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# The Crichlow Slide Rule

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## Introduction

In 1936, Robert Crichlow was a captain in the US Army and an instructor at the coast artillery school at Fort Monroe in Virginia. At the time, the coast artillery was beginning to specialize in antiaircraft artillery, which required the solution of many problems involving trigonometry. Crichlow developed a circular slide rule for computations arising in antiaircraft artillery. Crichlow went on to a distinguished career in the army, rising to the rank of Major General before his retirement in 1953.

The first version of this slide rule is described in the 1940 edition of the *Antiaircraft Artillery Field Manual*[1]. This version of the slide rule bears a copyright notice with the year 1936 and Crichlow's name. The slide rule was of the binary type, with two cursors that could be moved separately or together. One cursor was longer than the other and called "L", while the shorter cursor was called "S". The cursors were fastened to the disk with a flat spring that acted to hold the two cursors together.

In artillery work, all angles were given in the mil system, with 6400 mils to a full circle, 1600 mils to a right angle, and so on. The outermost scale was a simple scale of 6400 mils, allowing the slide rule to be used as a circular protractor. The remaining scales moving from the outside to the center were simply labeled A through F.

Scale E was a conventional one cycle logarithmic scale. This scale could be used with the two cursors for multiplication and division problems. Scale F was a two cycle logarithmic scale that could be used with the E scale to compute squares and square roots.

The A scale ranged from 105 to 1500 mils. After setting the cursor to an angle  $\theta$  on this scale, the value of  $1/\sin(\theta)$  could be read on the E scale. Similarly, the B scale could be used to compute values of  $1/\cos(\theta)$ , and the C scale could be used to compute values of  $\tan(\theta)$  for  $\theta$  between 800 and 1490 mils and  $\cot(\theta)$  for angles between 120 and 800 mils. The D scale was also used to compute values of  $1/\sin(\theta)$ . The D scale was setup with three sets of labels. The first two sets of labels were such that angles from 100 mils to 1400 mils had values of  $1/\sin(\theta)$  between 1 and 10 while angles from 10 to 100 mils had values of  $1/\sin(\theta)$  between 10 and 100. The third part of the D scale covered angles from 1800 mils to 3080 mils, again with values of  $1/\sin(\theta)$  between 10 and 100.

Instructions for the solution of right triangles and oblique triangles were printed in the center of the slide rule. For example, to solve for the hypotenuse  $D$  of a right triangle given a side  $H$  and the opposite angle  $\epsilon$ , the user would move the short cursor "S" to the index,

and set the long cursor "L" to the angle  $\epsilon$  on the D scale. Then, while holding the angle between "L" and "S" fixed, the user would move the cursors until the short cursor "S" was at  $H$  on the E scale. Finally, the user could read the length of the hypotenuse under the "L" cursor on the E scale. This amounts to computing  $D = H/\sin(\epsilon)$  by multiplying  $H$  times  $1/\sin(\epsilon)$ .

The description of the Crichlow slide rule in the 1940 edition of the field manual ends with a note that the design of the slide rule was being revised. The redesigned slide rule was designated the M1 slide rule. The 1943 edition of the field manual describes the M1 version of the Crichlow slide rule[2].

While the author is not aware of any existing examples of the original model of the Crichlow slide rule, the M1 slide rule is fairly common, appearing on eBay several times each year. The M1 slide rule is about 12" in diameter and 1/16" thick, made of a masonite like material, with yellow plastic cursors.

In the redesigned slide rule, the outer protractor scale, the F scale, and the redundant A scale are removed. The remaining scales are not renamed but are rearranged, with the D scale outermost, followed by the E scale, B scale, and C scale. Instructions for the solution of right triangles are given on the front of the slide rule, while instructions for the solution of oblique triangles are moved to the back of the slide rule. A small plotting grid also appears on the back of the rule.

Detailed instructions on the use of the Crichlow slide rule can be found in both the 1940 and 1943 editions of the field manual[1,2]. Another source of information on the Crichlow slide rule is a textbook on mathematics for artillery written by Sophia H. Levy[3]. Levy's book contains detailed instructions for the use of the M1 slide rule. This book came with two straight plastic rules. The first of these rules has copies of the E and D scales from the Crichlow slide rule. The second rule has the C, B, E, and D scales. These two scales can be used together to perform computations in the same way as on the Crichlow slide rule.

