		+0.61	1.00	24 27.75	.00
ζ Cassiopeæ	W.	−0.59	+1.67	30 52.81	−.09
α Cassiopeæ	E.	−0.70	−1.78	34 18.27	+.01
β Ceti		+0.82	1.06	38 06.64	−.01
ζ Androm		+0.17	1.09	41 32.82	+.01
ε Piscium		+0.43	1.01	57 16.52	−.02
β Androm	E.	−0.05	−1.22	1 03 36.87	+.03

Normal equation, $10\Delta t+0.18a_w+0.67a_e+0.47c+30^s.55=0$

Adopted $a_w=-0^s.24$ $a_e=-0^s.36$ $c=+0^s.04$

Chronometer fast $3^s.03$ at $0^h.53$.

[Cisco, Texas, December 11, 1889. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ε Cassiopeæ	E.	−1.12	−2.21	1 46 32.09	−.02
ν Arietis		+0.21	1.07	2 32 37.31	−.05
θ Persei	E.	−0.41	−1.52	36 44.50	+.10
η Persei	W.	−0.68	+1.76	42 43.41	−.02

Normal equation, $4\Delta t-2.00a-3.04c+12^s.33=0$

Adopted $a_w=-0^s.50$ $a_e=-0^s.50$ $c=+0^s.08$

Chronometer fast $3^s.27$ at $2^h.41$.

TABLE III.—*Details of time work*—Continued.

[Sierra Blanca, Texas, May 16, 1890. Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
υ Hydræ	W.	+0.76	+1 04	10 44 20.23	—.01
46 Leonis		—0.08	1.22	49 20.24	+.03
β Urs. Maj		—0.80	1.83	57 24.79	+.02
ψ Urs. Maj		—0.34	1.42	11 05 40.19	—.00
δ Leonis	W.	+0.19	+1.07	08 25.49	—.08
υ Urs. Maj	E.	—0.05	—1.20	11 43.35	+.12
λ Draconis		—1.82	2.92	25 08.58	—.09
κ Urs. Maj		—0.45	1.51	40 26.55	—.17
β Leonis		+0.28	1.04	43 37.05	+.02
β Virginis	E.	+0.48	—1.00	45 07.63	+.13

Normal equation, $10\Delta t-1.83a-1.09c+105^s.31=0$

Adopted $a=+2^s.49$ $c=+0^s.067$

Chronometer fast $10^s.07$ at $11^h.25$.

[Sierra Blanca, Texas, May 16, 1890. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
δ Corvi	E.	+0.76	—1.04	12 24 19.68	+.04
8 Can. Ven		—0.25	1.34	28 42.95	—.09
γ Virginis		+0.53	1.00	36 14.95	—.06
31 Comæ Ber		+0.06	1.13	46 31.67	+.05
ε Urs. Maj	E.	—0.78	—1.81	49 24.99	+.04
ε Virginis	W.	+0.34	+1.02	56 52.34	—.03
θ Virginis		+0.59	1.00	13 04 25.01	+.03
γ Hydræ		+0.87	1.08	13 05.59	—.02
ζ Urs. Maj		—0.73	1.77	19 43.47	+.11
69 H. Urs. Maj	W.	—1.00	+2.03	24 39.32	—.11

Normal equation, $10\Delta t+0.39a+0.58c+99^s.86=0$

Adopted $a_w=a_e=+2^s.26$ $c=+0^s.02$

Chronometer fast $10^s.08$ at $12^h.91$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, May 25, 1890. Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
β Urs. Maj	W.	−0.80	+1.83	10 55 30.45	−.04
ψ Urs. Maj		−0.34	1.42	11 03 46.92	+.02
δ Leonis		+0.19	1.07	08 33.42	−.01
δ Crateris		+0.73	1.03	14 08.15	−.07
σ Leonis	W.	+0.42	+1.01	15 45.80	+.07
τ Leonis	E.	+0.47	−1.00	22 34.43	+.09
υ Leonis		+0.52	1.00	31 36.48	−.08
χ Urs. Maj		−0.45	1.51	40 32.14	−.09
β Leonis		+0.28	1.04	43 44.56	.00
γ Urs. Maj	E.	−0.67	−1.71	48 20.57	+.07

Normal equation, $10\Delta t+0.20a_w+0.15a_e+0.10c+73^s.05=0$

Adopted $a_w=+0^s.21$ $a_e=0^s.00$ $c=-0^s.227$

Chronometer fast $17^s.31$ at $11^h.38$.

[St. Louis, Missouri, May 25, 1890. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ε Virginis	E.	+0.34	−1.02	12 57 00.09	+.01
θ Virginis		+0.59	1.00	13 04 33.16	−.04
43 Comæ		+0.05	1.14	07 02.69	+.07
20 Can. Ven		−0.23	1.33	12 55.04	+.01
ζ Urs. Maj	E.	−0.73	−1.77	19 48.64	−.01
69 H. Urs. Maj	W.	−1.00	+2.03	24 45.05	+.01
ζ Virginis		+0.52	1.00	29 23.87	+.05
m Virginis		+0.64	1.01	36 08.88	−.02
τ Bootis		+0.24	1.05	42 20.80	−.05
η Urs. Maj	W.	−0.50	+1.55	43 31.06	−.02

Normal equation, $10\Delta t-0.10a_w+0.02a_e+0.38c+73^s.92=0$

Adopted $a_w=+0^s.23$ $a_e=+0^s.23$ $c=-0^s.236$

Chronometer fast $17^s.38$ at $12^h.36$.

TABLE III.—*Details of time work*—Continued.

[Sierra Blanca, Texas, May 28, 1890. Before signals. Observer, Woodward.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. m. s.	*s.*
β Urs. Maj	E.	−0.80	−1.83	10 55 30.69	+.01
ψ Urs. Maj		−0.34	1.42	11 03 47.51	−.01
δ Leonis		+0.19	1.07	08 34.52	+.04
δ Crateris		+0.73	1.03	14 09.52	−.09
σ Leonis	E.	+0.42	−1.01	15 47.04	+.08
υ Leonis	W.	+0.52	+1.00	31 38.31	−.04
χ Urs. Maj		−0.45	1.51	40 33.81	−.04
β Leonis		+0.28	1.04	43 46.32	+.04
β Virginis		+0.48	1.00	45 17.36	+.01
γ Urs. Maj	W.	−0.67	+1.71	48 22.13	+.05

Normal equation, $10\Delta t+0.16a_w+0.20a_e-0.10c+6^s.56=0$

Adopted $a_w=-0^s.32$ $a_e=-0^s.39$ $c=-0^s.09$

Chronometer fast $18^s.64$ at $11^h.41$.

[Sierra Blanca, Texas, May 28, 1890. After signals. Observer, Woodward.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. m. s.	*s.*
δ Virginis	W.	+0.46	+1.00	12 50 23.45	+.05
ε Virginis		+0.34	1.02	56 01.79	−.02
θ Virginis		+0.59	1.00	13 04 34.94	−.06
20 Can. Ven		−0.23	1.33	12 56.75	+.02
ζ Urs. Maj	W.	−0.73	+1.77	19 50.33	−.01
69 H. Urs. Maj	E.	−1.00	−2.03	24 45.43	+.11
ζ Virginis		+0.52	1.00	29 25.08	+.08
m Virginis		+0.64	1.01	36 10.03	−.08
τ Bootis		+0.24	1.05	42 21.91	.00
η Urs. Maj	E.	−0.50	−1.55	43 32.48	−.12

Normal equation, $10\Delta t+0.43a_w-0.10a_e-0.52c+7^s.10=0$

Adopted $a_w=0^s.00$ $a_e=-0^s.10$ $c=-0^s.09$

Chronometer fast $18^s.72$ at $13^h.33$.

TABLE III.—*Details of time work*—Continued.

[Sierra Blanca, Texas, May 29, 1890. Before signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
δ Crateris	W.	+0.73	+1.03	11 14 10.07	.00
υ Leonis		+0.52	1.00	31 38.66	—.04
3 Draconis		—1.53	2.60	36 39.69	—.01
χ Urs. Maj		—0.45	1.51	40 34.15	+.02
β Leonis	W.	+0.28	+1.04	43 46.70	+.06
γ Urs. Maj	E.	—0.67	—1.71	48 23.07	+.10
π Virginis		+0.41	1.01	55 34.34	.00
o Virginis		+0.38	1.01	59 56.55	.00
δ Urs. Maj		—0.83	1.87	12 10 19.40	—.12
η Virginis	E.	+0.52	—1.00	14 36.93	—.03

Normal equation, $10\Delta t - 0.45a_w - 0.19a_e + 0.58c + 2^s.82 = 0$

Adopted $a_w = -0^s.253$ $a_e = -0^s.209$ $c = +0^s.181$

Chronometer fast $19^s.31$ at $11^h.79$.

[Sierra Blanca, Texas, May 29, 1890. After signals. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ε Virginis	E.	+0.34	—1.02	12 56 62.66	+.06
θ Virginis		+0.59	1.00	13 04 35.79	—.01
43 Comæ		+0.05	1.14	07 05.04	—.04
20 Can. Ven		—0.23	1.33	12 57.35	—.13
ζ Urs. Maj	E.	—0.73	—1.77	19 51.20	+.14
69 H. Urs. Maj	W.	—1.00	+2.03	24 46.13	+.13
ζ Virginis		+0.52	1.00	29 25.66	+.06
m Virginis		+0.64	1.01	36 10.61	—.10
τ Bootis		+0.24	1.05	42 22.58	+.04
η Urs. Maj	W.	—0.50	+1.55	43 33.14	—.13

Normal equation, $10\Delta t - 0.10a_w + 0.02a_e + 0.38c + 4^s.26 = 0$

Adopted $a_w = 0^s.00$ $a_e = -0^s.08$ $c = +0^s.141$

Chronometer fast $19^s.43$ at $13^h.36$

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, October 27, 1889. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
α Aquarii	W.	+0.637	+1.000	22 06 36.28	+.03
ι Pegasi		+0.263	1.102	08 22.44	+.09
π Pegasi		+0.125	1.187	11 35.32	—.08
24 Cephei		—1.750	3.200	14 15.52	—.03
θ Aquarii	W.	+0.739	+1.011	17 29.86	+.02
π Aquarii	E.	+0.614	—1.000	26 07.46	—.02
η Aquarii		+0.634	1.000	36 10.14	.00
31 Cephei		—1.941	3.434	39 36.01	+.03
η Pegasi		+0.180	1.150	44 19.35	—.11
μ Pegasi	E.	+0.276	—1.095	51 10.29	+.10

Normal equation, $10\Delta t+0.004a_w-0.237a_e-0.179c-99^s.30=0$

Adopted $a_w=-1^s.214$ $a_e=-1^s.102$ $c=+0^s.262$

Clock fast $389^s.91$ at $22^h.32$.

[St. Louis, Missouri, October 27, 1889. After signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
τ Pegasi	E.	+0.291	—1.087	23 21 40.24	—.02
κ Piscium		+0.617	1.000	27 45.74	—.12
70 Pegasi	E.	+0.456	—1.023	30 04.08	+.11
41 H. Cephei	W.	—1.233	+2.580	49 12.52	—.06
φ Pegasi		+0.363	1.055	53 22.94	+.12
ω Piscium		+0.539	1.006	0 00 08.83	+.04
ν Pegasi	W.	+0.423	+1.033	14 03.49	—.07

Normal equation, $7\Delta t+0.92a_w+1.364a_e+2.564c-69^s.67=0$

Adopted $a_w=-1^s.264$ $a_e=-1^s.041$ $c=+0^s.338$

Clock fast $390^s.05$ at $23^h.67$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, October 28, 1889. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. m. s.	*s.*
α Aquarii	W.	+0.64	+1.00	22 06 38.22	+.06
ι Pegasi		+0.26	1.10	08 24.40	+.14
π Pegasi		+0.12	1.19	11 37.20	—.10
24 Cephei		—1.75	3.20	14 17.39	—.03
θ Aquarii	W.	+0.74	+1.01	17 31.71	—.07
π Aquarii	E.	+0.61	—1.00	26 09.40	—.03
η Aquarii		+0.63	1.00	36 11.99	—.09
31 Cephei		—1.94	3.43	39 37.75	+.03
η Pegasi		+0.18	1.15	44 21.50	+.13
μ Pegasi	E.	+0.28	—1.09	51 12.09	—.03

Normal equation, $10\Delta t + 0.01 a_w - 0.24 a_e - 0.17 c - 18^s.48 = 0$

Adopted $a_w = -1^s.22$ $a_e = -1^s.04$ $c = +0^s.26$

Clock fast $391^s.83$ at $22^h.32$.

