

Two parallel straight tracks may be conveniently connected by a turnout in four different ways.

- I. By a reversed curve, the two curves having equal radii.
- II. By a reversed curve, the two curves having unequal radii, and with P.R.C. at point of frog F.
- III. By (a) a simple curve to F, (b) tangent, and return by (c.) curve of radius equal to the first.
- IV. By (a.) a simple curve to F, (b.) tangent, and return by (c.) simple curve of radius unequal to first.

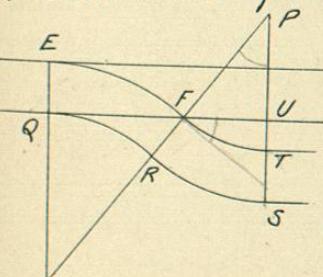
I. Problem. Given the perpendicular distance between two parallel tangents = P ; also the common radius = R .

Required I_r .

$$\text{Formula (65.) vers } I_r = \frac{\frac{1}{2}P}{R}$$

II. Problem, Given, the radius of the first curve = R , also I' and P

Required, the radius of the second curve R_2 to connect the parallel tangents.



If P.R.C. be taken at F
Then $I_r = I'$

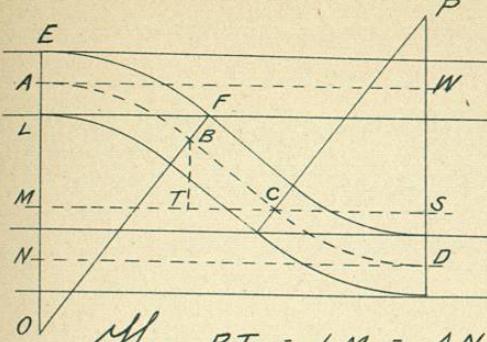
$$\begin{aligned} UT &= US - TS \\ PT \text{ vers } TPF &= US - TS \\ \left(R - \frac{g}{2}\right) \text{ vers } I' &= P - g \\ R - \frac{g}{2} &= \frac{P-g}{\text{vers } I'} \quad (106) \end{aligned}$$

Problem Given as above R , $-I'$, $P-n$
Required to show that

$$R_2 - \frac{P}{2} = (P-g) 2 n^2 \quad (107)$$

III. Problem Given R. F. p

Required the length ℓ of tangent between the two curves of equal radii.



Let $AW - ND$ be the center lines of the parallel tracks and $ABCD$ the turnout curve. Draw the perpendiculars $LB - MCS - BT$.

$$\text{Then } BT = LM = AN - AL - MN$$

$$CB \sin BCT = AN - AO \text{ vers } AOF - PD \text{ vers } DPC.$$

$$\ell \sin I' = P - R \text{ vers } I' - R \text{ vers } I'$$

$$\ell = \frac{P - 2R \text{ vers } I'}{\sin I'} \quad (108.)$$

Roughly Approximate Formula.

$$R \text{ vers } I' = g \text{ (approx.)}$$

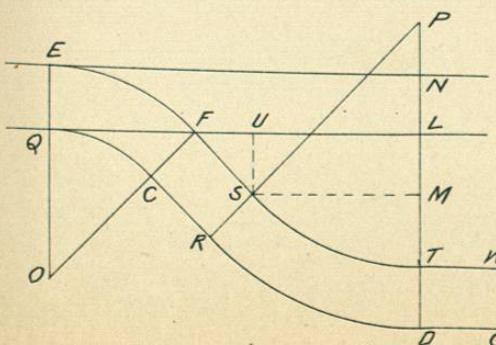
$$\sin I' = 2 \tan \frac{1}{2} I' = \frac{2}{ct \frac{1}{2} I'} = \frac{1}{n} \text{ (approx.)}$$

$$\text{from (108.) } \ell = (P - 2g)n \text{ (roughly)} \quad (109.)$$

The value thus found is hardly accurate enough for direct use in laying out track, but for "checking" and perhaps for other purposes will be found useful.

