A. R. ALGER

100
368
THS

THESIS

Test of Capabilities
of Coast and
Geodetic Survey Level

A.R. Alger W. F. Millar

1904

THESIS

T H E S I S.

The promotion of the rapidity and accuracy of levelling is one of the most important features of modern engineering. By means of a system of precise levelling, a net-work of lines establishing standard bench works, has been run throughout this country, and all constructive operations are referenced from these benches. This work has been accomplished by the Coast and Geodetic Survey, together with the lines of levels taken by the Geological Survey.

On account of the importance of this work, much attention has been paid to the improvement of instruments to be used. One of the most modern is the precise level recently adopted by the United States Coast and Geodetic Survey, and the determination of the capabilities of one of these instruments is the object of our research.

The instrument used was the United States Coast and Geodetic Survey Precise Level No. manufactured by Mann and Company of St Louis, Missouri, U. S. A. This level was in factory condition, never having been taken from the box until the beginning of this work.

With the aforesaid object in view, a line was selected about ten miles long, extending from a bench work cut in

THESIS

stone window-sill of Piatt's power house in Lansing to a bench work on corner stone of foundation of Lake Shore depot at Dimondale, Michigan.

The general direction of the line was southwesterly through a slightly hilly country.

The levelling party consisted of three men, their duties being as follows:- (1) Instrument man; (2) Rod man; and (3) A man to take notes and keep the instrument shaded with an umbrella whenever the sun shone.

The general atmospheric conditions were comparatively favorable for working.

Before beginning the test, the instrument was adjusted until the error of closure was only $\frac{1}{3}$ m.m. for 100 feet.

Permanent bench ~~work~~ mark (I) north side of Piatt's power house, cross-notched on top of east end of stone sill of east window.

The following is a copy of notes taken while running line.

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DIRECT LINE.

March 28, 1904.

Point.	Back Sights. Thread Readings. 1.	2.	3.	Thread dist.	Temp.		Remarks.
P.B.M.1.	27.70	26.72	25.70	26.71	2.00	37	Cloudy. Windy.
T.P.1.	13.34	11.84	10.38	11.85	2.96	37	
" 2.	14.98	13.41	11.78	13.39	3.20	38	" "
" 3.	17.87	16.34	14.71	16.31	3.16	39	Reading fair.
" 4.	23.91	22.28	20.52	22.24	3.39	40	Umb. for Wind.
" 5.	25.50	23.59	21.52	23.54	3.98	38	
" 6.	13.53	11.90	10.18	11.87	3.35	39	
				125.91	22.04		

REVERSE LINE.

T.B.M.2.	20.40	18.79	17.05	18.75	3.35	38	
T.P..1.	16.60	14.71	12.69	14.67	3.91	36	
" 2..	8.52	6.92	5.29	6.92	3,23	36	
" 3.	8.81	7.30	5.70	7.27	3.11		
" 4.	11.49	9.39	8.20	9.86	3.29		
" 5	18.29	16.67	14.94	16.63	3.35	36	Cloudy.Read fine.
" 6	11.20	10.24	9.24	10.23	1.96		
				84.33	22.20		

DIRECT LINE.

Point.	Fore sights. Thread readings. 1.	2.	3.	Mean.	Thread dist.		Remarks.
T.P.1.	12.10	11.15	10.12	11.12	1.98		Cloudy Windy.
" 2.	15.72	14.20	12.59	14.17	3.13		
" 3.	12.59	11.00	9.28	10.96	3.31		" " "
" 4.	8.00	6.40	4.73	6.38	3.27	39	Sunny. Reading poor.
" 5.	16.56	14.99	13.31	14.95	3.25	40	Umb.for Wind.
" 6.	17.12	15.33	13.43	15.29	3.69	38	
T.B.M.2.	20.40	18.79	17.05	18.75	3.35	38	
				91.62	21.98		

REVERSE LINE.

T.P.1.	13.51	11.89	10.18	11.86	3.32	37	
" 2.	25.98	23.85	21.58	23.80	4.40	36	Poor read.
" 3.	15.29	13.69	12.01	13.66	3.28	36	
" 4.	17.39	15.81	14.19	15.80	3.20	36	Read. fine.
" 5.	15.28	13.74	12.11	13.71	3.17	36	" " Cloudy
" 6.	16.39	14.88	13.27	14.85	3.12	36	" " "
P.B.M.1.	25.82	25.04	24.14	25.00	1.68	36	" " "
				118.68	22.17		

DIRECT LINE.

