

adopted by the Union Pacific management in 1898. The construction work was inaugurated some time later by J. B. Berry, then chief engineer of the company. A most complete study of the problem was made from the previous surveys and explorations and from new surveys. These studies were continued down to the commencement of the work on this section last fall.

A profile of the original line (with some subsequent improvements) is shown in the upper part of the opposite page and the profile of the new second track at the lower part. A study of these will prove interesting, if it is borne in mind that the new line shows great improvement over the old in other ways than grade reductions (see accompanying table); although the actual decrease in total ascent is only $17\frac{1}{2}$ ft., and the saving in distance is practically nothing, the saving in total curvature is more than a half. The new line has a fairly uniform grade of 1.14% (compensated)

COMPARATIVE SUMMARY OF OLD AND NEW LINES OF UNION PACIFIC R.R., WAHSATCH TO EMORY, UTAH

Physical Characteristics	Via Present Operated Line	Via New Line	Difference Saving
Distance	16.159 mi.	15.817 mi.	0.342 mi.
Maximum curve	6° 00'	3° 00'	3° 00'
Total curvature (angle)...	1,321° 43'	564° 04'	757° 39'
Total curvature (length)...	7.654 mi.	5.703 mi.	1.951 mi.
Per cent. of line on curve...	47.3%	36.1%	11.2%
Maximum grade, eastbound	1.77%	1.14%	0.59%
Total ascents, eastbound..	905.40	887.92	17.48
Maximum grade	93.0	60.0	33.0

or 60 ft. per mi., while the grades on the old line on the approach to the summit average about 1.7% with a maximum of 1.77% or 93 ft. per mi.

This was accomplished, however, only at large expense as may be judged from the very heavy grading on the new line as shown on the profile. There are three tunnels in this 17-mi. stretch, and several fills of a half million cubic yards or more each, one of which has a maximum height of nearly 130 ft. The cost of these $13\frac{1}{2}$ mi. is in excess of \$3,000,000, which proves the truth of the statement made by Mr. Berry in 1904 that the great reduction in curvature and grades would not stand as a criticism of the work of the pioneer engineers who made the original location. The original lines located under the direction of the late Gen. Grenville M. Dodge, chief engineer, was allowed by law a maximum gradient of 116 ft. per mi., yet the grades were actually held down to a maximum of about 90 ft.

As shown in the plan the new second track is never more than 2,000 ft. from the old track. It lies mostly on the north or opposite side of the cañon, but crosses the old line at two places.

Much of the country is picturesque and in the cañon between the two tracks is a portion of the now famous Lincoln Highway. The accompanying views show the progress of the work on June 1, in the vicinity of Castle Rock, Utah. The chief engineer of the Union Pacific R.R. is R. L. Huntley, to whom *Engineering News* is indebted for the plan and profiles.