IV. Problem Given, R. - g - p - ℓ - F.

Required, R₂.



Let EN and QL TW and DG be the rails of the parallel tangents and $EFST$ and $QCRD$ the rails of the turnout.

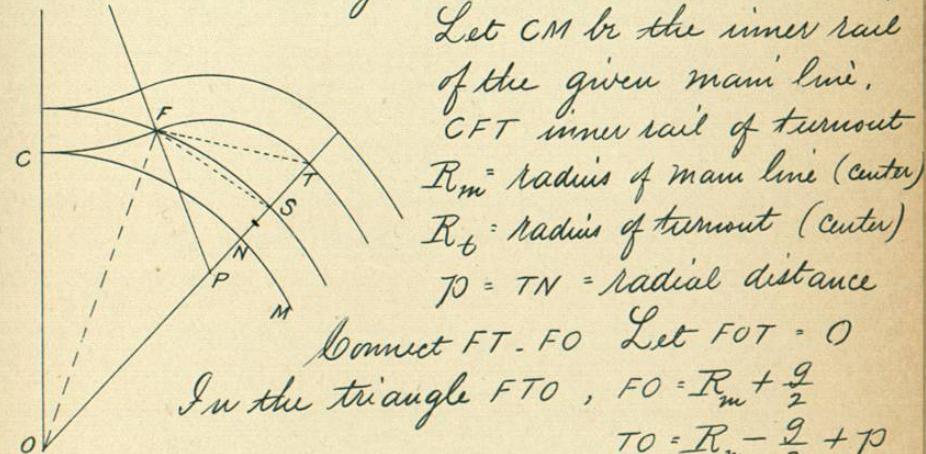
Draw the perpendiculars $US - SM$.

$$\begin{aligned} \text{Then } SU - LM &= NT - NL - MT \\ FS \sin UFS &= NT - NL - PS \text{ vers SPM} \\ \ell \sin F &= P - g - (R_2 - \frac{g}{2}) \text{ vers } F' \\ R_2 - \frac{g}{2} &= \frac{P - g - \ell \sin F}{\text{vers } F'} \quad (110.) \end{aligned}$$

Problem Given the radial distance P between a given curved main track and a parallel siding, also frog angle F (or number n) and gauge of track g .

Required the radius of second curve to connect point of frog with siding.

I. When the siding is outside the main track.



Let CM be the inner rail of the given main line.

CFT inner rail of turnout

R_m = radius of main line (center)

R_t = radius of turnout (center)

$P = TN$ = radial distance

Connect $FT - FO$ Let $FOT = O$

In the triangle FTO , $FO = R_m + \frac{g}{2}$

$$TO = R_m - \frac{g}{2} + P$$

$$\text{also } OFT + OTF = 180^\circ - O$$

$$OFT - OTF = OFT - PFT = F$$

$$\text{Then } \tan \frac{1}{2}(OFT + OTF) : \tan \frac{1}{2}(OFT - OTF) = TO + FO : TO - FO$$

$$\cot \frac{1}{2} O : \tan \frac{1}{2} F = 2R_m + P : P - g$$

$$\tan \frac{1}{2} O = \frac{P - g}{2R_m + P} \cot \frac{1}{2} F = \frac{P - g}{R_m + \frac{P}{2}} \cdot \frac{\cot \frac{1}{2} F}{2}$$

$$\tan \frac{1}{2} O = \frac{P - g}{R_m + \frac{P}{2}} n \quad (111.)$$

$$\text{Similarly } FPT = F + O. \text{ Join } FS \quad (112.)$$

$$\text{In the triangle } PFS, \tan \frac{1}{2}(F+O) = \frac{P - g}{R_t - \frac{P}{2}} n ; R_t - \frac{P}{2} : \frac{(P-g)n}{\tan \frac{1}{2}(F+O)}$$

$$\text{Length of curve } I = \frac{100(F+O)}{D_t} \quad (113.)$$

Approximate Method.