Back Sights.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread dist.	Temp.	Remarks.
T.B.M.2.	30.51	28.94	27.29	28.91	3.22	41	Reading good. Cloudy.
T.P.1.	19.89	18.38	16.79	18.35	3.09	41	
" 2.	21.06	19.48	17.79	19.44	3.27	41	
" 3.	20.45	18.92	17.32	18.90	3.13	41	
" 4.	19.52	18.00	16.36	17.96	3.16	42	
T.B.M.3.	31.91	30.19	28.39	30.16	3.52	42	
T.P.1	25.05	23.59	22.08	23.57	2.97	43	
" 2.	22.19	20.62	18.98	20.60	3.21	43	
" 3.	18.49	18.10	17.69	18.09	0.80	44	
				195.98	26.44		

REVERSE LINE.

T.B.M.4.	30.81	29.43	28.01	29.42	2.80	46
T.P.1.	5.00	4.50	3.95	4.48	1.05	46
" 2.	13.43	11.93	10.30	11.89	3.13	96
" 3.	12.26	10.76	9.14	10.72	3.12	46
T.B.M.3.	24.88	23.00	21.02	22.96	3.84	46
T.P.1.	13.00	11.40	9.80	11.40	3.20	46
" 2.	12.88	11.24	9.51	11.21	3.37	47
" 3.	12.56	10.99	9.32	10.96	3.25	47
" 4.	15.89	14.50	13.05	14.48	2.84	48
				127.52	23.76	

DIRECT LINE.

Point.	Back Sights. Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.P.1.	12.78	11.27	9.68	11.24	3.10	41	
" 2.	12.86	11.40	9.86	11.37	3.00	41	
" 3.	13.68	12.24	10.70	12.21	2.98	41	
" 4.	13.61	12.00	10.32	11.98	33.29	41	
T.B.M.3.	24.78	22.96	20.94	22.87	3.84	42	
T.P.1.	12.95	11.39	9.71	11.35	3.24	42	
" 2.	16.55	15.00	13.39	14.98	3.16	43	
" 3.	5.19	4.66	4.11	4.65	1.68	43	
T.B.M.4.	30.81	29.43	28.01	29.42	2.80	44	
				130.07	26.39		

REVERSE LINE.

T.P.1.	18.46	18.07	17.66	18.06	.80	46	
" 2.	21.99	20.41	18.74	20.38	3.25	46	
" 3.	20.72	19.43	18.09	19.41	2.63	46	
T.B.M.3.	32.50	30.50	28.39	30.46	4.11	46	
T.P.1.	19.51	18.00	16.41	17.97	3.10	46	
" 2.	19.80	18.35	16.79	18.31	3.01	46	
" 3.	20.14	18.60	16.97	18.57	3.17	47	
" 4.	20.52	18.92	17.24	18.89	3.28	47	Cloudy.
T.B.M.2.	32.52	31.02	29.47	31.00	3.05	48	Reading fine.
				193.05	23.35		

DIRECT LINE.

Point.	Back Sights. Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.B.M.4.	31.52	30.10	28.60	30.07	2.92	54	Cloudy.
T.P.1.	32.33	30.83	29.27	30.81	3.06	54	"
" 2.	7.70	6.29	4.79	6.26	2.91	54	"
" 3.	29.91	28.39	26.77	28.36	3.14	54	"
" 4.	27.24	25.70	24.05	25.65	3.19	54	"
" 5.	26.97	25.21	23.37	25.19	3.60	54	"
" 6.	18.90	16.80	14.57	16.76	4.33	54	"
" 7.	1.51	.96	.38	.95	1.13	54	Sunny.
				164.05	24.28		

REVERSE LINE.

T.B.M.5.	27.61	25.95	24.20	25.92	3.41	52	
T.P.1	22.76	21.76	20.70	21.74	2.06	53	
" 2.	27.52	25.60	23.52	25.55	4.00	53	
" 3.	5.46	4.39	3.26	4.37	2.29	54	Sunny.
" 4.	30.35	28.33	26.20	28.29	4.15	54	Used umbrella.
" 5.	30.58	28.84	27.09	28.84	3.39	54	" "
" 6.	14.19	12.19	10.09	12.16	4.10	54.	Shady.
				146.87	23.40		

DIRECT LINE.