## References

- [1] War Department, Field Manual FM 4-110, *Antiaircraft Artillery Field Manual*. Washington, US Government Printing Office, 1940.
- [2] War Department, Field Manual FM 4-110, *Antiaircraft Artillery Field Manual*. Washington, US Government Printing Office, 1943.
- [3] Levy, Sophia H. *Introductory Artillery Mathematics and Antiaircraft Mathematics*. Berkeley, University of California Press, 1943.

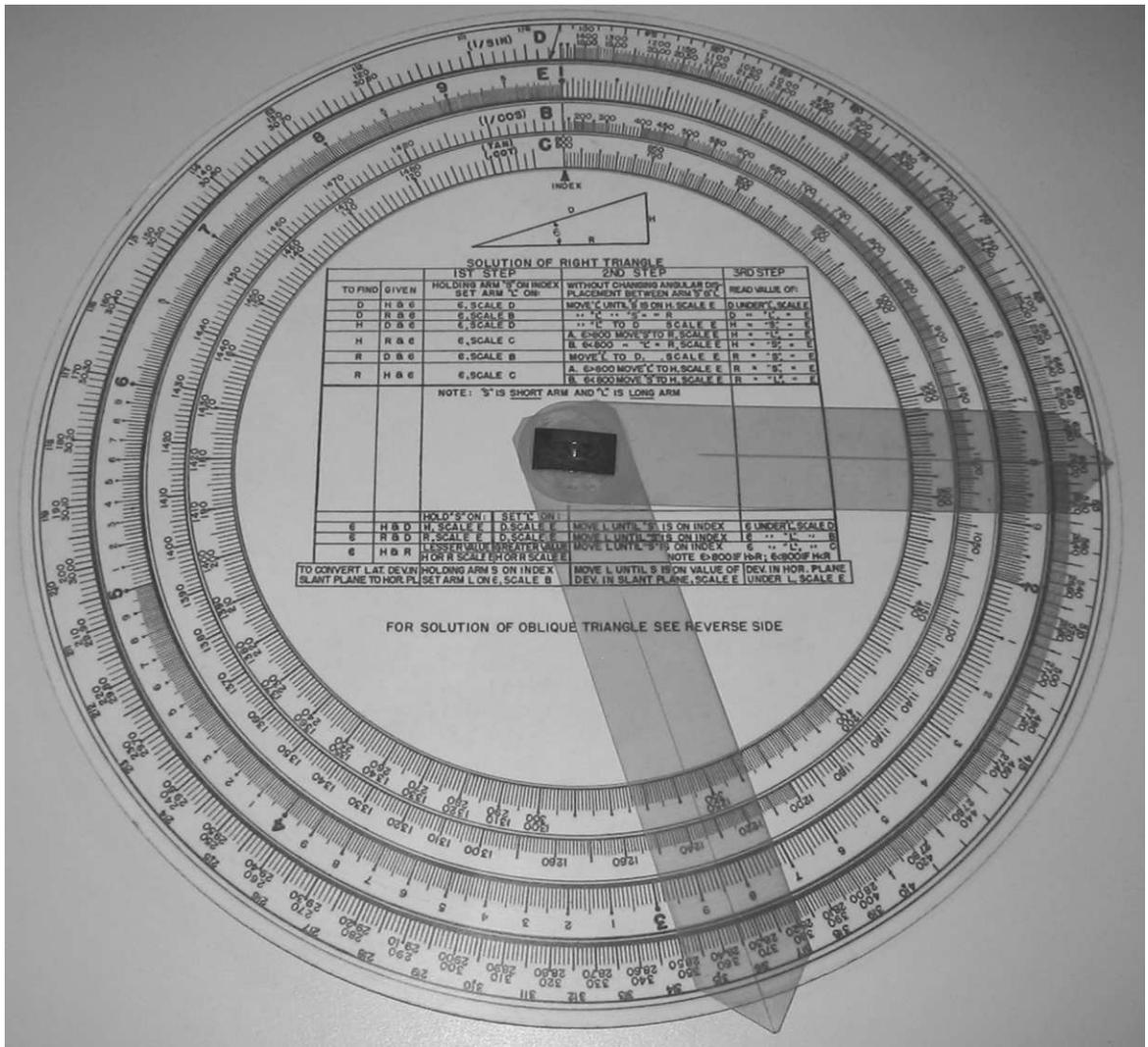


Figure 1: Front view of the Crichlow Slide Rule.

