# SOLUTION OF RAILROAD PROBLEMS BY THE SLIDE RULE

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# PREFACE

The ease and rapidity of solving problems in Railroad Curves by the use of the slide rule led the author to develop a set of problems for class-room work. The object of this book is to present similar problems for the convenience of students who have studied Railroad Curves and the Theory of the Slide Rule.

Where it is possible the solution of the problems should be made by the use of the *C* and *D* scales of the Mannheim slide rule on account of their greater precision.

The notation used in Allen's "Railroad Curves and Earthwork" is used thruout this discussion.

The discussion of the slide rule is from Professor C. W. Crockett's article in the *Polytechnic* of May 2, 1910.

The discussion of the slide rule, the development of the equations used and the discussion of the easement curve have been added to make this book of more general interest.

E. R. Cary.

Troy, N. Y.
*March* 1, 1913.

# THE SOLUTION OF RAILROAD PROBLEMS BY THE SLIDE RULE

THIS discussion will be given under the following heads: The Slide Rule, Problems in Simple Curves, Problems in Compound Curves, The Vertical Curve, Turnouts, The Easement Curve, and Problems in Earthwork.

## CHAPTER I

### THE SLIDE RULE

1. The Mannheim and Carpenter rules are the most common types of the slide rule. The face of either bears two kinds of scales, on one of which, for the ordinary ten-inch rule, the distance from 1 to 1 is about 5 inches, while on the other the distance from 1 to 1 is about 10 inches, the latter distance being exactly double the former.

Let us call the shorter scale the single scale and the longer scale the double scale; on the

Mannheim rule, the single scale is called $A$ or $B$ and the double scale is $C$ or $D$; on the Carpenter rule, the single scale is called $A$ or $B$, and the double scale is called $C$. Note that the double scale is the long scale.

Let $a$ and $b$ be constant numbers and $x$ a third number to which different values are to be assigned, and suppose we wish to find the values of $y$ in any one of the following expressions:

$$y = \frac{ax}{b},\ y = \frac{ax^2}{b^2},\ y = \sqrt{\frac{ax}{b}},\ y = \sqrt{\frac{ax^2}{b^2}},$$

$$y = \frac{ab}{x},\ y = \frac{ab^2}{x^2},\ y = \sqrt{\frac{ab}{x}},\ y = \sqrt{\frac{ab^2}{x^2}},$$

or of any similar expression containing two factors in the numerator and one in the denominator, any one or more being squared, $a$ being a constant factor in the numerator.

The method of setting the instrument is as follows:

1°. If $x$ is in the numerator, use the slide direct.

If $x$ is in the denominator, use the slide inverted.

2°. The numbers $a$, $b$, $x$ and $y$ are found on the instrument in the order named; $a$ on the rule, $b$ on the slide, $x$ on the slide, $y$ on the rule; that is, we look on the rule and slide in the following order: *Rule, slide, slide, rule.* Or we could find $a$ on the slide, $b$ on the rule, $x$ on the rule, $y$ on the slide; that is, we look on the rule and slide in this order, *Slide, rule, rule, slide.*

3°. If $a$, $b$ or $x$ is raised to the first power, we must find it on a single scale; if squared, on a double scale.

4°. If $y$ is a first power, we must find it on a single scale; if a square root, on a double scale.

Thus to find the value of $y = \frac{ax^2}{b^2}$ with the Mannheim rule, we may proceed in two ways, using the slide direct, since $x$ is in the numerator:

(a) Find $a$ on the *single* scale on the *rule*, and opposite it set $b$ on the *double* scale on the *slide;* find $x$ on the *double* scale on the *slide*, and opposite it read the result $y$ on the *single* scale on the *rule.* Or:

(b) Find $a$ on the *single* scale on the *slide*, and opposite it set $b$, found on the *double* scale on the rule; find $x$ on the *double* scale on the rule, and opposite it read the result $y$ on the *single* scale on the *slide.*

The same problem may be solved with the Carpenter or Thacher rule, but only by the second method, since the slide does not bear a double scale; this limitation is not objectionable, however, except in continued operations, where it is desirable to use the runner.

Had we wished to find the value of $y = \sqrt{\frac{ax^2}{b^2}}$, the settings on the Mannheim rule would have been the same as before, but the result $y$ would have been on the *double* scale instead of on the single scale. The Carpenter or Thacher rule cannot solve this problem without first reading on the slide the value of $\frac{ax^2}{b^2}$, and then determining its square root.

2. The Mannheim slide rule is used in the solution of the problems given herein. The scales of this rule are as follows: The upper scale of the rule, *A*; the upper scale of the slide, *B*; the lower scale of the slide, *C*; the lower scale of the rule, *D*. On the back of the slide are the sine and tangent scales, and when these are to be used the slide must be reversed, i.e., the slide changed in the rule so that the back face is brought to the front.

## CHAPTER II

### SIMPLE CURVES

**3.** The center line of a railroad track consists of tangents and curves (circular arcs), and, in modern practice, also of some form of easement curve connecting them.

**4.** In this country a curve is designated by its degree. The degree of a curve is the central angle subtended by a chord of one hundred feet. If the metric system is used, the degree of a curve may be defined as the central angle subtended by a chord of ten meters. In almost all other countries a curve is designated by its radius.

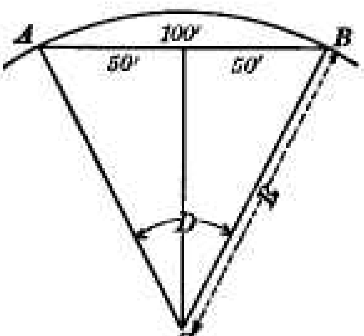

Fig. 1

From Fig. 1,

$$R \sin \tfrac{1}{2} D = 50;$$

$$R = \frac{50}{\sin \tfrac{1}{2} D}.$$