[St. Louis, Missouri, October 28, 1889. After signals. Observer, Pritchett.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. m. s.	*s.*
π Cephei	E.	—2.25	—3.81	23 10 59.72	+.03
τ Pegasi		+0.29	1.09	21 42.33	+.06
κ Piscium		+0.62	1.00	27 47.85	+.02
70 Pegasi		+0.46	1.02	30 05.96	+.02
ι Androm	E.	—0.09	—1.36	39 15.82	—.14
41 Cephei	W.	—1.23	+2.58	49 14.40	+.03
φ Pegasi		+0.36	1.05	53 24.99	+.18
ω Piscium		+0.54	1.01	0 00 10.83	+.06
22 Androm		—0.17	1.42	11 08.69	—.09
ν Pegasi	W.	+0.42	+1.03	14 05.38	—.17

Normal equation, $10\Delta t - 0.08 a_w - 0.97 a_e - 1.19 c - 21^s.42 = 0$

Adopted $a_w = -1^s.20$ $a_e = -1^s.16$ $c = +0^s.30$

Clock fast $392^s.06$ at $23^h.62$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, November 2, 1889. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
σ Aquarii	E.	+0.78	—1.02	22 31 28.02	+.20
η Aquarii		+0.63	1.00	36 20.68	—.13
31 Cephei		—1.94	3.43	39 45.72	—.07
λ Pegasi	E.	+0.29	—1.08	47 53.06	—.01
μ Pegasi	W.	+0.28	+1.09	51 21.25	—.12
β Pegasi		+0.22	1.13	23 05 06.49	+.10
π Cephei		—2.25	3.81	11 10.18	+.09
ø Aquarii		+0.71	1.01	15 16.60	—.07
τ Pegasi		+0.29	1.09	21 51.38	+.02
κ Piscium	W.	+0.62	+1.00	27 36.87	—.01

Normal equation, $10\Delta t - 0.13a_w - 0.24a_e + 2.60c - 6^s.72 = 0$

Adopted $a_w = -1^s.14$ $a_e = -0^s.92$ $c = +0^s.29$

Clock fast $400^s.56$ at $22^h.87$.

[St. Louis, Missouri, November 2, 1889. After signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
κ Androm	W.	—0.12	+1.38	23 41 40.09	—.17
41 H. Cephei		—1.23	2.58	49 22.89	+.05
φ Pegasi		+0.36	1.06	53 33.25	—.03
ω Piscium	W.	+0.54	+1.01	24 00 19.37	+.13
ι Ceti	E.	+0.75	—1.01	20 28.31	-.01
44 Piscium		+0.61	1.00	26 25.03	+.10
12 Ceti		+0.69	1.00	31 04.58	+.03
π Androm		+0.12	1.19	37 40.09	—.02
δ Androm		+0.17	1.16	40 06.41	—.08
21 Cass	E.	—2.17	—3.71	45 07.62	+.01

Normal equation, $10\Delta t - 0.45a_w + 0.17a_e - 3.04c - 5^s.89 = 0$

Adopted $a_w = -1^s.29$ $a_e = -1^s.06$ $c = +0^s.26$

Clock fast $400^s.63$ at $24^h.18$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, November 15, 1889. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ι Piscium	E.	+0.56	—1.00	23 34 01.32	+.04
41 H. Cephei		—1.23	2.58	42 25.64	.00
φ Pegasi		+0.36	1.06	46 37.64	.00
ω Piscium		+0.54	1.01	53 23.80	—.11
β Cassiopeæ		—0.65	1.92	0 03 04.24	+.06
σ Androm	E.	+0 06	—1.24	12 19.59	+.01
π Androm	W.	+0.12	+1.19	30 45.76	—.10
δ Androm		+0.17	1.16	33 11.84	+.17
21 Cassiopeæ		—2.16	3.71	38 14.13	—.06
ζ Androm		+0.28	1.09	41 15.49	+.04
δ Piscium		+0.53	1.01	42 43.27	—.04
ε Piscium	W.	+0.52	+1.01	56 58.85	—.02

Normal equation, $12\Delta t - 0.90a + 0.36c + 51^s.85 = 0$

Adopted $a_w = -1^s.04$ $a_e = -1^s.04$ $c = +0^s.28$

Clock slow $14^s.41$ at $24^h.27$.

[St. Louis, Missouri, November 15, 1889. After signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ν Piscium	W.	+0.56	+1.00	1 35 27.19	+.07
o Piscium		+0.51	1.01	39 20.13	—.15
ε Cassiopeæ	W.	—0.92	+2.21	46 17.30	+.07
α Arietis	E.	+0.29	—1.09	2 00 43.03	—.08
β Trianguli		+0.09	1.21	02 44.79	—.01
ξ¹ Ceti		+0.51	1.01	06 54.53	+.08
ι Cassiopeæ	E.	—1.21	—2.55	19 47.32	+.01

Normal equation, $7\Delta t + 0.15a_w - 0.32a_e - 1.64c + 100^s.85 = 0$

Adopted $a_w = -1^s.37$ $a_e = -1^s.03$ $c = +0^s.37$

Clock slow $14^s.34$ at $1^h.93$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, November 23, 1889. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ω Piscium	W.	+0.54	+1.01	23 53 24.33	+.10
α Androm		+0.20	1.14	0 02 27.33	−.04
γ Pegasi		+0.42	1.03	07 19.15	+.04
ν Androm		+0.06	1.24	12 20.45	−.06
44 Piscium		+0.61	1.00	19 30.57	−.02
κ Cassiopeæ		−0.86	2.15	26 32.44	−.07
ζ Cassiopeæ	W.	−0.42	+1.68	30 37.05	+.07
δ Androm	E.	+0.17	−1.16	33 11.32	+.11
21 Cassiopeæ		−2.16	3.72	38 11.96	−.02
ζ Androm		+0.28	1.09	41 15.01	−.03
δ Piscium		+0.53	1.01	42 42.80	−.07
μ Androm		+0 01	1.27	50 23.92	−.02
ε Piscium	E.	+0.52	−1.01	56 58.27	+.03

Normal equation, $13\Delta t+0.55a_w-0.65a_e-0.01c+184^s.82=0$

Adopted $a_w=-0^s.95$ $a_e=-1^s.15$ $c=+0^s.30$

Clock slow $14^s.23$ at $24^h.46$.

[St. Louis, Missouri, November 23, 1889. After signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
γ Piscium	E.	+0.56	−1.00	1 35 26.88	+.04
ο Piscium		+0.51	1.01	39 19.72	−.12
ν Arietis		+0.36	1.06	47 14.56	−.20
50 Cassiopeæ		−1.77	3.21	53 51.21	−.06
ν Androm		−0.07	1.34	56 53.89	+.28
α Arietis	E.	+0.30	−1.08	2 00 43.11	+.06
β Trianguli	W.	+0.08	+1.21	02 45.67	+.05
γ Trianguli		+0.11	1.20	10 32.25	+.03
ι Cassiopeæ		−1.21	2.55	19 49.29	−.01
ξ² Ceti		+0.52	1.01	22 03.91	−.13
δ Ceti		+0.63	1.00	33 35.75	+.02
γ Ceti	W.	+0.59	+1.00	37 21.16	+.04

Normal equation, $12\Delta t-0.11a_e+0.72a_w-0.73c+51^s.16=0$

Adopted $a_w=-1^s.19$ $a_e=-1^s.11$ $c=+0^s.28$

Clock slow $14^s.18$ at $2^h.08$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, November 25, 1889. After signals. Observor, Pritchett]

Name of star.*	Clamp.	*A*	*C*	*t*	*v*
				h. m. s.	*s.*
δ Ceti	W.	+0.63	+1.00	2 33 35.57	+.07
γ Ceti		+0.59	1.00	37 21.11	—.05
μ Ceti		+0.49	1.01	38 44.85	—.04
41 Arietis		+0.23	1.12	43 16.05	—.02
48 H. Cephei		−2.85	4.56	3 06 15.84	.00
ζ Arietis	W.	+0.33	+1.07	08 20.05	+.04
o Tauri	E.	+0.51	—1.01	18 38.05	+.13
2 H. Camelop		—0.71	1.97	19 56.12	+.03
f Tauri		+0.45	1.02	24 32.73	—.14
5 H. Camelop		—1.64	3.07	38 33.13	—.03
η Tauri		+0.28	1.09	40 41.57	—.05
γ Tauri	E.	+0.55	—1.01	57 02.77	+.07

Normal equation, $12\Delta t - 0.58a_w - 0.56a_e + 0.59c + 50^s.28 = 0$

Adopted $a_w = -1^s.23$ $a_e = -1^s.22$ $c = +0^s.32$

Clock slow $14^s.32$ at $3^h.18$.

[St. Louis, Missouri, December 8, 1889. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. m. s.	*s.*
44 Piscium	E.	+0.61	−1.00	0 19 28.43	+.06
12 Ceti		+0.69	1.00	24 08.08	+.05
π Androm		+0.12	1.19	30 43.73	—.07
δ Androm		+0.17	1.16	33 10.08	—.02
21 Cassiopeæ	E.	—2.16	—3.73	38 09.86	—.01
ε Piscium	W.	+0.52	+1.01	56 57.42	+.12
β Androm		+0.08	1.22	1 03 18.64	—.06
π Piscium		+0.46	1.02	30 59.72	+.01
γ Piscium		+0.56	1.00	35 26.01	+.02
o Piscium	W.	+0.51	+1.01	39 18.87	—.09

Normal equation, $10\Delta t + 2.13a_w - 0.57a_e - 2.82c + 157^s.44 = 0$

Adopted $a_w = -1^s.08$ $a_e = -1^s.08$ $c = +0^s.26$

Clock slow $15^s.50$ at $0^h.92$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, December 8, 1889. After signals. Observer, Pritchett.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. m. s.	s.
δ Ceti	W.	+0.63	+1.00	2 33 34.46	+.11
γ Ceti		+0.59	1.00	37 19.98	.00
μ Ceti		+0.49	1.01	38 43.67	+ 06
41 Arietis		+0.23	1.12	43 14.84	+.04
47 H. Cephei		—3.39	5.24	51 21.70	—.09
o Persei	W.	+0.01	+1.28	57 52.55	—.12
48 Cephei	E.	—2.85	—4.56	3 06 11.49	+.07
ζ Arietis		+0.33	1.07	08 18.39	—.04
o Tauri		+0.51	1.01	18 37.01	+.10
ξ Tauri		+0.50	1.01	21 55.84	+.10
f Tauri		+0.45	1.02	24 31.51	+.02
17 Tauri		+0.28	1.10	38 04.40	—.06
ζ Tauri	E.	+0.28	—1.09	40 40.64	—.18

Normal equation, $13\Delta t-1.44a_w-0.50a_e-0.21c+199^s.26=0$

Adopted $a_w=-1^s.04$ $a_e=-1^s.17$ $c=+0^s.29$

Clock slow $15^s.48$ at $3^h.08$.

[St. Louis, Missouri, December 10, 1889. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. m. s.	s.
κ Piscium	E.	—0.86	—2.15	0 26 29.34	+.04
π Androm		+0.12	1.19	30 43.64	—.07
δ Androm		+0.17	1.16	33 09.88	+.09
ζ Androm		+0.28	1.09	41 13.62	—.06
γ Casssiopeæ		—0.74	2.01	49 48.67	—.03
ε Piscium	E.	+0.52	—1.01	56 56.91	+.04
β Androm	W.	+0.08	+1.22	1 03 18.68	—.05
τ Piscium		+0.18	1.15	05 20.25	—.01
η Piscium		+0.42	1.03	25 19.68	—.04
40 Casssiopeæ		—1.85	3.32	29 32.23	.00
ν Piscium		+0.56	1.00	35 26.02	+.12
α Trianguli	W.	+0.19	+1.14	46 32.93	—.02

Normal equation, $12\Delta t-0.42a_w-0.51a_e+0.25c+184^s.74=0$

Adopted $a_w=-1^s.08$ $a_e=-1^s.09$ $c=+0^s.32$

Clock slow $15^s.49$ at $1^h.04$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, December 10, 1889. After signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ξ[1] Ceti	W.	+0.51	+1.01	2 06 54.07	+.02
γ Trianguli		+0.11	1.20	10 30.95	+.01
θ Arietis		+0.35	1.06	11 44.54	—.02
ξ[2] Ceti		+0.52	1.01	22 02.53	+.02
ν Arietis	W.	+0.32	+1.07	32 18.44	—.03
41 Arietis	E.	+0.23	—1.12	43 14.34	+.01
σ Arietis		+0.42	1.03	45 08.83	—.03
δ Arietis		+0.35	1.06	3 05 04.05	+.02
ζ Arietis		+0.33	1.07	08 18.53	—.02
o Tauri	E.	+0.51	—1.01	18 37.21	+.04

Normal equation, $10\Delta t+1.81a_w+1.84a_e+0\ 06c+158^s.07=0$

Adopted $a_w=-1^s.12$ $a_e=-1^s.09$ $c=+0^s.25$

Clock slow $15^s.40$ at $2^h.64$.