Point.	Fore Sights. Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.P.1.	30.64	29.39	28.04	29.36	2.60	54	Cloudy.
" 2.	28.92	27.54	26.07	27.51	2.85	54	"
" 3.	18.58	16.39	14.08	16.35	4,50	54	"
" 4.	17.76	15.77	13.62	15.72	4.14	54	"
" 5.	13.28	12.09	10.82	12.06	2.46	54	"
" 6.	29.05	27.85	26.58	27.83	2.47	54	"
" 7.	27.71	26.82	25.90	26.81	1.81	54	"
T.B.M.5	27.61	25.95	24.20	25.92	3.41	53	"
				181.56	24.24		

REVERSE LINE.

T.P.1	1.51.	0.95	0.38	0.95	1.13	52	
" 2.	13.70	11.72	9.61	11.68	4.09	53	
" 3.	31.70	30.00	28.20	29.97	3.50	53	
" 4.	26.17	23.69	21.08	23.65	5.09	54	
" 5.	24.83	22.62	20.28	22.58	4.55	54	Got Sunny.
" 6.	14.31	12.97	11.56	12.95	2.75	54	
T.B.M.4.	29.33	27.29	25.16	27.26	4.17	54.	Reading fine.
				129.04	25.28		

DIRECT LINE.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.B.M.5.	6.52	5.10	3.61	5.08	2.91		7:15 A.M.
T.P.1.	32.46	30.84	29.32	30.89	3.14		Nice.
" 2.	30.32	29.78	29.40	29.83	0.92	44	Cloudy.
" 3.	32.52	30.88	29.13	30.84	3.39		"
" 4.	3.69	2.32	0.90	2.30	2.79		"
T.B.M.6.	7.69	5.38	2.91	5.33	4.78	43	"
T.P.1.	31.62	30.71	29.75	30.69	1.87		"
" 2.	27.78	26.49	25.13	26.47	2.65	45	"
" 3.	2.39	1.41	0.38	1.39	2.01	46	"
" 4.	2.84	2.54	2.23	2.54	0.61	46	"
T.B.M.7.	9.39	7.95	6.43	7.92	2.96		"
T.P.1.	32.08	21.65	31.21	31.65	0.87		"
" 2.	32.69	32.09	31.48	32.09	1.21		"
" 3.	30.92	29.91	28.84	29.89	2.08		"
" 4.	5.55	5.07	4.56	5.06	0.99		"
" 5.	28.74	28.27	27.77	28.26	0.97	48	"
" 6.	22.79	21.05	19.19	21.01	3.60		"
" 7.	24.20	22.52	20.77	22.50	3.43		"
" 8.	18.72	16.61	14.36	16.56	4 36		"
				360.30	43.54		

DIRECT LINE.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.P.1.	24.60	21.60	18.50	21.57	6.10		Cloudy.
" 2.	30.21	27.37	24.36	27.31	5.85		"
" 3.	4.03	3.86	3.67	3.85	0.38		"
" 4.	25.20	23.71	22.14	23.68	3.06		"
T.B.M.6.	25,57	24.12	22.59	24.09	2.98		"
T.P.1.	23.73	22.11	20.39	22.08	3.34	44	"
" 2.	1.77	1.4.	1.01	1.40	0.76	44	"
" 3.	26.05	24.93	23.76	24.91	2.29	45	"
" 4.	30.23	29.88	29.53	29.88	0.70	46	"
T.B.M.7.	32.30	31.50	30.66	31.49	1.64		"
T.P.1.	7.97	6.84	5.67	6.83	2.30		"
" 2.	4.13	3.96	3.79	3.96	0.34		"
" 3.	5.03	4.82	4.53	4.81	0.56		"
" 4.	20.40	19.56	18.88	19.61	1.52		"
" 5.	26.61	24.54	22.33	24.49	4.28		"
" 6.	3.46	3.06	2.64	3.05	0.82		"
" 7.	12.08	10.67	9.20	10.65	2.88		"
" 8.	25.86	24.38	23.42	24.65	2.44		"
T.B.M.8.	13.09	11.59	10.01	11.56	3.08		"
				319.37	44.92		

March 30, 1904. P.M.