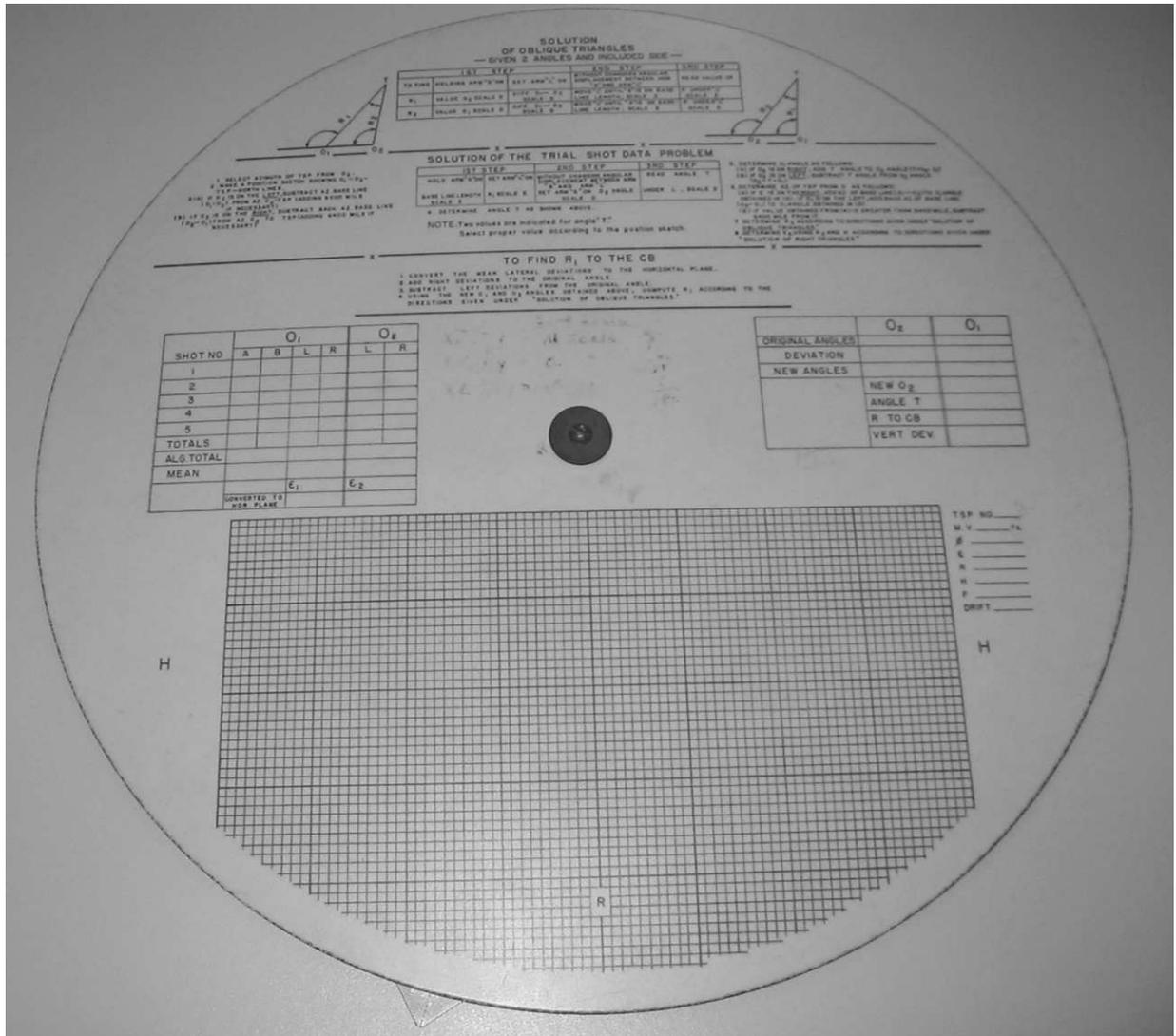


Figure 2: Back view of the Crichlow Slide Rule.