[St. Louis, Missouri, December 11, 1889. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
43 H. Cephei	E.	—9.68	—13.23	0 53 44.92	—.11
ε Piscium		+0.52	1.01	56 56.78	+.13
β Androm		+0.08	1.22	1 03 17.76	+.09
τ Piscium		+0.18	1.15	05 19.54	—.05
f Piscium		+0.58	1.00	11 50.32	+.03
ν Piscium	E.	+0.23	—1.12	13 08.59	—.08
η Piscium	W.	+0.42	+1.03	25 19.56	.00
40 Cassiopeæ		—1.85	3.32	29 32.07	+.02
ν Piscium		+0.56	1.00	35 26.03	+.05
o Piscium		+0.51	1.01	39 18.87	—.10
α Trianguli		+0.19	1.14	46 32.85	+.01
β Arietis	W.	+0.34	+1.07	48 17.74	+.01

Normal equation, $12\Delta t-0.17a_w-8.09a_e-10.16c+180^s.01=0$

Adopted $a_w=-1^s.09$ $a_e=-1^s.15$ $c=+0^s.30$

Clock slow $15^s.51$ at $1^h.32$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, December 11, 1889. After signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
γ Trianguli	W.	+0.11	+1.20	2 10 30.97	—.12
ξ2 Ceti		+0.51	1.01	22 02.41	+.10
36 H. Cass		—1.83	3.30	27 23.29	—.03
υ Arietis		+0.32	1.07	32 18.45	—.13
δ Ceti	W.	+0.63	+1.00	33 34.36	+.17
41 Arietis	E.	+0.23	—1.12	43 14.00	+.10
σ Arietis		+0.42	1.03	45 08.77	—.19
47 H. Cephei		—3.39	5.24	51 18.31	+.01
δ Arietis		+0.35	1.06	3 05 03.77	+.07
ζ Arietis		+0.33	1.07	08 18.43	—.16
o Tauri	E.	+0.51	—1.01	18 36.86	+.18

Normal equation, $11\Delta t - 0.26a_w - 1.55a_e - 2.95c + 170^s.61 = 0$

Adopted $a_w = -0^s.90$ $a_e = -1^s.05$ $c = +0^s.29$

Clock slow $15^s.60$ at $2^h.64$.

[St. Louis, Missouri, December 18, 1889. First series. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ω Piscium	E.	+0.54	— 1.01	23 53 22.42	+.01
33 Piscium		+0.71	1.01	58 24.81	+.02
β Cassiopeæ		—0.65	1.92	0 3 02.25	—.04
γ Pegasi		+0.42	1.03	7 17.11	+.01
σ Androm		+0.06	1.24	12 18.07	.00
44 Piscium		+0.61	1.00	19 28.61	—.07
ζ Cassiopeæ		—0.42	1.68	30 34.26	+.04
δ Androm		+0.17	1.16	33 09.90	+.04
ζ Androm		+0.28	1.09	41 13.60	.00
δ Piscium		+0.53	1.01	42 41.41	+.02
γ Cassiopeæ	E.	—0.74	—2.01	49 48.39	—.02
43 H. Cephei	W.	—9.64	+13.18	53 46.67	—.01
f Piscium		+0.58	1.00	1 11 50.87	—.02
ν Piscium		+0.23	1.12	13 09.00	—.05
δ Cassiopeæ		—0.71	1.98	18 22.41	+.02
η Piscium		+0.42	1.03	25 19.36	+.03
π Piscium	W.	+0.46	+ 1.02	30 59.55	+.04

Normal equation, $17\Delta t - 8.66a_w + 1.51a_e + 5.17c - 257^s.68 = 0$

Adopted $a_w = +0^s.89$ $a = +0^s.82$ $c = -0^s.18$

Clock slow $15^s.59$ at $24^h.83$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, December 18, 1889. Second series. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
γ Eridani	W.	+0.67	+1.00	4 30 33.38	+.01
Gr. 848		—2.45	4.06	33 52.05	+.21
4 Camelop		—0.56	1.81	38 36.13	+.05
ι Tauri		+0.36	1.06	44 40.66	—.03
π^5 Orionis		+0.59	1.00	48 15.38	+.05
ε Aurigæ		—0.12	1.38	53 49.37	+.10
ι Tauri	W.	+0.32	+1.07	56 15.53	+.02
17 Camelop	E.	—0.91	—2.20	5 19 32.50	—.21
ζ Tauri		+0.32	1.07	30 48.12	.00
o Aurigæ		—0.30	1.55	38 07.26	—.01
θ Aurigæ		+0.03	1.26	51 57.60	—.15
66 Orionis		+0.57	1.00	58 53.32	+.11
ν Orionis		+0.42	1.03	6 01 01.31	+.01
22 H. Camelop	E.	—1.45	—2.84	06 29.70	—.08

Normal equation, $14\Delta t-1.19a_w-1.32a_e+0.43c-217^s.21=0$

Adopted $a_w=+0^s.93$ $a_e=+0^s.84$, $c=-0^s.24$

Clock slow $15^s.68$ at $5^h.26$.

[St. Louis, Missouri, December 19, 1889. First series. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
η Piscium	E.	+0.42	—1.03	1 25 19.08	+.02
40 Cassiopeæ		—1.85	3.32	29 29.70	—.14
43 Cassiopeæ		—1.26	2.61	33 56.95	—.05
o Piscium		+0.51	1.01	39 18.35	.00
ε Cassiopeæ		—0.92	2.21	46 13.74	+.07
ξ Piscium		+0.59	1.00	47 34.90	+.02
50 Cassiopeæ		—1.76	3.22	53 48.77	—.06
α Arietis		+0.29	1.09	2 00 41.86	+.05
β Trianguli		+0.09	1.21	02 43.59	+.10
ξ^1 Ceti	E.	+0.51	—1.01	06 53.53	+.10
ι Cassiopeæ	W.	—1.21	+2.55	19 46.95	—.29
ξ^2 Ceti		+0.52	1.01	23 02.41	+.01
36 H. Cassiopeæ		—1.83	3.30	27 22.69	+.34
ν Arietis		+0.32	1.08	32 18.32	—.06
γ Ceti		+0.59	1.00	37 19.90	—.05
41 Arietis		+0.23	1.12	43 14.78	—.02
σ Arietis	W.	+0.42	+1.03	45 09.19	—.02

Normal equation, $17\Delta t-0.96a_w-3.38a_e-6.62c-261^s.20=0$

Adopted $a_w=+1^s.02$ $a_e=+0^s.83$ $c=-0^s.21$

Clock slow $15^s.51$ at $2^h.09$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, December 19, 1889. Second series. Observer, Pritchett.]

Name of star.	Clamp	A	C	t	v
				h. m. s.	s.
17 Tauri	W.	+0.28	+1.09	3 39 04.89	—.04
η Tauri		+0.28	1.09	40 41.08	—.09
27 Tauri		+0.28	1.09	42 21.60	—.05
9 H. Camelop		—0.77	2.05	47 31.70	—.01
λ Tauri		+0.46	1.02	54 19.23	+.04
ν Tauri		+0.55	1.00	58 02.31	+.05
o Eridani	W.	+0.72	+1.01	4 06 13.77	+.03
γ Tauri	E.	+0.41	—1.04	13 15.82	+.01
ε Tauri		+0.36	1.06	21 55.48	.00
Eridani		+0 67	1.00	30 33.06	—.03
Gr. 848		—2.45	4.06	33 50.74	+.04
α Camelop		—1.14	2.47	42 52.93	—.01
π^5 Orionis	E.	+0.59	—1.00	48 15.00	+.08

Normal equation, $13\Delta t + 1.80a_w - 1.56a_e - 2.28c - 203^s.06 = 0$

Adopted $a_w = +0^s.98$ $a_e = +0^s.99$ $c = -0^s.19$

Clock slow $15^s.57$ at $4^h.15$.

[St. Louis, Missouri, December 18, 1889. First series. Observer, Woodward.]

Name of star.	Clamp	A	C	t	v
				h. m. s.	s.
ω Piscium	W.	+0.54	+1.01	23 53 41.02	+.09
33 Piscium		+0.71	1.01	59 43.51	—.06
γ Pegasi		+0.42	1.03	0 07 35.44	—.08
σ Androm		+0.06	1.24	12 36.17	+.09
44 Piscium		+0.61	1.00	19 47.17	+.01
ζ Cassiopeæ		—0.42	1.68	30 51.86	+.03
δ Androm		+0.17	1.16	33 28.05	—.05
δ Piscium		+0.53	1.01	42 59.90	—.05
γ Cassiopeæ	W.	—0.74	+2.01	50 05.52	+.03
43 H. Cephei	E.	—9.64	—13.18	53 51.61	+.06
β Androm		+0.08	1.22	1 03 35.83	—.25
υ Piscium		+0.23	1.12	13 26.90	—.05
δ Cassiopeæ		—0.71	1.98	18 39.13	—.08
η Piscium		+0.42	1.03	25 37.59	—.05
π Piscium		+0.46	1.02	31 18.04	+.16
o Piscium		+0.51	1.01	39 37.14	+.15
ε Cassiopeæ	E.	—0.92	—2.21	46 31.24	+.04

Normal equation, $17\Delta t - 7.69a - 11.62c + 2^s.63 = 0$

Adopted $a_w = -0^s.33$ $a_e = -0^s.33$ $c = +0^s.09$

Chronometer fast $2^s.24$ at $0^h.83$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, December 18, 1889. Second series. Observer, Woodward.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. *m.* *s.*	*s.*
ν Eridani	E.	+0.67	−1.00	4 30 53.03	.00
Gr. 848		−2.45	4.06	34 07.65	+.09
4 Camelop		−0.56	1.82	38 53.07	−.11
i Tauri		+0.36	1.05	44 58.84	−.04
ε Aurigæ		−0.12	1.38	54 07.00	−.09
ι Tauri	E.	+0.32	−1.07	56 33.70	−.06
τ Orionis	W.	+0.72	+1.01	5 12 18.55	+.14
17 Camelop		−0.91	2.20	19 49.86	+.05
χ Aurigæ		+0.13	1.18	25 36.48	−.08
ζ Tauri		+0.32	1.07	30 06.68	+.08
o Aurigæ		−0.30	1.55	37 25.27	+.03
θ Aurigæ		+0.03	1.26	52 15.64	.00
66 Orionis	W.	+0.57	+1.00	59 12.20	+.07

Normal equation, $13\Delta t+0.56a_w-1.78a_e-1.11c+29^s.83=0$.

Adopted $a_w=-0^s.10$, $a_e=-0^s.29$, $c=+0^s.065$.

Chronometer fast $2^s.32$ at $5^h.24$.

[St. Louis, Missouri, December 19, 1889. First series. Observer, Woodward.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. *m.* *s.*	*s.*
η Piscium	W.	+0.42	+1.03	1 25 37.77	+.08
o Piscium		+0.51	1.01	39 37.16	+.12
ε Cassiopeæ		−0.92	2.21	46 31.00	.00
50 Cassiopeæ		−1.76	3.22	54 04.91	−.07
α Arietis		+0.29	1.09	2 01 00.34	−.01
β Trianguli		+0.09	1.21	03 01.86	−.07
ξ¹ Ceti	W.	+0.51	+1.01	07 12.34	+.03
ι Cassiopeæ	E.	−1.21	−2.55	20 03.37	+.33
ξ² Ceti		+0.51	1.01	22 21.07	.00
36 H Cassiopeæ		−1.83	3.30	27 38.15	−.30
ν Arietis		+0.32	1.08	32 36.64	−.01
γ Ceti		+0.59	1.00	37 38.57	−.02
41 Arietis		+0.23	1.12	43 32.90	−.11
σ Arietis	E.	+0.42	−1.03	45 27.84	+.14

Normal equation, $14\Delta t+1.83a-0.31c+35^s.25=0$.

Adopted $a_w=a_e=-0^s.28$, $c=+0^s.13$.

Chronometer fast $2^s.55$ at $2^h.20$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, December 19, 1889. Second series. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
17 Tauri	E.	+0.28	−1.09	3 38 23.22	−.01
η Tauri		+0.28	1.09	40 59.46	+.09
27 Tauri		+0.28	1.09	42 39.90	−.03
9 H. Camelop		−0.77	2.05	47 48.63	−.10
λ Tauri		+0.46	1.02	54 37.94	+.06
o¹ Eridani	E.	+0.72	−1.01	4 06 32.78	+.06
γ Tauri	W.	+0.41	+1.04	13 34.62	−.02
ε Tauri		+0.36	1.06	22 14.16	−.05
ν Eridani		+0.67	1.00	30 52.18	+.01
Gr. 848		−2.45	4.06	34 05.66	−.29
δ Camelop		−1.14	2.48	43 10.01	+.28
π⁵ Orionis	W.	+0.59	+1.00	48 34.13	+.01

Normal equation, $12\Delta t - 1.56a_w + 1.25a_e + 3.29c + 30^s.30 = 0$.

Adopted $a_w = -0^s.47$, $a_e = -0^s.22$, $c = +0^s.10$.

Chronometer fast $2^s.58$ at $4^h.17$.

[St. Louis, Missouri, April 29, 1890. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
Gr. 1706	E.	−3.168	−4.957	10 49 40.83	.00
χ Leonis		+0.514	1.010	58 58.34	+.02
ρ Leonis		+0.590	1.001	11 00 55.54	+.02
δ³ Leonis	E.	+0.322	−1.072	07 52.92	−.05
τ Leonis	W.	+0.577	+1.001	21 54.06	−.05
λ Draconis		−1.515	2.916	23 25.93	+.01
υ Leonis		+0.627	1.000	30 56.36	−.06
χ Urs. Maj		−0.256	1.506	39 50.43	+.11
β Leonis	W.	+0.412	+1.036	11 42 03.98	+.01

Normal equation, $9\Delta t - 0.155a_w - 1.742a_e - 0.581c - 25^s.09 = 0$

Adopted $a_w = -2^s.213$ $a_e = -2^s.271$ $c = +0^s.341$

Clock slow $24^s.33$ at $11^h.28$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, May 1, 1890. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
λ Draconis	E.	−1.5150	−2.916	11 24 52.56	+.01
υ Leonis		+0.6213	1.000	30 45.45	−.07
χ Urs. Maj		−0.2551	1.506	39 54.82	−.01
β Virginis		+0.5918	1.001	44 25.06	+.10
π Virginis	E.	+0.5251	−1.008	54 42.34	+.04
o Virginis	W.	+0.4958	+1.013	11 59 05.62	−.02
4 Draconis		−3.1255	4.903	12 07 32.52	−.02
20 Comæ		+0.3165	1.075	23 43.94	−.04
24 Comæ		+0.3566	1.058	29 08.42	+.04
δ Virginis	W.	+0.5698	+1.003	12 49 31.99	−.03

Normal equation, $10\Delta t - 1.3878a_w - 0.0319a_e + 1.621c - 220^s.56 = 0$

Adopted $a_w = +15^s.344$ $a_e = +15^s.370$ $c = -0^s.332$

Clock slow $24^s.29$ at $12^h.00$.