REVERSED LINE.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.B.M.8.	12.58	11.06	9.44	11.03	3.14	52	
T.P.1	32.14	30.64	29.06	30.61	3.08		
" 2.	17.13	14.73	12.19	14.68	4.94	52	
" 3.	15.88	13.35	10.67	13.30	5.21		
" 4.	13.65	12.69	11.72	12.69	1.93		
" 5.	2.78	2.50	2.20	2.49	0.58		
" 6.	2.12	1.81	1.63	1.88	0.49		
T.B.M.7.	29.22	28.49	27.69	28.45	1.53		
T.P.1.	30.98	30.15	29.28	30.14	1.70		
" 2.	28.17	26.02	23.73	25.97	4.44		
" 3.	3.36	3.01	2.03	3.00	0.73	46	
" 4.	16 77	14.37	11.81	14.32	4.96		
" 5.	20.79	20.24	19.65	20.23	1.14		
				208.79	33.87		

DIRECT LINE SECOND TIME.

T.B.M.5.	8.41	6.99	5.49	6.96	2.92		
T.P.1.	26.56	24.25	21.78	24.20	4.78		
" 2.	21.96	21.21	20.41	21.19	1.55		
" 3.	30.54	30.24	29.92	30.23	0.62		
" 4.	25.35	23.08	20.70	23.04	4.65		
" 5.	4.45	3.70	2.93	3.69	1.52		
				109.31	39.91		

REVERSED LINE.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.P.1.	27.37	25.41	23.35	25.38	4.02	50	Rainy 12:30 P.M.
" 2.	23.62	21.72	19.72	21.69	3.90		Rainy.
" 3.	31.92	31.29	30.62	31.28	1.30		
" 4.	13.52	12.48	11.37	12.46	2.15		
" 5.	31.65	30.84	29.99	30.82	1.66		
" 6.	32.58	32.35	32.12	32.35	0.46		
T.B.M.7.	20.65	18.06	15.29	18.00	5.36		
T.P.1.	2.90	2.63	2.33	2.62	0.57		Still sprinkling.
" 2	2.41	1.84	1.25	1.83	1.16		
" 3.	28.90	28.43	27.93	28.42	0.97		
" 4.	28.46	27.68	26.83	27.66	1.63		
" 5.	6.11	5.64	5.15	5.63	0.96		
T.B.M.6.	12.95	12.72	12.49	12.72	0.46		
				250.86	34.60		

DIRECT LINE SECOND TIME.

Apr. 23,1904.

T.P.1.	31.35	30.59	29.73	30.56	1.62		
" 2.	2.16	1.72	1.25	1.71	0.91		
" 3.	31.95	28.73	25.40	28.73	6.55		Reading Poor.
" 4.	3.79	3.53	3.29	3.52	0.45	78	
" 5.	28.29	26.62	24.86	25.59	3.43		
T.B.M.6.	21.12	19.99	18.78	19.96	2.34	71	
				111.07	29.90		

DIRECT LINE.

April 23, 1904 P.M.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.B.M.8.	21.24	19.88	18.42	19.85	2.82	80	
T.P.1.	13.96	12.45	10.82	12.41	3.14	81	
" 2.	13.26	11.86	10.40	11.84	2.86	81	
" 3.	12.95	11.37	9.68	11.33	3.27	82	Getting Cloudy.
" 4.	6.76	5.75	4.65	5.72	2.11	82	
" 5.	4.94	4.50	4.02	4.49	0.72		
T.B.M.9.	26.39	25.13	23.81	25.11	2.58		Bright.
T.P.1.	23.43	21.94	20.33	21.90	3.10		
" 2.	31.80	30.42	28.96	30.39	2.89	83	
" 3.	11.98	9.93	7.80	9.90	4.18		
" 4.	31.52	29.22	26.79	29.18	4.73		
" 5.	15.65	14.49	13.03	14.39	2.62		
" 6.	6.65	5.39	5.03	5.87	1.57		
				202.38	36.54		

REVERSE LINE.