It may readily be shown to be approximately true that if the entire turnout from a straight track be calculated, and the degree of each curve found, then by adding or subtracting the degree of curve of main track, the resulting degree of curve will be the degree required. The distances CF - FT will be the same as in the turnout from straight track. The demonstration will follow in principle closely that given in reaching (91.)

Example.

Turnout from straight line with No. 9 frog - $\gamma = 15$.

$$R - \frac{P}{2} = (P-g) 2 n^2 = (15.0 - 4.7) 2 \times 81 = 1668.6$$

$$R = 1676.1 ; D = 3^\circ 25' ; F = 6^\circ 22' (\text{Table XI})$$

$$I = \frac{100 \times 6^\circ 22'}{3^\circ 25'} = 186.3$$

Turnout from Curve outside the main track on 4° curve.

Precise Method

$$\begin{aligned} \tan \frac{1}{2} O &= \frac{P-g}{R_m - \frac{P}{2}} n & 92.7 \log 1.967080 \\ &= \frac{10.3}{1440.2} \times 9 & 1440.2 \log 3.158422 \\ &= \frac{92.7}{1440.2} & \frac{\frac{1}{2} O = 3^\circ 41'}{\tan 8.808658} \\ && \frac{\frac{1}{2} F = 3^\circ 11'}{\frac{1}{2}(F+O) = 6^\circ 52'} \\ && \frac{92.7}{\tan 9.080710} \\ && \log 1.967080 \end{aligned}$$

$$\begin{aligned} R_t - \frac{P}{2} &= \frac{(P-g) n}{\tan \frac{1}{2}(F+O)} & 92.7 \\ &= \frac{92.7}{\tan 6^\circ 52'} & 769.8 \\ && \frac{769.8}{\log 2.886370} \\ && \frac{7.5}{\log 1.967080} \end{aligned}$$

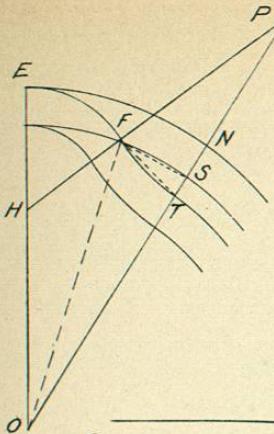
$$\begin{aligned} R_t &= 777.3 \\ D_t &= 7^\circ 23' \\ I_t &= \frac{100(F+O)}{D_t} = \frac{100 \times 13^\circ 44'}{7^\circ 23'} = 186.4 \end{aligned}$$

Turnout from Curve - Approximate Method

$$D_t = \frac{D}{4^\circ} + D_m = 7^\circ 25' (7^\circ 23' \text{ precise method}).$$

$$I_t = 186.3 \text{ as with straight track. (186.4 precise method).}$$

II. When the siding is inside the main track.



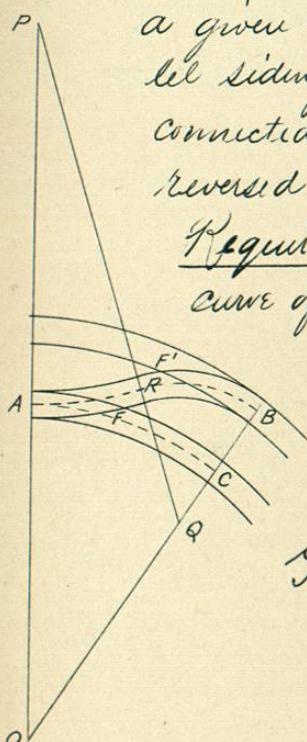
In a similar fashion it may be shown, using this figure, that $\tan \frac{1}{2} O = \frac{P - g}{R_m - \frac{P}{2}} n \quad (114.)$

$$R_s - \frac{P}{2} = \frac{(P - g) n}{\tan \frac{1}{2}(F - O)} \quad (115.)$$

$$I_1 = \frac{100(I - O)}{D_t} \quad (116)$$

Problem. Given, the radial distance between a given curved main track and a parallel siding. The two tracks are to be connected by a crossover which is a reversed curve of given unequal radii.