[St. Louis, Missouri, May 2, 1890. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
32[2] Camelop	W.	−6.827	+9.591	12 48 05.24	+.01
ε Virginis		+0.464	1.021	56 18.88	−.04
θ Virginis		+0.692	1.004	13 03 52.08	−.01
43 Comæ	W.	+0.202	+1.137	06 21.46	+.05
η Urs. Maj	E.	−0.303	−1.552	18 07.57	−.08
η Bootis		+0.356	1.058	48 04.24	+.02
τ Virginis		+0.596	1.001	55 40.48	+.05
α Draconis		−1.044	2.357	14 01 02.46	+.01
d Bootis	E.	+0.250	−1.109	05 00.31	−.01

Normal equation, $9\Delta t - 5.469a_w - 0.145a_e + 5.676c - 38^s.94 = 0$

Adopted $a_w = -0^s.100$ $a_e = -0^s.997$ $c = +0^s.025$

Clock slow $24^s.23$ at $13^h.30$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, May 16, 1890. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
π Virginis	W.	+0.53	+1.01	11 54 53.45	+.13
o Virginis		+0.50	1.01	59 15.55	+.03
4 H. Draconis		−3.13	4.90	12 06 44.49	−.01
η Virginis		+0.62	1.00	14 55.90	−.05
6 Can. Ven	W.	−0.02	+1.30	20 05.14	−.11
20 Comæ	E.	+0.32	−1.07	12 23 50.17	+.07
κ Draconis		−1.57	2.98	28 25.32	.00
γ Virginis		+0.64	1.00	35 43.61	−.11
31 Com. Ber		+0.21	1.13	45 58.94	−.07
δ Virginis	E.	+0.57	−1.00	12 49 42.35	+.11

Normal equation, $10\Delta t-1.500a_w+0.170a_e+2.040c-22^s.43=0$

Adopted $a_w=-0^s.503$ $a_e=-0^s.490$ $c=-0^s.435$

Clock slow $22^s.26$ at $12^h.36$.

[St. Louis, Missouri, May 16, 1890. After signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
Gr. 2001	E.	−1.93	−3.41	13 22 58.97	+.02
ζ Virginis		+0.62	1.00	28 44.02	+.01
τ Bootis		+0.37	1.05	41 40.84	+.02
η Bootis	E.	+0.36	−1.06	49 05.53	−.04
τ Virginis	W.	+0.60	+1.00	13 55 42.45	−.10
α Draconis		−1.04	2.36	14 01 05.70	−.01
d Bootis		+0.25	1.11	05 02.73	+.08
ι Virginis		+0.70	1.00	09 54.50	−.01
ρ Bootis	W.	+0.16	+1.16	14 26 45.21	+.03

Normal equation, $9\Delta t+0.67a_w-0.58a_e+0.11c-19^s.93=0$

Adopted $a_w=-0^s.460$ $a_e=-0^s.527$ $c=-0^s.410$

Clock slow $22^s.23$ at $13^h.85$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, May 25, 1890. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
4 Draconis	E.	—3.126	—4.90	12 06 49.99	+.01
2 Can. Ven		—0.062	1.33	10 16.32	—.07
η Virginis		+0.624	1.00	13 54.57	+.06
20 Comæ		+0.316	1.07	33 50.45	+.04
24 Comæ	E.	+0.355	—1.06	39 15.30	—.03
31 Com. Ber	W.	+0.206	+1.13	45 00.48	—.10
δ Virginis		+0.570	1.00	49 42.79	+.05
ε Virginis		+0.464	1.02	12 56 21.41	+.02
43 Comæ		+0.202	1.14	13 06 24.58	+.05
Gr. 2001	W.	—1.926	+3.41	22 07.84	—.02

Normal equation, $10\Delta t-0.484a_w-1.888a_e-1.66c-4^s.93=0$

Adopted $a_w=+2^s.270$ $a_e=+2^s.394$ $c=-0^s.406$

Clock slow $20^s.99$ at $12^h.63$.

[St. Louis, Missouri, May 25, 1890. After signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
τ Virginis	W.	+0.596	+1.00	13 55 42.15	—.02
α Draconis		—1.044	2.36	14 00 09.63	—.01
d Bootis		+0.250	1.10	05 03.21	+.01
ρ Bootis	W.	+0.157	+1.17	26 46.00	+.01
ε Bootis	E.	+0.217	—1.13	39 50.44	—.05
109 Virginis		+0.592	1.00	40 19.77	+.07
β Urs. Min		—2.215	3.77	50 49.25	.00
ψ Bootis	E.	+0.220	—1.13	59 23.41	—.01

Normal equation, $8\Delta t-0.041a_w-1.186a_e-1.40c-5^s.65=0$

Adopted $a_w=+2^s.194$ $a_e=+2^s.395$ $c=-0^s.426$

Clock slow $21^s.00$ at $14^h.45$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, May 28, 1890. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. m. s.	*s*
o Virginis	E.	+0.496	−1.01	11 59 14.24	+.01
4 H. Draconis		−3.126	4.90	12 06 54.36	−.01
2 Can. Ven		−0.062	1.04	10 16.87	−.05
η Virginis	E.	+0.024	−1.33	13 54.19	+.06
20 Comæ	W.	+0.317	+1.07	23 51.52	+.12
κ Draconis		−1.571	2.98	28 35.84	−.01
31 Com. Ber		+0.206	1.13	46 00.72	−.11
δ Virginis		+0.570	1.00	49 42.49	+.04
ε Virginis	W.	+0.464	+1.02	56 21.22	−.04

Normal equation, $9\Delta t - 0.014a_w - 2.006a_e - 1.08c - 176^s.70 = 0$

Adopted $a_w = +3^s.725$ $a_e = +3^s.759$ $c = -0^s.440$

Clock slow $20^s.46$ at $12^h.45$.

[St. Louis, Missouri, May 28, 1890. After signals. Observer, Pritchett.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. m. s.	*s.*
θ Virginis	E.	−0.692	−1.00	13 03 53.82	+.01
43 Comæ		+0.202	1.14	06 23.87	+.01
20 Can. Ven		−0.059	1.33	12 17.08	−.02
Gr. 2001	E.	−1.931	−3.41	23 08.14	+.02
α Draconis	W.	−1.044	+2.36	14 01 11.78	+.01
d Bootis		+0.250	1.11	05 03.40	.00
ι Virginis	W.	+0.699	+1.00	09 53.35	−.02

Normal equation, $7\Delta t - 0.095a_w - 1.096a_e - 2.40c - 139^s.62 = 0$

Adopted $a_w = +3^s.745$ $a_e = +3^s.660$ $c = -0^s.436$

Clock slow $20^s.42$ at $13^h.63$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, May 29, 1890. Before signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
κ Draconis	W.	—1. 571	+2. 98	12 28 25. 97	. 00
31 Com. Ber		+0. 206	1. 13	46 02. 23	—. 10
δ Virginis		+0. 570	1. 00	49 46. 31	+. 03
ε Virginis	W.	+0. 464	+1. 02	12 56 24. 45	+. 03
α Virginis	E.	+0. 770	—1. 02	13 19 06. 39	+. 04
Gr. 2001		—1. 931	3. 41	22 55. 70	+. 04
ζ Virginis		+0. 624	1. 00	28 47. 42	+. 04
m Virginis		+0. 735	1. 01	35 32. 77	—. 04
τ Bootis	E.	+0. 371	—1. 05	41 43. 54	—. 05

Normal equation, $9\Delta t - 0.331a_w + 0.569a_e - 1.36c - 182^s.22 = 0$

Adopted $a_w = -2^s.650$ $a_e = -2^s.830$ $c = -0^s.439$

Clock slow $20^s.26$ at $13^h.16$.

[St. Louis, Missouri, May 29, 1890. After signals. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
α Draconis	E.	—1. 044	—2. 36	14 01 02. 89	. 00
α Bootis		+0. 250	1. 11	05 04. 17	+. 01
ι Virginis		+0. 699	1. 00	09 57. 19	. 00
φ Virginis		+0. 648	1. 00	22 14. 43	+. 03
ρ Bootis	E.	+0. 157	—1. 16	26 46. 36	—. 06
π Bootis	W.	+0. 387	+1. 04	35 16. 08	+. 06
μ Virginis		+0. 696	1. 00	36 59. 27	+. 04
109 Virginis		+0. 592	1. 00	40 24. 46	+. 07
ψ Bootis		+0. 220	1. 13	59 26. 22	—. 06
δ Bootis		+0. 102	1. 20	15 10 46. 20	—. 12
1 H. Urs. Min	W.	—1. 290	+2. 65	13 03. 38	—. 01

Normal equation, $11\Delta t + 0.707a_w + 0.710a_e + 1.39c - 108^s.48 = 0$

Adopted $a_w = -2^s.77$ $a_e = -2^s.83$ $c = -0^s.480$

Clock slow $20^s.28$ at $14^h.58$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, June 7, 1890. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
4 Urs. Min.	E.	−3.072	−4.84	14 08 42.62	.00
ρ Bootis		+0.157	1.16	26 47.99	−.10
π Bootis		+0.387	1.05	35 17.42	+.03
109 Virginis		+0.696	1.00	36 01.57	+.03
μ Virginis	E.	+0.592	−1.00	40 26.45	+.04
β Urs. Min	W.	−2.215	+3.77	14 50 36.45	+.01
β Libræ		+0.748	1.01	15 10 52.66	−.04
τ¹ Serpentis		+0.403	1.04	20 26.81	+.05
β Cor. Bor		+0.182	1.15	23 02.03	−.02
α Cor. Bor	W.	+0.224	+1.12	15 29 46.46	−.01

Normal equation, $10\Delta t - 0.658a_w - 1.240a_e - 0.96c - 200^s.53 = 0$

Adopted $a_w = 5^s.820$ $a_e = 5^s.662$ $c = 0^s.569$

Clock slow $18^s.91$ at $14^h.87$.

[St. Louis, Missouri, June 9, 1890. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
τ Virginis	W.	+0.60	+1.00	13 55 46.21	+.04
α Draconis		−1.04	2.36	14 01 12.29	−.01
d Bootis		+0.25	1.11	05 06.80	−.03
ι Virginis		+0.70	1.00	09 58.10	+.08
λ Bootis	W.	−0.20	+1.46	11 57.06	−.10
ρ Bootis	E.	+0.16	−1.16	26 46.57	−.04
π Bootis		+0.39	1.05	35 14.50	.00
109 Virginis		+0.59	1.00	40 22.22	−.01
β Urs. Min.		−2.22	3.77	50 44.43	.00
ψ Bootis		+0.22	1.13	14 59 25.25	−.01
β Libræ	E.	+0.75	−1.01	15 10 46.30	+.06

Normal equation, $11\Delta t + 0.31a_w - 0.11a_e - 2.19c - 207^s.15 = 0$

Adopted $a_w = +0^s.891$ $a_e = +0^s.807$ $c = -1^s.267$

Clock slow $18^s.56$ at $14^h.49$

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, June 10, 1890. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
φ Virginis	E.	+0.648	—1.00	14 22 11.93	—.03
5 Urs. Min		—2.559	4.20	27 40.30	.00
π Bootis		+0.387	1.04	35 14.38	—.02
109 Virginis		+0.592	1.00	40 21.43	+.01
α Libræ		+0.842	1.04	44 26.86	+.06
Pz. XIV, 221	E.	+0.416	—1.04	50 42.67	—.03
β Libræ	W.	+0.748	+1.01	15 10 45.77	—.07
τ Serpentis		+0.403	1.04	20 23.37	+.07
α Cor. Bor		+0.224	1.12	29 44.77	—.01
α Serpentis		+0.531	1.01	38 32.51	—.01
β Serpentis		+0.404	1.04	40 48.71	—.01
μ Serpentis		+0.666	1.00	43 33.77	+.03
ζ Urs. Min	W.	—3.099	+4.87	48 02.21	.00

Normal equation, $13\Delta t - 0.123a_w + 0.326a_e + 1.77c - 237^s.28 = 0$

Adopted $a_w = +4^s.090$ $a_e = +4^s.079$ $c = -0^s.453$

Clock slow $18^s.25$ at $15^h.12$.