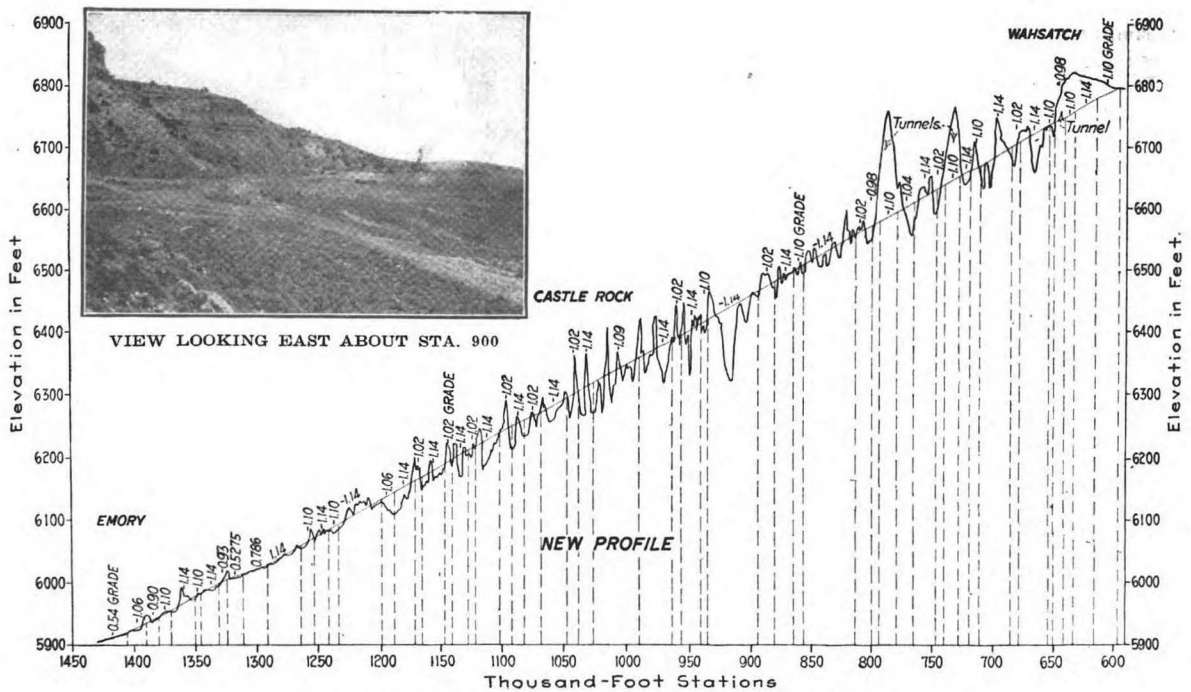
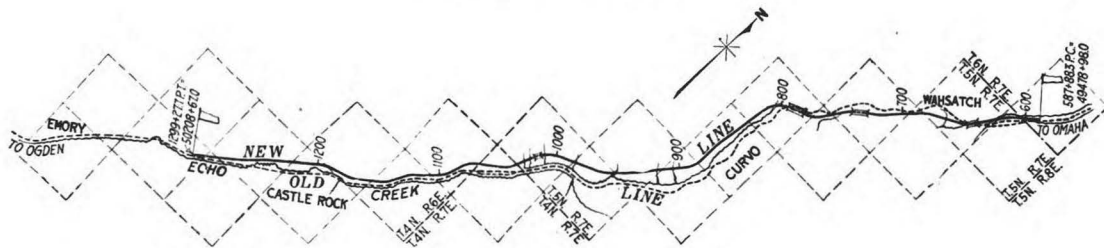
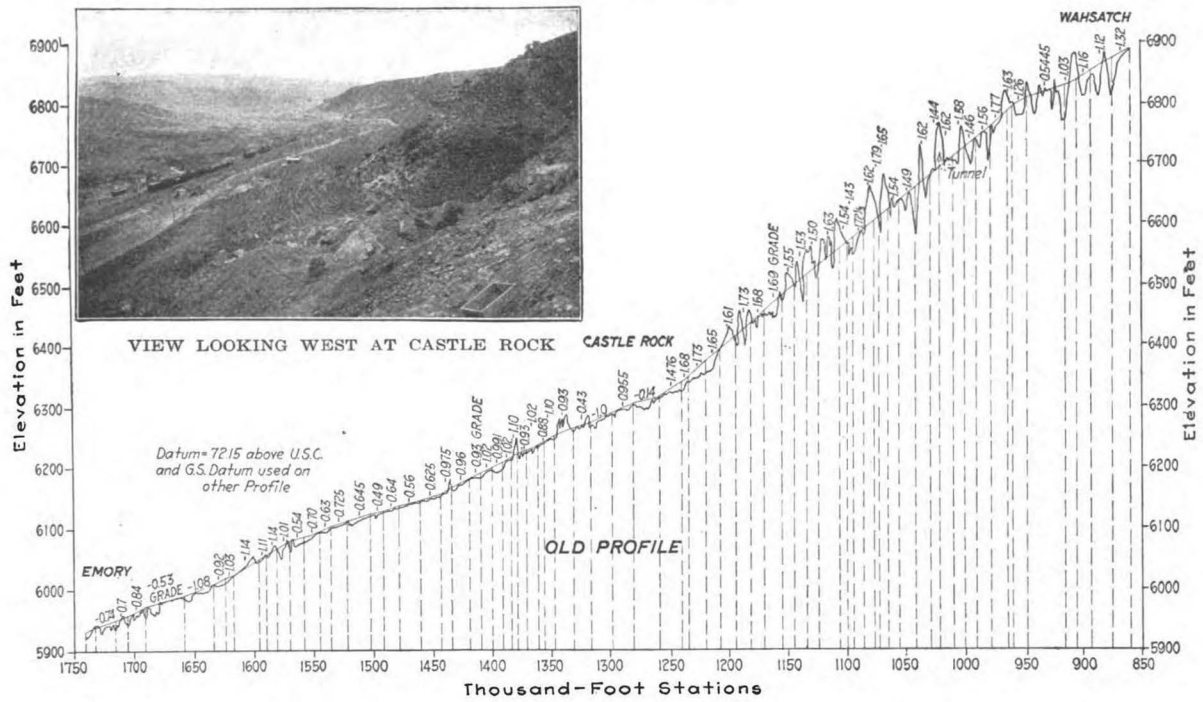
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New Line of Union Pacific R.R. Through Echo Cañon, Utah

A piece of railway construction which is notable and interesting from several points of view, is the building of the second track on the Wyoming division of the Union Pacific R.R. from Emory eastward to Wahsatch, the summit of the Wahsatch Mountains, near the boundary of Utah and Wyoming. This work is through the famous Echo Cañon, and is one of the two places on the Wyoming division of the Union Pacific where the reduction of the gradients to a maximum of 0.82% or 43.3 ft. per mi. is not feasible. The other place is from Cheyenne westward to Buford.

The stretch from Emory to Wahsatch up the head waters of Echo Creek, about $13\frac{1}{2}$ mi. long, which is now under construction, presents some interesting problems in railway location. This is a part of the original line located in 1864 by Samuel B. Reed, who selected the Weber and Echo Cañon route as the most feasible outlet from the Great Salt Lake Basin to the East, after many explorations and reconnoissances made under trying conditions. He went overland by stage to Salt Lake City and worked eastward.

The double-tracking of the line through this mountain pass is a part of the extensive program of betterment



DOUBLE-TRACKING THE UNION PACIFIC R.R. IN UTAH