T.B.M.10.	32.16	31.19	30.17	31.17	1.99	82	
T.P.1.	29.70	28.40	27.01	28.87	2.69	82	
" 2.	8.11	6.58	4.98	6.56	3.13		Getting Cloudy.
" 3.	5.62	4.12	2.58	4.11	3.04	79	Partly "
" 4.	18.90	17.40	15.81	17.37	3.09		"
" 5.	4.14	3.36	2.52	3.24	1.62		
" 6.	10.05	8.33	6.50	8.29	3.55		
" 7.	6.82	6.48	6.10	6.47	0.72		

DIRECT LINE.

Fore Sights.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.P.1.	13.07	11.46b	9.72	11.42	3.35		
" 2.	10.69	9 20	7.61	9.16	3.08		
" 3.	24.40	22.99	21.50	22.96	2.90		
" 4.	10.03	8.46	6.77	8.42	3.26		
" 5.	31.29	30.70	30.10	30.70	1.19		
T.B.M.9.	32.32	31.26	30.06	31.23	2.32		Cloudy.
T.P.1.	3.74	2.34	0.96	2.31	2.78		
" 2.	7.85	6.31	4.68	6.23	3.27		Bright.
" 3.	6.82	5.00	3.08	4.97	3.74		"
" 4.	8.60	7.06	5.42	7.03	3.18	86	"
" 5.	7.80	6.64	5.44	6.63	2.36		
" 6.	29.73	28.47	27.13	28.44	2.61		
T.B.M.10.	32.16	31.19	30.17	31.17	1.99		
				200.72	36.13		

REVERSE LINE.

T.P.1.	6.65	5.89	5.08	5.87	1.57	82	
" 2.	15.70	14.39	13.00	14.36	2.70		
" 3.	25.97	24.45	22.84	24.42	3.13	80	Cloudy.
" 4.	16.29	14.80	13.21	14.77	3.08	79	
" 5.	26.98	25.32	23.59	25.30	3.39		
" 6.	28.08	26.38	24.58	26.35	3.50		
" 7.	32.06	30.58	29.01	30.55	3.05		

REVERSE LINE (Cont'd.)

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.B.M.9.	32.54	31.38	30.13	31.35	2.41	76	
T.P.1.	33.21	32.11	31.00	32.11	2.21	74	
" 2.	21.15	19.39	17.50	19.35	3.65		
" 3.	17.40	15.45	13.39	15.41	4.01		
" 4.	15.76	14.24	12.61	14.20	3.15		
" 5.	7.29	6.43	5.53	6.42	1.76		
				224.52	37.02		

REVERSE LINE. (Cont'd.)

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.B.M.9.	14.51	13.91	13.30	13.91	1.21		
T.P.1.	1.90	1.31	0.70	1.30	1.20	74	
" 2.	19.08	17.19	15.19	17.15	4.89		
" 3.	7.62	6.00	4.29	5.97	3.33		
" 4.	20.13	19.05	17.90	19.03	2.23		
" 5.	16.48	15.31	14.10	15.30	2.48		
				226.13	36.91		

DIRECT LINE.

Back Sights.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.B.M.10.	4.53	3.49	2.40	3.47	2.13	68	
T.P.1.	3.19	2.01	0.77	1.99	2.42		
" 2.	14.39	13.11	11.78	13.09	2.61		
" 3.	11.33	10.17	8.90	10.15	2.43		
				28.70	9.64		

REVERSE LINE.

T.B.M.11.	30.81	29.30	27.71	29.27	3.10		
T.P.1.	30.14	28.58	27.55	28.86	2.59		
" 2.	17.43	16.34	15.12	16.31	2.36		
" 3.	24.66	23.65	22.58	23.63	2.08		
				98.07	10.13		

DIRECT LINE.

T.B.M.XI.	30.81	30.07	29.28	30.05	1.53		
T.P.1.	16.94	14.71	12.38	14.66	4.61		
" 2.	4.91	4.34	3.73	4.33	1.18	70	
" 3.	3.43	2.31	1.07	2.29	2.41		
" 4.	20.01	17.33	15.61	17.83	4.40		
				69.16	14.13		

DIRECT LINE.

Fore sights.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.P.1.	25.13	24.04	22.91	24.03	2.22	68	Very windy.
" 2.	15.75	14.60	13.36	14.57	2.39		"
" 3.	25.79	24.55	23.26	24.58	2.53		"
T.B.M.XI.	30.81	29 30	27.71	29.27	3.10		"
				92.45	10.24		

REVERSE LINE.