[St. Louis, Missouri, June 11, 1890. Observer, Pritchett.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
γ^2 Urs. Min	W.	—1.82	+3.28	15 20 41.50	+.03
β Cor. Bor		+0.18	1.15	22 01.64	—.07
α Cor. Bor		+0.22	1.12	29 49.95	+.05
α Serpentis		+0.53	1.01	38 34.97	+.02
β Serpentis	W.	+0.40	+1.04	40 50.67	+.06
μ Serpentis	E.	+0.67	—1.00	43 35.90	—.04
ε Serpentis		+0.56	1.00	45 03.11	+.01
ζ Urs. Min		—3.10	4.87	47 45.14	—.02
ε Cor. Bor		+0.22	1.12	52 45.12	—.09
δ Ophhiuchi		+0.67	1.00	16 08 18.08	—.02
λ Herculis	E.	+0.35	—1.06	16 47.33	+.06

Normal equation, $11\Delta t - 0.49a_w - 0.63a_e - 2.45c - 89^s.25 = 0$

Adopted $a_w = -0^s.126$ $a_e = -0^s.128$ $c = -0^s.403$

Clock slow $18^s.01$ at $15^h.73$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, April 29, 1890. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
Gr. 1706	W.	−3.17	+4.97	10 51 17.07	+.04
χ Leonis		+0.51	1.01	59 31.96	+.04
p Leonis		+0.59	1.00	11 01 29.07	−.06
δ³ Leonis	W.	+0.32	+1.07	08 26.55	−.03
τ Leonis	E.	+0.58	−1.00	22 26.61	−.06
λ Draconis		−1.52	2.92	24 56.90	−.06
ν Leonis		+0.63	1.00	31 28.97	−.02
χ Urs. Maj		−0.26	1.51	40 22.46	+.06
β Leonis	E.	+0.41	−1.04	43 36.56	+.11

Normal equation, $9\Delta t - 1.91a + 0.58c + 73^s.66 = 0$

Adopted $a_w = -2^s.43$ $a_e = 2^s.43$ $c = -0^s.89$

Chronometer fast $8^s.64$ at $11^h.29$.

[St. Louis, Missouri, May 1, 1890. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
λ Draconis	W.	−1.52	+2.92	11 25 11.39	+.08
ν Leonis		+0.63	1.00	31 32.83	+.01
χ Urs. Maj		−0.26	1.51	40 29.90	−.04
β Virginis		+0.59	1.00	45 11.86	+.03
π Virginis	W.	+0.52	+1.01	55 28.14	−.03
o Virginis	E.	+0.50	−1.01	59 47.48	−.12
4 Draconis		−3.10	4.91	12 07 12.99	−.01
20 Comæ		+0.32	1.08	24 23.11	−.01
24 Comæ		+0.36	1.06	29 48.19	+.06
δ Virginis	E.	+0.57	−1.00	50 15.14	+.03

Normal equation, $10\Delta t - 0.04a_w - 1.35a_e - 1.62c + 117^s.75 = 0$

Adopted $a_w = +0^s.43$ $a_e = +0^s.26$ $c = -1^s.43$

Chronometer fast $11^s.97$ at $12^h.02$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, May 2, 1890. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
20 Comæ	W.	+0.32	+1.08	12 24 26.61	—.03
κ Draconis		—1.57	2.98	29 05.57	—.01
ε Virginis		+0.46	1.02	56 56.92	+.01
θ Virginis		+0.69	1.00	13 4 29.92	.00
43 Comæ	W.	+0.20	+1.14	6 59.62	.00
ζ Urs. Maj	E.	—0.51	—1.77	19 45.45	—.11
η Bootis		+0.36	1.06	49 41.57	.00
τ Virginis		+0.60	1.00	56 17.46	+.02
α Draconis		—1.04	2.36	14 01 41.64	+.13
d Bootis	E.	+0.25	—1.11	05 37.79	—.02

Normal equation, $10\Delta t+0.10a_w-0.34a_e-0.08c+8^s.68=0$

Adopted $a_w=+0^s.61$ $a_e=+0^s.43$ $c=-0^s.20$

Chronometer fast $13^s.86$ at $13^h.32$.

[St. Louis, Missouri, June 7, 1890. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
4 Urs. Min	W.	—3.07	+4.84	14 10 06.92	.00
ρ Bootis		+0.16	1.16	27 48.58	+.21
π Bootis, pr		+0.39	1.05	36 16.14	+.03
μ Virginis		+0.70	1.00	37 58.15	—.09
109 Virginis	W.	+0.59	+1.00	41 23.63	—.16
β Urs. Min	E.	—2.22	—3.77	51 49.30	.00
β Libræ		+0.75	1.01	15 11 47.42	—.10
τ[1] Serpentis		+0.40	1.04	21 24.02	+.09
β Cor. Bor		+0.18	1.15	24 00.55	—.11
α Cor. Bor	E.	+0.22	—1.12	30 44.92	+.10

Normal equation, $10\Delta t-1.23a_w-0.67a_e+0.96c-18^s.14=0$

Adopted $a_w=+0^s.77$ $a_e=+1^s.02$ $c=-0^s.048$

Chronometer fast $41^s.65$ at $14^h.89$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, June 9, 1890. Observer, Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
ε Bootis	W.	+0.35	+1.06	13 50 10.31	—.06
τ Virginis		+0.60	1.00	56 46.36	.00
α Draconis		—1.04	2.36	14 02 09.59	—.05
d Bootis		+0.25	1.11	06 06.69	+.07
ι Virginis		+0.70	1.00	10 58.24	—.03
λ Bootis	W.	—0.20	+1.46	12 56.25	+.05
ρ Bootis	E.	+0.16	—1.16	27 48.84	—.25
π Boots, pr		+0.39	1.04	36 17.11	+.14
109 Virginis		—0.59	1.00	41 24.87	+.11
β Urs. Maj		—2.22	3.77	51 48.74	.00
ψ Bootis		+0.22	1.13	15 00 27.70	—.02
β Libræ	E.	+0.75	—1.01	11 48.89	+.02

Normal equation, $12\Delta t+0.66a_w-0.11a_e-1.12c+4^s.77=0$

Adopted $a_w=+0^s.173$ $a_e=+0^s.239$ $c=-0^s.047$

Chronometer fast $42^s.41$ at $14^h.43$.

[St. Louis, Missouri, June 10, 1890. Observer Woodward.]

Name of star.	Clamp.	A	C	t	v
				h. m. s.	s.
φ Virginis	W.	+0.65	+1.00	14 23 16.01	—.02
5 Urs. Min.		—2.56	4.20	28 33.32	.00
π Bootis, pr		+0.39	1.05	36 17.46	.00
109 Virginis		+0.59	1.00	41 25.26	—.01
α² Libræ		+0.84	1.04	45 31.61	—.05
Pz. XIV, 221	W.	+0.42	+1.04	51 45.96	+.10
β Libræ	E.	+0.75	—1.01	15 11 49.10	—.07
τ Serpentis		+0.40	1.04	21 25.39	+.12
β Cor. Bor		+0.18	1.15	24 01.85	+.05
α Cor. Bor		+0.22	1.12	30 45.91	—.08
β Serpentis		+0.40	1.04	41 50.70	+.01
μ Serpentis		+0.67	1.00	44 36.71	—.04
ζ Urs. Min	E.	—3.10	—4.87	48 48.32	.00

Normal equation, $13\Delta t+0.33a_w-0.48a_e-1.90c+8^s.87=0$

Adopted $a_w=+0^s.089$ $a_e=+0^s.161$ $c=-0^s.093$

Chronometer fast $42^s.69$ at $15^h.12$.

TABLE III.—*Details of time work*—Continued.

[St. Louis, Missouri, June 11, 1890. Observer, Woodward.]

Name of star.	Clamp.	*A*	*C*	*t*	*v*
				h. m. s.	s.
γ^2 Urs. Min	W.	−1.82	+3.28	15 21 41.60	−.02
β Cor. Bor		+0.18	1.15	24 02.27	−.02
α Cor. Bor		+0.22	1.12	30 46.43	−.04
α Serpentis		+0.53	1.01	39 35.57	+.06
β Serpentis	W.	+0.40	+1.04	41 51.23	+.04
μ Serpentis	E.	+0.67	−1.00	44 37.07	+.01
ε Serpentis		+0.56	1.00	46 04.26	.00
ζ Urs. Min		−3.10	4.87	48 48.41	−.01
ε Cor. Bor		+0.22	1.12	53 46.48	.00
δ Ophiuchi		+0.67	1.00	16 09 19.18	−.04
γ Herculis	E.	+0.35	−1.06	17 48.46	−.02

Normal equation, $11\Delta t - 0.49a_w - 0.63a_e - 2.45c + 10^s.30 = 0$

Adopted $a_w = 0^s.00$ $a_e = +0^s.111$ $c = -0^s.084$

Chronometer fast $42^s.95$ at $15^h.76$.

7. *Time-piece corrections and rates.*—Collecting the clock corrections and their epochs from the preceding tables and computing the hourly rates from the differences of the corrections and epochs, there results the following Table IV:

TABLE IV.—*Time-piece corrections, epochs, rates, etc.*

Station.	Date.	Chronometer correction.	Epoch.	Hourly rate of time-piece.	Chronometer by Bond & Sons.
	1889.	*s.*	*h.*	*s.*	
Spearville, Kansas	Oct. 27	—39.23	21.41		187
		—39.24	22.87	—0.003	
	28	—39.49	21.41		
		—39.57	22.81	—0.057	
	Nov. 2	—41.67	21.93		
		—41.64	23.26	+0.023	
Boisé City, Idaho	15	—36.77	22.40		
		—36.68	24.35	+0.051	
	23	—40.98	22.52		
		—40.95	24.57	+0.015	
	24	—40.82	22.91		
		—40.74	24.51	+0.050	
Cisco, Texas	Dec. 8	+ 0.62	0.08		
		+ 0.54	2.17	—0.038	
	10	— 2.17	0.39		
		— 2.38	2.03	—0.134	
	11	— 3.03	0.53		
		— 3.27	2.41	—0.128	
St. Louis, Missouri	18	— 2.24	0.83		
		— 2.32	5.24	—0.018	
	19	— 2.55	2.20		
		— 2.58	4.17	—0.015	
	1890.				
	Apr. 29	— 8.64	11.29		
	May 1	—11.97	12.02		
	2	—13.86	13.32		
Sierra Blanca, Texas	16	—10.07	11.25		
		—10.08	12.91	+0.006	
	25	—17.31	11.38		
		—17.38	13.36	+0.035	
	28	—18.64	11.41		
		—18.72	13.33	+0.042	
	29	—19.31	11.79		
		—19.43	13.36	+0.076	
St. Louis, Missouri	June 7	—41.65	14.89		
	9	—42.41	14.43		
	10	—42.69	15.12		
	11	—42.95	15.76		

TABLE IV.—*Time-piece corrections, epochs, rates, etc.*—Continued.

Station.	Date.	Clock correction.	Epoch.	Hourly rate of time-piece.	Clock by Howard.
	1889.	*s.*	*h.*	*s.*	
St. Louis, Missouri	Oct 27	—389.91	22.32		214
		—390.05	23.67	—0.104	
	28	—391.83	22.32		
		—392.05	23.62	—0.169	
	Nov. 2	—400.56	22.87		
		—400.63	24.18	—0.053	
	15	+ 14.41	0.27		
		+ 14.34	1.93	—0.041	
	23	+ 14.23	0.46		
		+ 14.18	2.08	—0.030	
	25	+ 14.18	22.97		
		+ 14.32	3.18	+0.046	
	Dec. 8	+ 15.50	0.92		
		+ 15.48	3.08	—0.010	
	10	+ 15.49	1.04		
		+ 15.40	2.64	—0.051	
	11	+ 15.51	1.32		
		+ 15.60	2.64	+0.069	
	18	+ 15.59	0.83		
		+ 15.68	5.26	+0.020	
	19	+ 15.51	2.09		
		+ 15.57	4.15	+0.029	
	1890.				
	Apr. 29	+ 24.33	11.28		
	May 1	+ 24.29	12.00		
	2	+ 24.23	13.30		
	16	+ 22.26	12.36		
		+ 22.23	13.85	—0.020	
	25	+ 20.99	12.63		
		+ 21.00	14.45	—0.006	
	28	+ 20.45	12.45		
		+ 20.42	13.63	—0.026	
	29	+ 20.26	13.16		
		+ 20.28	14.58	+0.014	
	June 7	+ 18.91	14.87		
	9	+ 18.56	14.49		
	10	+ 18.25	15.12		
	11	+ 18.01	15.73		

(8) *Record of clock comparisons and apparent differences of longitude.*—In comparing time-pieces both automatic and arbitrary signals were exchanged. In general the comparisons were derived from the mean of the arbitrary signals so selected as to give a nearly symmetrical distribution throughout a whole minute and throughout one revolution of the chronograph cylinder. A like distribution of automatic signals, when equally legible, gave the same result. The records of these comparisons and the apparent differences of longitude of the field stations and St. Louis are given in Table V, and the corresponding data for the personal equation work are given in Table VI.

TABLE V.—*Apparent differences of longitude.*

[Results for differences from arbitrary signals made at field station.]

