down of a double throw switch with somewhat unusual elements, how he obtained the positions of frogs, etc., he replied that he got them all by scale from a plot on a large scale—graphically, in fact, which is the way Trautwine recommends. Now, the author is far from being opposed to graphic methods, and is especially fond of them in his own practice; but in the case of complicated switch and turnout problems, the graphic method (except as a check on final results when it is invaluable) is extremely tedious, and necessitates a large amount of trial and error work, plenty of paper and table room and lots of time. A man cannot have all these things with him in the field, and more time is wasted in going to his office perhaps 30 or 40 miles and coming back with the results.

For above mentioned reasons, the writer long ago came to the conclusion that the lead of the turnout should be circular from the heel of switch to the point of the frog, the slide rail being part of the circular curve instead of external to it, and being bent around stop spikes driven into the ties to this circular form. So far, so good; and he believes that this is not only his own practice but that of many others. Now to find the frog distance. Let A, fig. 2, be the frog, and a its angle. Produce its line to meet the opposite rail at P, then AP.C $= a$. Let g represent the gauge of track

$$AP = g. \operatorname{cosec} a \text{ or } \frac{g}{\sin a}$$

but A.P. is the subtangent of the circular arc AB, and the angle being small the arc and chord are for practical purposes equal to one another, and also to the sum of the subtangents = 2 AP = frog dist.

Frog distance, $$F = \frac{2g}{\sin a} \quad (1)$$

Now the number of the frog is the reciprocal of the chord of the angle, or in small angles such as generally occur on railways practically of its sine. Thus a No. 10 frog has a chord or sine of $\frac{1}{10}$.

Hence approximately the frog distance

$$F = 2 N g. \quad (2)$$

g being taken as 4.7 feet a No. 10 frog will then have a frog distance of 94 feet. We shall see further on how well this agrees with another formula obtained in a different way.

F in this and subsequent formulas and equations means the distance of frog point from the heel of the switch instead of from the toe, as in the pocket-book tables we have quoted.

This last distance we shall refer to as the lead, and denote by the letter L. The length of slide rail we will call S.

g is the gauge usually 4.7 ft.

T is the throw of switch usually 5 inches, which for simplicity and with ample accuracy we may consider as ·4 ft.

Now to obtain the length of slide rail S. Take the diagram in Fig. 3, a simple turnout with a 1 in 10 frog. For such a small arc as 94 ft. we may consider the curve as being a parabola and that the offsets from the tangent are proportional to the squares of the distances from the heel of switch or point of curvature.

Now at the toe we have an offset by hypothesis of T, or ·4 ft. At the frog we have the gauge or 4.7 ft.

Hence $$\frac{S^2}{F^2} = \frac{T}{g}$$

$$S^2 = F^2 \left(\frac{T}{g}\right)$$

and $$S = F\sqrt{\frac{T}{g}} \quad (3)$$

For all ordinary railway cases T and G are constants

and $$\sqrt{\frac{T}{G}} = \cdot 29$$

Hence $$S = \cdot 29 \text{ F} \quad (4)$$

or in Fig. 3 S = ·29 × 94 = 27.3 feet.