T.P.1.	11.39	10.18	8.90	10.16	2.49		
" 2	18.68	17.44	16.13	17.42	2.55		Rained.
" 3.	3.85	2.58	1.22	2.55	2.63		
T.B.M.X.	5.26	4.24	3.17	4.22	2.09		
				34.35	9.76		

DIRECT LINE.

T.P.1.	12.22	10.93	9.54	10.90	2.68		
" 2.	32.30	30.74	29.00	30.71	3.21		
" 3.	32.80	30.40	27.80	30.33	5.00		
" 4.	18.07	17.89	17.71	17.89	0.36		
P.B.M.2.	3.72	3.57	3.41	3.57	0.31		
				93.40	11.56		

REVERSE LINE.

Back Sights.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
P.B.M.2.	3.72	3.57	3.41	3.57	0.31		
T.P.1.	30.13	28.37	26.48	28.33	3.65		
" 2.	30.93	29.64	28.28	29.62	2.65		
" 3.	21.18	20.54	19.44	20.32	1.74	68	
" 4.	16.88	14.88	12.78	14.85	4.10		
				96.69	12.45		

REVERSE LINE.

Fore sights.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.P.1.	20.02	17.88	15.63	17.84	4.39	67	
" 2.	7.97	6.19	4.18	6.12	3.79		
" 3.	1.07	0.92	0.76	0.92	0.31		
" 4.	18.46	16.96	15.39	16.99	3.07		
T.B.M.XI.	31.56	30.78	29.97	30.77	1.59		
				72.59	13.15		

DIRECT LINE.

Back sights.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
P.B.M.II.	24.40	23.62	22.79	23.60	1.61	70	
T.P.1.	31.21	30.79	30.35	30.78	0.76		
" 2.	32.63	31.42	30.14	31.40	2.49		
" 3.	21.98	21.15	20.29	21.14	1.68		
" 4.	23.81	21.66	19.38	21.62	4.43		
" 5.	28.67	25.86	22.90	25.81	5.77		
" 6.	25.16	22.12	18.88	22.05	6.28		
" 7.	5.96	4.82	3.61	4.80	2.35		
T.B.M.12..	12.91	11.54	10.10	11.52	2.81	72	
T.P 1.	4.11	3.65	3.17	3.64	0.94		
" 2.	11.72	10.80	9.82	10.78	1.90	71	
" 3.	30.20	27.33	24.28	27.27	5.92		
" 4.	16.12	13.83	11.38	13.78	4.75		
" 5.	13.03	30.39	28.65	30.36	3.38		
				278.55	44.97		

DIRECT LINE.

Fore sights.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.P.1.	3.03	2.12	1.16	2.10	1.87		
" 2.	4.10	2.83	1.46	2.80	2.64	66	Breezy
" 3.	3.64	3.19	2.71	3.18	0.93		
" 4.	3.83	2.39	0.82	2.35	3.11		Cloudy.
" 5.	20.56	17.43	14.07	17.35	6.49	68	Slight wind, Cloudy.
" 6.	21.62	19.80	17.88	19.77	3.44		"
" 7.	15.03	12.55	9.93	12.50	5.10		"
T.B.M.12.	20.53	17.82	14.92	17.77	5.68	72	"
T.P.1.	31.71	31.13	30.53	31.13	1.18		"
" 2.	29.34	26.92	24.33	26.86	5.01	71	"
" 3.	15.89	13.18	10.31	13.13	5.58	69	"
" 4.	13.19	12.50	11.77	12.49	1.42		"
" 5.	11.46	10.82	10.14	10.81	1.32		"
P.B.M.III.	5.82	4.43	3.63	4.43	1.69		
				176.71	45.76		

Reverse Line.