Field station.	Date.	Mean difference of clock-face times.	Number of signals.	St. Louis clock correction.	Field chronometer correction.	Field station west of St. Louis.
	1889.	*h. m. s.*		*m. s.*	*s.*	*h. m. s.*
Spearville, Kansas	Oct. 27	0 44 02.23	25	−6 29.99	−39.24	0 38 11.48
	28	03.68	25	−6 31.95	−39.54	11.28
	Nov. 2	10.45	30	−6 40.59	−41.65	11.51
Boisé City, Idaho	15	1 43 12.01	19	+ 14.36	−36.71	1 44 03.08
	23	07.97	21	+ 14.20	−40.96	03.13
	24	08.11	15	+ 14.22	−40.78	03.11
Cisco, Texas	Dec. 8	0 34 51.54	22	+ 15.49	+00.56	35 06.47
	10	48.72	11	+ 15.44	−02.31	06.47
	11	47.78	19	+ 15.57	−03.16	06.51
	1890.					
Sierra Blanca, Texas	May 16	0 60 04.15	13	+ 22.24	−10.08	1 00 36.47
	25	59 58.11	15	+ 20.99	−17.36	36.46
	28	59 57.32	8	+ 20.44	−18.70	36.46
	29	59 56.80	11	+ 20.27	−19.39	36.46

[Results for differences from arbitrary signals made at St. Louis.]

Field station.	Date.	Mean difference of clock-face times.	Number of signals.	St. Louis clock correction.	Field chronometer correction.	Field station west of St. Louis.
	1889.					
Spearville, Kansas	Oct. 27	0 44 02.10	12	−6 29.98	−39.24	0 38 11.36
	28	03.57	21	−6 31.94	−39.54	11.18
	Nov. 2	10.33	23	−6 40.59	−41.65	11.39
Boisé City, Idaho	15	1 43 11.72	23	+ 14.36	−36.71	1 44 02.79
	23	07.70	26	+ 14.20	−40.96	02.86
	24	07.84	16	+ 14.22	−40.78	02.84
Cisco, Texas	Dec. 8	0 34 51.39	29	+ 15.49	+00.56	0 35 06.32
	10	48.59	24	+ 15.44	−02.30	06.33
	11	47.64	18	+ 15.56	−03.16	06.36
	1890.					
Sierra Blanca, Texas	May 16	0 60 03.91	15	+ 22.24	−10.08	1 00 36.23
	25	59 57.82	13	+ 20.99	−17.36	36.17
	28	59 57.00	11	+ 20.44	−18.70	36.14
	29	59 56.52	7	+ 20.27	−19.39	36.18

TABLE VI.—*Apparent differences of longitude. Personal equation work at St. Louis.*

[From record of Geological Survey chronograph.]

Date.	Mean difference of clock-face times.	Number of signals.	St. Louis clock correction.	Field chronometer correction.	Δλ
1889.	*s.*		*s.*	*s.*	*s.*
Dec. 18	17.97	21	+15.57	— 2.22	0.18
	18.00	17	+15.59	— 2.24	.17
	18.01	13	+15.61	— 2.25	.15
	18.06	18	+15.66	— 2.30	.10
	18.06	15	+15.68	— 2.32	.06
	18.06	18	+15.70	— 2.34	.04
19	18.25	5	+15.49	— 2.54	.22
	18.25	5	+15.51	— 2.55	.19
	18.26	5	+15.53	— 2.56	.17
	18.28	5	+15.55	— 2.57	.16
	18.28	5	+15.57	— 2.58	.13
	18.29	5	+15.59	— 2.59	.11
1890.					
Apr. 29	33.23	10	+24.33	— 8.63	.27
May 1	36.44	10	+24.29	—11.97	.18
2	38.17	15	+24.23	—13.88	.06
June 7	60.83	15	+18.91	—41.65	.27
9	61.13	15	+18.56	—42.41	.16
10	61.16	15	+18.25	—42.69	.22
11	61.10	15	+18.01	—42.95	.14

[From record of Prof. Pritchett's chronograph.]

1889.					
Dec. 18	17.99	9	+15.57	— 2.22	0.20
	18.00	9	+15.59	— 2.24	.17
	18.00	13	+15.61	— 2.25	.14
	18.07	16	+15.66	— 2.30	.11
	18.07	11	+15.68	— 2.32	.07
	18.08	17	+15.70	— 2.34	.04
19	18.24	5	+15.49	— 2.54	.21
	18.22	5	+15.51	— 2.55	.16
	18.25	5	+15.53	— 2.56	.16
	18.28	5	+15.55	— 2.57	.16
	18.28	5	+15.53	— 2.58	.13
	18.28	5	+15.55	— 2.59	.10
1890.					
Apr. 29	33.21	10	+24.33	— 8.63	.25
May 1	36.42	10	+24.29	—11.97	.16
2	38.17	15	+24.23	—13.88	.06
June 7	60.81	15	+18.91	—41.65	.25
9	61.11	15	+18.56	—42.41	.14
10	61.16	15	+18.25	—42.69	.22
11	61.10	15	+18.01	—42.95	.14

(9) *Longitude differences uncorrected for personal and instrumental equation.*—Calling the result for a longitude difference from the record of the western observer's chronograph $\varDelta\lambda_1$, and the corresponding result from the eastern observer's chronograph $\varDelta\lambda_2$, we get the following table of results for longitude differences and transmission times:

TABLE VII.—*Approximate results for longitude differences and transmission times.*

Station.	Date.	$\Delta\lambda_1$	$\Delta\lambda_2$	$\frac{1}{2}(\Delta\lambda_2+\Delta\lambda_1)$	$\frac{1}{2}(\Delta\lambda_2-\Delta\lambda_1)$
	1889.	*h. m. s.*	*h. m. s.*	*h. m. s.*	*s.*
Spearville, Kansas	Oct. 27	0 38 11.36	0 38 11.48	0 38 11.420	0.060
	28	11.18	11.28	.230	.050
	Nov. 2	11.39	11.51	.450	.060
Boisé City, Idaho.........	Nov. 15	1 44 02.79	1 44 03.08	1 44 02.935	0.145
	22	02.86	03.13	.995	.135
	24	02.84	03.11	.975	.135
Cisco, Texas	Dec. 8	0 35 06.32	0 35 06.47	0 35 06.385	0.075
	10	06.33	06.47	.400	.070
	11	06.36	06.51	.435	.075
	1890.				
Sierra Blanca, Texas.....	May 16	1 00 36.23	1 00 36.47	1 00 36.350	0.120
	25	36.17	36.46	.320	.145
	28	36.14	36.46	.300	.160
	29	36.18	36.46	.320	.140

The values of $\frac{1}{2}(\varDelta\lambda_1+\varDelta\lambda_2)$ in the preceding table give a series of observation equations of the form

$$\varDelta\lambda-\tfrac{1}{2}(\varDelta\lambda_1+\varDelta\lambda_2)=v.$$

Denoting the values of $\varDelta\lambda$ for the several stations by accents we find the following equations:

Observation equations for the quantities $\varDelta\lambda$.

Station.	Date.	Equation.	Residual.	Weight.
	1889.	*h. m. s.*	*s.*	
Spearville, Kansas	Oct. 27	$1\Delta\lambda^{i}$ −0 38 11.420	−0.053	1
	28	1 .230	+0.137	1
	Nov. 2	1 .450	−0.083	1
Boisé City, Idaho	15	$1\Delta\lambda^{ii}$ −1 44 02.935	+0.031	1
	23	1 .995	−0.029	0.2
	24	1 .975	−0.009	1
Cisco, Texas	Dec. 8	$1\Delta\lambda^{iii}$ −0 35 06.385	+0.016	1
	10	1 .400	+0.001	1
	11	1 .435	−0.034	0.5
	1890.			
Sierra Blanca, Texas.......	May 16	$1\Delta\lambda^{iv}$ −1 00 36.350	+0.028	1
	25	1 .320	−0.002	1
	28	1 .300	−0.022	1
	29	1 .320	−0.002	1

The result of November 23 for Boisé City is given a weight of 0.2 for the reason that no time observations were made at St. Louis on that date, the clock correction being interpolated from observations of November 22 and 24. Likewise, the result of December 11 for Cisco is given half weight for the reason that the time determinations both at St. Louis and Cisco were imperfect (on account of cloudiness) after exchange of signals on that date.

Since the results for the first three stations were obtained under similar circumstances, and will have the same correction for personal equation applied to them, we shall treat the first nine of the above equations as one group and the last four as another group. There result, therefore,

$$\begin{aligned} & \quad\ \ {}^{h}\ \ {}^{m}\ \ \ {}^{s}\qquad\quad {}^{s} \\ \varDelta\lambda^{i} &= 0\ 38\ 11.367 \pm 0.028, \\ \varDelta\lambda^{ii} &= 1\ 44\ 02.966 \pm 0.033, \\ \varDelta\lambda^{iii} &= 0\ 35\ 06.401 \pm 0.031, \\ \varDelta\lambda^{iv} &= 1\ 00\ 36.322 \pm 0.007. \end{aligned}$$

(10) *Corrections for personal and instrumental equation*, 1889.—As stated in section (6), the observations for personal equation were made in the same way as those for longitude. In the work of 1889, however, six comparisons of the time-pieces were made on each of the dates of observation instead of one, as is usual in the longitude work. These comparisons were made at the beginning of each of the two time determinations, at the epoch of each reversal, and at the end of each determination. The earlier and later of such comparisons have less weight than those made near the mean of the epochs of the two clock corrections; and since the rates of the time-pieces are obtained by dividing the difference of the clock corrections by the difference of their epochs, the early and late comparisons will show in an exaggerated form any change in personal equation which may occur. But since the personal equation is the unknown quantity sought, we have considered the clock corrections as fallible quantities giving rise to discrepant values of the personal equation. If we call $\varDelta t^{i}$ and t^{i} the clock correction and epoch respectively from the first time determination, and denote by $\varDelta t^{ii}$ and t^{ii} the corresponding quantities from the second determination, the correction to either time-piece at the time $t+t^{i}$ is of the form

$$(1-m)\varDelta t^{i} + m\varDelta t^{ii}, \qquad (a)$$

in which

$$m=\frac{\tau}{t^{ii}-t^{i}};$$

and if t is the time of comparison,

$$\tau = t - t^{i}.$$

Assuming the probable errors of $\varDelta t^{i}$ and $\varDelta t^{ii}$ equal, the weight of the above correction is proportional to

$$(1-2m+2m^{2})^{-1}. \qquad (b)$$

A result for personal equation, or $\frac{1}{2}(\Delta\lambda_1+\lambda_2)$ involves the difference of two corrections of the form (*a*), but since the values of *m* are nearly identical in the two, weights may be computed from (*b*). The following table gives the results for personal equation, together with their weights and the data on which the latter depend:

Results for personal equation of 1889.

Date.	$t^{ii}-t^{i}$	t	m	Weight.	Result $\frac{1}{2}(\Delta\lambda_1+\Delta\lambda_2)$.	Weighted mean.
1889.	*h.*	*h.*			*s.*	*s.*
Dec. 18	4.42	−1.16	−0.262	0.60	0.190	
18		−0.23	−0.005	0.99	.170	
18		+0.77	+0.174	1.40	.145	
18		+3.47	+0.785	1.51	.105	
18		+4.20	+0.950	1.11	.065	
18		+5.35	+1.210	0.66	.040	0.119
19		−0.79	−0.392	0.47	0.215	
19		+0.04	+0.020	1.04	.175	
19		+0.64	+0.317	1.76	.165	
19		+1.38	+0.683	1.76	.160	
19		+2.11	+1.049	0.91	.130	
19		+2.74	+1.356	0.51	.105	0.159

The results from the individual comparisons indicate a progressive decrease of the equation on both dates. A decrease is no doubt real in each case, but its apparent progressive character is due to the linear function used in computing the clock corrections rather than to any such systematic change in the equation itself. It would appear that the early and late comparisons were of little value except to show that the rates attributed to the time-pieces are not the real rates. The two weighted mean values, however, differ immaterially from the values which would have resulted from single comparisons at times falling midway between the epochs of the clock corrections.

Taking the half sum of the two weighted means in the table and computing a probable error from their difference, we have

$$0^s.139 \pm 0^s.013.$$

Prof. Pritchett's transit during this personal equation work was west of Woodward's 4.2 feet, or $0^s.004$. This diminishes the above result to

$$0^s.135 \pm 0^s.013.$$

In view of the previous and subsequent experience of the same observers in determining their relative equation, it would appear that the probable error just given is too small. As explained below, the mean of seven results, obtained on as many different dates in 1890, shows a probable error of $\pm 0^s.021$. It is evident that the mean of the more consistent though smaller number of results of 1889 should not have a less probable error. Hence we adopt as the value applicable to the work for 1889

$$0^s.135 \pm 0^s.021.$$

This correction will be applied to $\Delta\lambda^{i}$, $\Delta\lambda^{ii}$, and $\Delta\lambda^{iii}$ given in section (9) above. It means that Pritchett observes the transit of a star later than Woodward, and hence the longitude differences are to be increased by this amount.

(11) *Correction for personal and instrumental equation*, 1890.—In the personal equation work of 1890, applicable to the apparent longitude difference of St. Louis and Sierra Blanca, Texas, or $\Delta\lambda^{iv}$, given in section (9) above, but one time determination and one comparison of timepieces were made on any date. Observations were made at St. Louis on April 29, May 1, and May 2, before going to Sierra Blanca, and on June 7, 9, 10, and 11, after returning from that station. The results derived from Table III are given below:

Results for personal equation of 1890.

