All angles were checked by doubling and by compass readings, the rear flagman kept a list of all hubs to check the transitman, and the rodman worked out in a separate book all elevations of turning points, thus checking the leveler, this latter being most important.

In settled cultivated country, on both preliminary and location lines, hubs were set at all fences, as both stakes and hubs in the fields are frequently, and, in fact, usually, pulled up or destroyed soon after the line is run, while the hubs at the fences remain, enabling the ready re-establishment of the line. All tangents were run to an intersection, the P. C. and P. T. of all curves being set before the curves were run in.

Surveys were made of, and levels run on, all railroads crossed, for one mile on either side of the line.

An exact copy of the transit notes was made every night in an office notebook. Figs. 8 and 9 show typical pages of transit notes on preliminary and final location.

The head chainman is responsible to a greater degree perhaps than any other one man in the party for the progress of the work, that is to say, the actual physical progress, after the direction of the line has been determined. He must be a hustler from start to finish and for 10 or 11 hours per day, and, at the same time, be accurate; it is no use being careful about the instrumental work and the platting, if the chaining is not well done, and nothing is more annoying than to plat side lines forming traverses and find that they will not close, or to run in curves on location and not have them check. Chainmen, as a rule, are not college graduates, but are picked up in the country where the survey is carried on, and probably have had some experience, and there is no point where the engineer in charge of surveys can use his time to better advantage at the beginning of the work than in getting the chainman to do good work, not necessarily measuring to thousandths, but accurately enough for the work to be done.

There were three axemen (except in one or two cases of very heavy timber for several miles, where two extra men were put on for a short time); in wooded country, all chopped, but in that more or less open, one man helped the stake-marker by driving the stakes.

The writer has found it advisable to pick out one axeman and place him in charge of the others, spending time enough with him at the beginning of the survey to break him in thoroughly to the idea of

keeping on line and cutting only what is necessary to get the line through; the right kind of a man will soon learn what is required, and save a great deal of time.

Leveling.—Bench-marks were established every mile on preliminary lines and every half-mile on final location, care being taken to have these latter convenient for construction purposes, especially near bridge openings, etc., and away from all danger of being interfered with by the excavation. The elevation of each bench-mark was plainly marked on or near it.

TYPICAL PAGE. LEVEL NOTES.

				Line "S"		
Sta.	B.S.	F.S.	H.I.	Rod	Elev.	March 22, Started
					749.20	B.M. 30 ft. L. of 439+40 R. on White Oak
	10.24		759.44			N. Bk. 14 page 89
S.. 0				6.2	53.2	
1				8.3	51.1	
+35				10.4	49.0	
+40				10.8	48.6	
2				8.4	51.0	
3				4.1	55.3	
T.P.		1.06			755.38	On large boulder 3 R. of 3+45
	7.48		765.86			
4				5.4	60.5	
+65				1.1	64.8	
5				3.2	62.7	
6				5.1	60.8	
+30				7.8	58.1	
+60				10.1	55.8	
7				9.3	56.6	
8				8.1	57.8	
9				6.2	59.7	
T.P.		6.23			759.63	Peg at Sta. 9
	9.54		769.17			769.17 749.20
10				6.4	62.8	19.97
	27.26 7.29 19.97	7.29				

Fig. 10.

Level notes were kept in the form shown in Fig. 10.

On the final location at all bridge openings ravine sections were taken, all plusses being measured in with a cloth tape, and a very

NOTE.—In using the metric system, stakes are driven every 20 m., and numbered from the beginning, 0, 2, 4, 6, 8, 10, etc. Curves are run in, the same as when using 100-ft. stations, except that the deflections are for 20 m. instead of 100 ft.; as 20 m. equals very closely $\frac{2}{3}$ of 100 ft., the radius of an 8° curve metric equals approximately a 12° using 100-ft. chords. Tables of radii of metric curves are given in Henck and elsewhere.

Levels are taken as usual, ordinary readings to centimeters and target readings to millimeters. Profiles are platted on metric profile paper, the smallest divisions being millimeters, giving a profile, at the scale ordinarily used, about the same as that platted on Plate B paper.

Maps are usually platted on a scale of 1:5 000, about equal to 400 ft. to 1 in.