Back sights.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
P.B.M.III.	5.32	4.48	3.63	4.98	1.69		
T.P.1.	12.83	10.25	7.53	10.20	5.30		
" 2.	4.00	2.23	0.37	2.20	3.65	67	
" 3.	29.63	28.48	27.22	28.84	2.41		
" 4.	31.98	31.38	30.75	31.34	1.23	64	
" 5.	26.39	24.97	23.48	24.95	2.91		
" 6.	14.95	14.74	14.56	14.74	0.43		
" 7.	30.88	29.17	27.33	29.13	3.55		
" 8.	12.07	10.17	8.19	10.14	3.88		
" 9.	28.74	26.67	24.48	26.63	4.26		
" 10.	26.95	23.47	19.74	23.39	7.21	Getting dark.	
" 11.	8.86	6.32	3.55	6.24	5.31		
T.B.M.13.	5.92	5.33	4.71	5.33	1.21	46	
T.P.1.	6.28	4.97	3.58	4.99	2.70		
" 2.	12.06	11.64	11.21	11.64	0.85		
" 3.	11.18	11.06	10.94	11.06	0.24		
				244.85	46.81		

REVERSE LINE.

Fore sights.

Point.	Thread Readings. 1.	2.	3.	Mean.	Thread Dist.	Temp.	Remarks.
T.P.1.	32.03	30.39	28.65	30.36	3.38		Cloudy and slightly breezy.
" 2.	15.79	13.72	11.49	13.67	4.30		
" 3.	30.09	22.30	24.33	27.24	5.76	65	"
" 4.	7.25	5.12	2.83	5.07	4.42		"
" 5.	9.25	9.06	8.87	9.06	1.38		"
" 6.	14.95	16.74	14.52	14.74	0.43		"
" 7.	21.72	19.50	17.15	19.46	4.57	63	"
" 8.	27.80	7.16	6.48	7.15	1.32		"
" 9.	32.75	29.80	26.70	29.75	6.05		"
" 10.	27.18	24.51	21.66	24.45	5.52		"
" 11.	28.22	27.13	25.97	27.11	2.25		"
T.B.M.13.	23.21	22.82	22.41	22.81	0.80		"
T.P.1.	31.86	30.87	29.83	30.05	2.03		"
" 2.	31.39	30.80	30.18	30.79	1.21		"
" 3.	28.12	27.14	26.12	27.13	2.00		"
P.B.M.II.	27.89	27.15	26.36	27.13	1.53		"
				246.77	46.93		"

The following are the differences of elevation between the several temporary benchmarks together with the errors of closure:

From	P.B.M.I.	to	T.B.M.II	+ 34.32	d.c.m.	the	error	was	-.03
From	T.B.M.II	to	" IV.	+ 65.72	"	"	"	"	+.19
"	" IV	"	" V.	- 17.67	"	"	"	"	+.16
"	" V	"	" VIII	+ 40.37	"	"	"	"	+.06
"	"VIII	"	" X	+ 1.63½	"	"	"	"	+.02½
"	" X	"	" XI	- 63.73½	"	"	"	"	-.01½
"	" XI	"	P.B.M.II.	- 24.17	"	"	"	"	-.07
	Total differences			+ 36.47	"				
	From P.B.M.I to P.B.M.II			+101.88					

+138.35 d.c.m. The error was +.28 dcm

The following are the descriptions of the benchmarks established:

P.B.M.I. North side of Platt's power house. Cross scratched in top of east end of stone sill of east window.

T.B.M.2. Top of stone with little △ shaped top. 30' N. W. from telegraph pole marked + on side next to track 200 ft. west from Logan Street crossing.

T.B.M.3. Center of depression in west side of top of stone in ditch north of Grand Trunk railroad track about 160 paces east of wagon road.

T.B.M.4. Maple tree, on root 3' from tree on South-east side. Cross cut in root.

T.B.M.5. On stone in corner of lot by Leadley's. Stone between two elm trees.

T.B.M.6. Crack in south end of narrow stone near middle of road about 600' east of small stone bridge.

T.B.M.7. Highest point of granite stone under barbed wire fence 50 feet east of small swamp in road.

T.B.M.8. South east point of stone step in front of small yellow house on state road in Millett.

T.B.M.9. South end of bridge culvert about 6". from northwest corner of middle post, highest point of wall, 1" east of crack in wall. About 200' west from L. E. Walker's residence.

T.B.M.10. Stone on west side of road about 4' east

of wire fence and 2' north of telephone pole opposite Stiefle's.

T.B.M.II. Top of stone in hollow south of corner toward Dimondale.

P.B.M.II. Northeast corner of bridge across Grand River. On southeast corner of stone under bed plate.

P.B.M.III. Cross cut in top of west end of stone under southwest corner of west wing of Dimondale depot.

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