Date.	Result.	Correction for position of piers.	Corrected result.
1890.	*s.*	*s.*	*s.*
Apr. 29	0.26	+0.004	0.264
May 1	0.17	+0.004	0.174
2	0.06	+0.004	0.064
June 7	0.26	−0.004	0.256
9	0.15	−0.004	0.146
10	0.22	−0.004	0.216
11	0.14	−0.004	0.136

The piers used in this personal equation work were 4.2 feet or $0^s.004$ apart. Pritchett was east of Woodward on the first three dates and west of him on the last four dates. Hence the corrections given in the third column of the table above.

Assigning equal weights to the results in this table, the mean of the first three values in the last column, or the mean value of the equation before the exchanges for the longitude of Sierra Blanca, is $0^s.167$. Likewise the mean of the last four corrected results, or the mean value of the equation after the longitude exchanges, is $0^s.188$. The half sum of these two values, or $0^s.178$, was applied to $\Delta\lambda^{iv}$ of section (9) above in deriving the longitude of Sierra Blanca for the purpose of fixing the one hundred and fifth meridian. It would have been better, perhaps, to have used the mean of all the corrected results. This mean is $0^s.179 \pm 0^s.021$. It differs immaterially from the applied value, but its probable error derived from the discrepancies between the seven individual results and their mean, appears to be the best index of the precision of the applied value. Hence we adopt for the personal equation correction to be added to the longitude difference of St. Louis and Sierra Blanca, or $\Delta\lambda^{iv}$ of section (9),

$$0^s.178 \pm 0^s.021.$$

(12) *Arrangement of telegraphic circuits, transmission times, and instrumental equation.*—The routes of the telegraphic circuits used and their approximate lengths are as follows:

	Miles.
St. Louis to Spearville, Kansas, via Kansas City, Missouri	640
St. Louis to Boisé City, Idaho, via Omaha, Nebraska, and Ogden, Utah	1,950
St. Louis to Cisco, Texas, via Pine Bluff, Arkansas, and Dallas, Texas	860
St. Louis to Sierra Blanca, Texas, via Cairo, Illinois, Pine Bluff and Texarkana, Arkansas, and Sherman and Dallas, Texas	1,344

In the first of these circuits there were repeaters at Kansas City, and Nickerson, Kansas; in the second there were repeaters at Omaha, Nebraska, and at Ogden, Utah; in the third there were repeaters at Pine Bluff, Arkansas, and at Dallas, Texas; in the fourth at Pine Bluff, Arkansas, at Dallas, Texas, and at Big Springs, Texas.

Taking means of the transmission times given in Table VII, we have the following table of results:

Transmission times, lengths of circuits, etc.

Field station.	Average transmission time.	Number of repeaters used.	Approximate total length of telegraph line.
	s.		*Miles.*
Spearville, Kansas	0.067	2	640
Boisé City, Idaho	0.138	2	1,950
Cisco, Texas	0.073	2	860
Sierra Blanca, Texas	0.141	3	1,344

In all cases the transmission times given above involve the action times of three relays in addition to the action times of the repeaters. These relays are the clock relay, which repeats to the chronograph circuit; the main line relay, which also repeats to the chronograph circuit, and the chronograph relay. The electric apparatus used by Prof. Pritchett differed from that used by the field observer only in the chronograph relay and in the transit key. Whatever difference these may have produced should appear in the correction for personal equation given in sections (10) and (11) above.

(13) *Adopted longitudes.*—Applying the corrections for personal and instrumental equation given in sections (10) and (11), namely, $+0^s.135 \pm 0^s.021$ for 1889, and $+0^s.178 \pm 0^s.021$ for 1890, we have for the longitudes of the several field stations relative to the pier used at Washington University, St. Louis, Missouri:

	West of St. Louis.			
	h.	*m.*	*s.*	*s.*
Spearville, Kansas	0	38	11.502	±0.035
Boisé City, Idaho	1	44	03.101	±0.039
Cisco, Texas	0	35	06.536	±0.037
Sierra Blanca, Texas	1	00	36,500	±0.022

The longitude relative to Greenwich of the pier at St. Louis, used from 1881 to 1884, has been determined by the U. S. Coast and Geodetic Survey. Its adjusted value, given on page 423 of the report of that Survey for 1884, is

$$6^h\ 00^m\ 49^s.163.$$

The pier used in 1889 is 6 feet or $0^s.005$ west of this position, while the pier occupied during the longitude exchanges in 1890 is $0^s.001$ west of this position. Hence, to get longitudes with respect to Greenwich, we must add to the first three of the above differences $6^h\ 00^m\ 49^s.168$, and to the last $6^h\ 00^m\ 49^s.164$. Applying these values, we have—

	West of Greenwich.		
	h.	*m.*	*s.*
Spearville, Kansas	6	39	00.670
Boisé City, Idaho	7	44	52.269
Cisco, Texas	6	35	55.704
Sierra Blanca, Texas	7	01	25.668

(14) *Geographical positions of piers.*—Collecting the weighted mean latitudes of the observing piers given in Table II, and converting the longitudes just derived into arc, we have the following table of definitive values:

TABLE VIII.—*Geographical positions of piers.*

Station.	Latitude.			Longitude.		
	°	′	″	°	′	″
Spearville, Kansas	37	59	06.34	99	45	10.05
Boisé City, Idaho	43	35	57.98	116	13	04.04
Cisco, Texas	32	23	31.45	98	58	55.56
Sierra Blanca, Texas	31	10	27.64	105	21	24.96

FIXATION OF THE ONE HUNDRED AND FIFTH MERIDIAN IN EL PASO COUNTY, TEXAS.

(15) The intersection of the one hundred and fifth meridian of longitude with the Rio Grande determines the common corner of El Paso, Jeff Davis, and Presidio Counties, Texas. The position of this meridian was not known, except within rather wide limits of error, prior to the determination of the longitude of Sierra Blanca. After the first night of longitude work at this station the observing pier was found to be about twenty-one miles west of the meridian. The method which the nature of the country suggested as most practicable and accurate for measuring this distance was that of triangulation. From their junction at Sierra Blanca, the Texas and Pacific and Southern Pacific Railways run toward the southeast along a level valley furnishing many suitable sites for base-lines, and very favorably flanked by mesas and mountains available for triangulation stations. Accordingly, the method of triangulation was adopted.

As already stated, the details of this work were carried out chiefly by Mr. A. P. Davis. It is proper to state, also, in this connection that very substantial aid was rendered us by Prof. W. von Streeruwitz, of the Texas Geological Survey. Engaged in geological and topographical work in the same vicinity, he placed his assistants and camp outfit at our disposal and thus solved for us the serious problem in this region, especially destitute of water, of subsistence and transportation. During the previous winter in connection with his topographic work, Prof. Streeruwitz had measured in the same valley a base-line about four miles long (6,400.70 meters) with the secondary apparatus of the U. S. Coast and Geodetic Survey. This line, which was connected with our triangulation, served as a valuable check on the correctness of our work.

(16) *Measurement and length of base-line.*—The site selected for a base-line was a nearly level and straight portion of the Texas and Pacific Railway, extending from Sierra Blanca to Arispe, a station or section house about five miles east. On the south side of and 80.5 feet perpendicularly from the south rail of the main track at Arispe, an iron rod about two inches in diameter and two and one-half feet long was driven into the ground so that its upper end was a few inches below the surface of the ground. This rod marks the east end of the base and is called Arispe. The measurement of the base was made along the south rail of the main track from the point on this rail defined above to the point of intersection of the rail with the meridian through the center of the transit instrument at Sierra Blanca. This center is defined by a small hole drilled into the top of the capstone of the pier. This hole marks the west end of the base and is called Pier. The distance along the meridian from Pier to the west end of the line measured on the railway track is 296.84 feet, the pier being south of the track. The angle at the Pier between true north and Arispe is $108^{\circ} 30' 06''.6$, determined in a way explained below.

The length of the line between the two points on the railway track defined above was measured with a 100-foot Chesterman steel tape, U. S. G. S. No. 5. The measurement was made during the night of June 1, 1890. For very efficient aid rendered in this measurement the Survey is indebted to Prof. W. von Streeruwitz and his assistant, Mr. Taff of the Texas Geological Survey, and to Mr. Otto Peterler of the engineer staff of the Southern Pacific Railway.

The tape was stretched on the surface of the rails with a tension of 16 pounds, maintained by means of a spring-balance. The rear end of the tape was carried by Mr. Taff, who, with the assistance of Mr. Peterler, brought the 100-foot graduation of the tape into coincidence with the successive marks made on the rails at the front end. The front end was carried by Mr. Davis, who kept the tape at the standard tension. The position of the front end of the tape for a few tape lengths was marked on the rail by Prof. Streeruwitz with a cold-chisel. Although this method is a good one it failed in this instance for want of a sufficiently hard chisel. For the remainder and greater portion of the line the front end of the tape was marked by the writer with a sharp file. This method gives a well-defined mark and is more expeditious than the former, but is perhaps not quite so precise. Pins were used as in ordinary chaining to indicate the positions of the marks on the rails, and the count of the tape lengths was kept independently by three different persons. The time required in the measurement was about five hours.

The temperature of the tape was assumed to be the same as that of the rails on which it lay in close contact. To determine this temperature a thermometer was placed on the rail at the end of every ten stretches of the tape. Care was taken to bring the bulb of the thermometer into metallic contact with the rail so that it might commnicate its temperature to the bulb by the relatively rapid process of conduction. The observations showed that the measurement was begun somewhat too early in the evening (about 8 o'clock local time) for the most advantageous temperature conditions, since the temperature fell from 85° to 67° F. during the time of the first hundred stretches of the tape, and remained nearly stationary thereafter. The observed temperatures ranged from 85° F. to 61° F., the average being 68° F.

The whole distance measured was 244 tape lengths plus 8.833 feet. A tape length as here used is the distance between the 2-inch mark and the 100-foot mark of this tape when lying on a horizontal support and under a stress of 16 pounds.

The length of this space on the tape was determined by comparisons with a 300-foot steel tape of the Missouri River Commission. For this valuable courtesy the Survey is indebted to Lieut. J. C. Sanford, Corps of Engineers, U. S. Army, secretary of that Commission, and to his assistant engineers, O. B. Wheeler and G. A. Marr, who made the comparisons. The tapes were stretched in the basement of the exposition building at St. Louis, June 7, 1890. They were held up about fifteen inches above the floor on nearly frictionless supports which were placed at intervals of 33 feet along the length of the tape. The tapes were placed on the supports successively and were free to sag between supports. Temperatures were observed by three thermometers placed at intervals along the tape. The two comparisons, which differed by only 0.02 inch, gave in mean the equation—

$$3\times 100\text{-foot tape at } 70.4^\circ \text{ F.} = 300\text{-foot tape} + 0.28 \text{ inch at } 70.6^\circ \text{ F.}$$

The length assigned by the Missouri River Commission to the 300-foot tape used in these comparisons is

$$300.03162 \text{ feet} + 300\times 0.00000685(t - 62^\circ),$$

t being the temperature F. of the tape. Assuming the two tapes to have the same co-efficient of expansion, the above equations give

100-foot tape = 100.01845 feet at 62° F.[1]

Deducting from this value two inches, or 0.16667 foot, and applying the same co-efficient of expansion as given above for the 300-foot tape, we find for the tape length used in the base measurement

$$99.85178 \text{ feet} + 0.00068(t - 62°) \text{ feet.}$$

Since, as stated above, there were 244 tape lengths at an average temperature of 68° F., we have for the length of the measured line

244 × 99.85178 feet	=	24363.834 feet
Temperature correction	= +	0.996 feet
Fractional length	= +	8.833 feet
Total	=	24373.663 feet

According to a topographic map of the vicinity projected from the surveys of Prof. Streeruwitz, the elevation of the railway at Arispe is about one hundred and thirty feet less than at Sierra Blanca. Assuming the slope to be uniform between the two ends of the measured line, the grade angle would be 18′ 20″, and the corresponding grade correction is 0.35 foot. The measured line corrected for grade is, therefore, 24373.31 feet. The correction, derived from the data given above, to be applied to this length to get the line Pier-Arispe, is —95.69 feet. This gives for the latter line 24277.62 feet.

The elevation of Sierra Blanca above sea-level is given by the Southern Pacific Railway as 4,512 feet. Deducting from this one-half of the fall to Arispe, or 65 feet, we have for the mean height of the base above sea-level 4,447 feet. The base being in latitude 31° 10′, and having a mean inclination to the meridian of 71° 29′, the reduction to sea-level for the above elevation is —5.16 feet.

Collecting the several elements of the base just given, we have the following summary:

	Feet.
Length of measured line	24373. 66
Correction for grade	0. 35
Correction for transfer to line Pier-Arispe	95. 69
Correction for elevation	5. 16
Sea-level length of line Pier-Arispe	24272. 46

(17) *Angles of triangulation.*—The angles of the triangulation connecting the astronomical station with the one hundred and fifth meridian and with the base of the Texas Geological Survey, were measured by

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[1] A comparison of this tape with the mural standard of the U. S. Coast and Geodetic Survey, made June 26, 1890, at a temperature of 82° F., the tape being supported without sag on the standard, gave

100-foot tape = 100.02083 at 62° F.

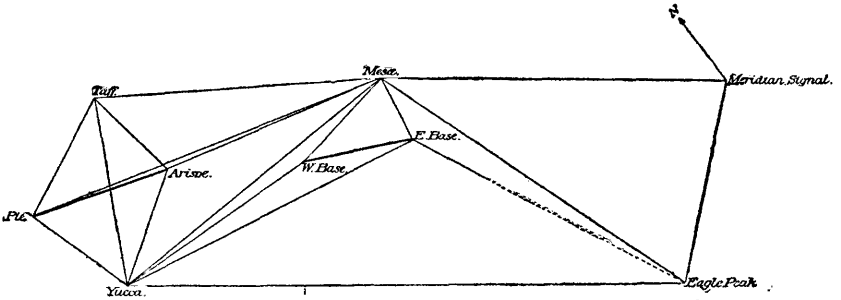
This value depends on the assumption that the mural standard and tape have the same rate of expansion. The correction for the error of this assumption and the correction for sag of tape as used at St. Louis would both diminish the discrepancy between the two values, which is now about $\frac{1}{30000}$.

Mr. A. P. Davis with a non-repeating theodolite, No. 437, made by Fauth & Co. This instrument has a circle eight inches in diameter graduated to 10′. The circle is read by two micrometer microscopes whose heads are divided to 2″. The telescope has an objective two inches in diameter and a focal length of about sixteen inches. It has a convenient device for shifting the circle, and is in all respects a high grade of instrument.

In general, four measurements of each angle were made on as many equidistant parts of the circle. By a measurement is meant the mean of two results obtained by moving the microscopes in the direction of the graduation and immediately afterwards in the opposite direction, or, vice versa, so as to eliminate twist of the instrument or its support.

The instrument was mounted in general on its heavy tripod and was protected from the sun and wind by a canvas screen. The signals used were either well defined targets of white cloth or symmetrical cairns of stones. Nearly all the stations are marked by such cairns so that they may be identified easily so long as they remain undisturbed.

Table IX, following, gives the angles and derived data used in computing the connection with the meridian and with the base of the Texas Geological Survey. As may be seen from the sketch of the triangulation below, many more angles than those used were measured.



TRIANGULATION CONNECTING SIERRA BLANCA PIER WITH 105TH MERIDIAN, EL PASO COUNTY, TEXAS.

Scale of miles.

Since our principal object was to locate the one hundred and fifth meridian well within the limits of the unavoidable errors in the astronomical longitude of the Pier, it was unnecessary to make use of all these angles as might have been done by means of a complex adjustment. Accordingly, the best chain of triangles essential to this purpose was selected and the angles of these triangles were adjusted for errors of closure simply.[1] As may be seen from the table, the maximum error of closure of these triangles is 5″.4 and the average error 2″.9. These errors of closure indicate a probable error of about ±1″.3 for a measured angle.

[1] To this statement there is one exception, viz, in the angles at Arispe. They were subjected to a local adjustment, and the angles given in the table are the locally adjusted angles. The maximum correction from this adjustment, however, was only 0″.5

TABLE IX.—*Principal triangles and their logarithmic sides.*

	Measured angles.	Spherical excess.	Adjusted spherical angle.	Log. sines.	Log. sides in meters.
	° ′ ″	″	° ′ ″		
Pier	49 01 42.2		49 01 41.3	9.877965	3.786814
Taff	65 51 57.8	0.10	65 51 56.9	9.960276	3.869125
Arispe	65 06 22.8		65 06 21.9	9.957650	3.866499
Arispe	55 43 22.7		55 43 22.0	9.917150	3.848998
Yucca	59 56 31.8	0.12	59 56 31.1	9.937276	
Pier	64 20 07.7		64 20 07.0	9.954890	3.886739
Pier	113 21 50.2		113 21 50.6	9.962844	4.080913
Taff	32 33 35.6	0.12	32 33 35.9	9.730929	
Yucca	34 04 33.2		34 04 33.6	9.748414	3.866483
Taff	32 33 35.6		32 33 35.9	9.730929	3.849014
Yucca	34 04 33.2	0.12	34 04 33.6	9.748414	
Pier	113 21 50.2		113 21 50.6	9.962844	4.080929
Taff	80 36 43.3		80 36 42.2	9.994144	4.268680
Mesa	39 48 49.9	0.49	39 48 48.8	9.806377	
Yucca	59 34 30.6		59 34 29.5	9.935654	4.210190
Taff	47 18 20.6		47 18 20.9	9.866277	4.110106
Mesa	20 26 02.4	0.18	20 26 02.7	9.542986	
Arispe	112 15 36.3		112 15 36.6	9.966364	4.210192
Arispe	126 54 38.3		126 54 39.1	9.902854	4.268674
Mesa	19 22 47.5	0.20	19 22 48.3	9.520919	
Yucca	33 42 31.9		33 42 32.3	9.744274	4.110094
Mesa	102 51 17.9		102 51 17.2	9.988977	4.515167
Eagle	33 33 09.7	1.06	33 33 09.0	9.742489	
Yucca	43 35 35.5		43 35 34.9	9.838553	4.364744
Mesa	30 52 10.1		30 52 08.3	9.710181	4.075016
Signal	88 49 40.2	0.61	88 49 38.4	9.999909	
Eagle	60 18 15.7		60 18 13.9	9.938852	4.303687
Mesa	79 40 29.8		79 40 28.0	9.992909	4.262332
E. Base	86 39 00.0	0.20	86 38 58.2	9.999257	
Yucca	13 40 35.7		13 40 34.0	9.373707	3.643130
E. Base	67 49 59.3		67 50 01.6	9.966655	3.795809
W. Base	40 39 41.8	0.07	40 39 42.1	9.813975	
Mesa	71 30 15.2		71 30 16.4	9.976968	3.806123

(18) *Connection with base of Texas Geological Survey.*—The logarithm of the base Pier-Arispe expressed in English feet, is 4.385114. Using Clarke's ratio for converting feet to meters, the corresponding logarithm of the base in meters is 3.869125. Using this logarithm and the angles of the triangles in Table IX, we find for the logarithm of the Texas base 3.806123, corresponding to 6399.16 meters.

The length of the Texas base, corrected for grade and temperature of measuring bars, as given me by Prof. Streeruwitz, is 6400.70 meters. The elevation of this base above sea-level is about the same as that of Torbert Station, which is given by the Southern Pacific Railway as 4,343 feet. The mean latitude of the base is 31° 05′, and its azimuth from the east end is 119° 05′. Hence, the reduction to sea-level is 1.33 meters, giving for the sea-level length of this base 6399.37 meters.

The discrepancy between this and the computed value given above is 0.21 meters, or $\frac{1}{32000}$ part. It is smaller than might reasonably be expected, since a change 0.5″ in the angle at Yucca of the triangle Mesa-East Base-Yucca would change the discrepancy by $\frac{1}{10000}$ part. For a precise connection of the two bases this triangle is ill-shaped. The connection suffices to show, however, that no error comparable with that in the longitude work lies in the triangulation.

(19) *Azimuth of base-line Pier-Arispe.*—The azimuth of the base-line depends on the azimuth of a meridian mark set up about one mile north of the pier. This mark was very nearly bisected by the middle line of the transit diaphragm during the period covered by the time observations May 25, 28, and 29. The average of the twelve azimuth factors of these dates (see Table III) makes the mark east of north 0″.85. Special observations, however, were made for the azimuth of the mark on May 31 with the meridian transit. Nine circumpolar stars, five at upper and four at lower culmination, were observed. The times of transit of the stars across the mid line of the instrument were recorded on the chronograph, and the small angles between the stars and the mark were measured by means of the micrometer screw of the movable V. The error of the chronometer was accurately known from its rate and previously determined error as well as from time stars observed during the course of the azimuth work. Correcting the results for inclination of horizontal axis and collimation, they gave in the mean 0″.58 east of north for the azimuth of the mark, a value not differing materially from the value derived from the time work as stated above. The angle at the pier between the meridian mark and Arispe was measured with the 8-inch theodolite described in section (17). Six measures on as many equidistant parts of the circle were made. Their mean value is 108° 30′ 06″.0. Adding to this the correction just given and 180°, we have for the adopted azimuth of the line Pier-Arispe 288° 30′ 06″.6.

(20) *Geodetic positions of points in triangulation.*—Using the triangulation given in Table IX and the initial azimuth derived above, the following geodetic positions and azimuths result:

TABLE X.—*Geodetic positions and azimuths in triangulation.*

Stations.	Latitudes.	Longitudes.	Azimuths.	Stations.	Reverse azimuths.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″
Pier	31 10 27.64	105 21 24.96	239 28 25	Taff	59 30 29
			288 30 07	Arispe	108 32 24
			352 50 14	Yucca	172 50 31
Taff	31 12 28.86	105 17 25.68	306 20 11	Mesa	126 24 27
			353 38 32	Arispe	173 38 46
			26 56 51	Yucca	206 55 04
Arispe	31 09 11.33	105 17 00.09	285 54 22	Mesa	105 58 24
			52 49 01	Yucca	232 47 01
Yucca	31 06 40.08	105 20 51.72	266 29 34	Mesa	86 35 35
			280 10 08	East Base	100 15 59
			310 05 09	Eagle Peak	130 13 15
Mesa	31 07 16.43	105 09 12.38	312 52 12	Meridian Signal	132 56 59
			343 44 20	Eagle Peak	163 46 26
			6 55 07	East Base	186 54 57
East Base	31 04 54.70	105 09 32.38	119 04 55	West Base	299 03 06
West Base	31 06 35.65	105 13 03.41			
Eagle Peak	30 55 14.41	105 05 08.13	224 03 40	Meridian Signal	44 07 21
Meridian Signal	30 59 51.56	104 59 56.49			

(21) *Positions of stones marking one hundred and fifth meridian.*—From the latitude and longitude of Meridian Signal given in Table X it appears that the one hundred and fifth meridian lies 305.51 feet west of that signal. The stones marking the meridian were actually set 295.94 feet west of Meridian Signal. This discrepancy between their actual positions and their proper positions relative to the triangulation arose in the following manner: By reason of a blunder in the field computation, made by the writer in deriving the tape length used in measuring the base, a linear error of $\frac{1}{12910}$ part (1.88 feet in length of base) was introduced into the triangulation. This error made the longitude of Meridian Signal 104° 59′ 56.60″, instead of 104° 59′ 56.49″ as given above.[1] As explained in section (22) below, however, this error of 9.57 feet in placing the meridian stones is small in comparison with the error of the initial longitude, and is entirely negligible in comparison with the unavoidable deflections of the plumb-line.

The meridian stones were set June 16, 1890, by Mr. A. P. Davis with the assistance of Prof. W. von Streeruwitz and Mr. J. A. Taff, of the Texas Geological Survey, and Col. J. R. Marmion, county surveyor of Presidio County. The stones are about one mile apart in a true north and south line, the northerly one being due east of Meridian Signal or in latitude 30° 59′ 51.56″. They are of limestone, dressed to a square cross section at their upper ends, and project a few inches above ground.

[1] The error of the tape length used in the field computation was $\frac{1}{3}\times\frac{1}{12}\times0.28$ foot, and was due to the omission of the term 0.28 inch from the observed equation of the 100-foot tape with the 300-foot tape of the Missouri River Commission (see section 16). The omission was not discovered until June 26, when the 100-foot tape was compared with the mural standard of the U. S. Coast and Geodetic Survey.

(22) *Probable error of position of meridian as defined by marking stones.*—It will be of some theoretical interest to state what degree of precision is attainable in fixing a meridian on the surface of the earth, and what probable error must be attributed to the position of the one hundred and fifth meridian defined by the stones set in El Paso County.

Evidently, the error in position of any meridian fixed by means of a longitude determination will depend on the errors of the longitude differences which enter into the determination. Other things being equal the uncertainty increases with the number of differences added together to make up the determination. If but one difference is involved the relative longitude of two places may be found with a probable error not greater than $0^s.02$ to $0^s.03$, or 15 to 20 feet in middle latitudes. In general, however, the longitude of a place depends on several such differences and the probable error is correspondingly greater.

In the present case we have to consider three differences of longitude, viz, the difference of St. Louis and Greenwich, Sierra Blanca and St. Louis, and Sierra Blanca and Meridian Signal. The probable error of the first of these differences is unknown, but it can hardly be less than $\pm 0^s.050$. The probable error of the second difference is given in section (16) as $\pm 0^s.022$. The probable error of the last difference, or that measured by the triangulation, may be estimated as $\frac{1}{10000}$ part of the linear distance between the meridian of the pier at Sierra Blanca and the one hundred and fifth meridian; that is, in time, $\pm 0^s.009$. Taking the square root of the sum of the squares of these próbable errors, we get for the probable error of the position of the one hundred and fifth meridian as fixed on the ground

$$\pm 0^s.055 = \pm 0''.825 = \pm 72 \text{ feet.}$$

This probable error, it will be seen, is substantially the same as that of the position of the pier at Sierra Blanca.

The probable error just given takes no account of the deviation of the plumb-line at Sierra Blanca from the normal to the earth's spheroid, and the question may be asked, would the adopted position of the one hundred and fifth meridian agree with the position which might be found by geodetic connection with some other astronomical station? The answer to this question is, in all probability it would not by some hundreds of feet. The average plumb-line deflection in such mountainous regions is three to five seconds of arc, which for the latitude of Sierra Blanca means 250 feet to 440 feet. This being the case, no two determinations from different initial longitude stations could be expected to agree except within some such limits as those just assigned, even if the astronomical and geodetic work could be done with perfect accuracy. Discrepancies of this character could be avoided only by means of geodetic operations too elaborate and too costly to be employed in fixing a boundary line.