Required, the central angle of each curve of the reversed curve.



Let ARB be center line of turnout.

AC center line of main track.

$$AO = R_m$$

$$AP = R_1$$

$$RQ = R_2$$

Then in the triangle POQ

$$PO = R_m + R_1$$

$$PQ = R_1 + R_2$$

$$\begin{aligned} OQ &= OC + CB - BQ \\ &= R_m + P - R_2 \end{aligned}$$

Solve for $OPQ - PQO - POQ$, then RQB

In practice this problem might take the following form Given $R_m - P - g$ Assume n (or I) and n' (or I'). From these calculate R_1 and R_2 (use Table XI scales). Then solve as above.

Approximate Method.

Where ρ is very small compared with R_m , the degree of curve used will frequently be found by the formulas (approx.) $D_{t_1} = D - D_m$

$$\text{and } D_{t_2} = D + D_m$$

The length of each part may be found for a cross over between parallel straight tracks and the same length used in the case of the cross over between curves.

The process is similar in every way to that shown by example in the previous problem.

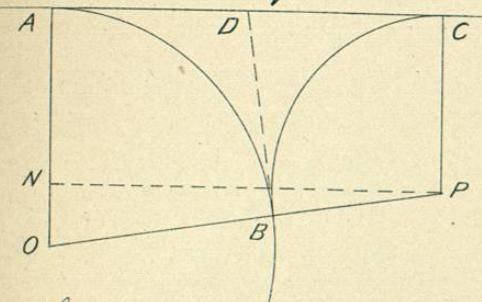
A similar method of treatment will be applicable in all turnouts from curves where the distance between tracks is not too great.

"Y" Tracks.

In many cases where a branch track leaves a main track, there is laid an additional track, connecting with the branch, but leading from the main line in a direction opposite from that of the branch track. Such a track is called a "Y" track and the combination of connecting tracks is called a "Y". The convenient use of a "Y" is to turn an entire train at once without uncoupling.

Problem Given, a straight main track, also the P.C. and radius of a simple curve turnout

Required, the distance from P.C. of turnout to P.C. of "Y" track, also the central angles of turnout and of "Y" track to the point of junction.



Let AC be the given straight main track.

AB the turnout

CB the "Y" track.

Draw perpendicular NP
also common tangent DB

Let $AC = \tau$; $\angle AOB = I_t$; $\angle CPB = I_y = 180 - I_t$.

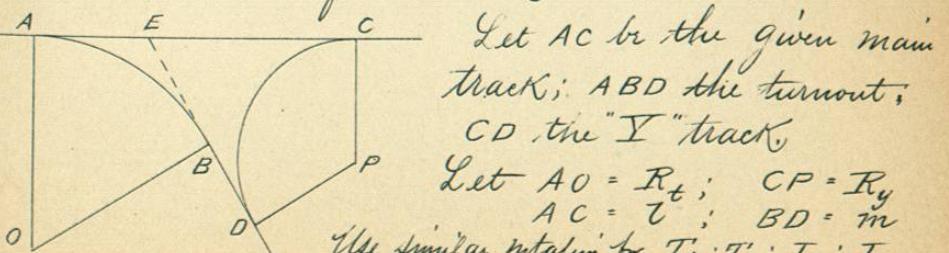
Then $\cos AOB = \frac{ON}{OP}$

$$\cos I_t = \frac{R_t - R_y}{R_t + R_y} \quad (117.)$$

$$\tau \cdot (R_t + R_y) \sin I_t \quad (118.)$$

Problem Given, a straight main track, also the P.C., radius and central angle of a simple curve turnout connecting with a second tangent; also the radius of a "Y" track.

Required, the distance from P.C. of turnout to P.C. of "Y" track, and from P.T. of turnout curve to P.T. of "Y" track.



Let AC be the given main track; ABD the turnout; CD the "Y" track.

$$\text{Let } AO = R_t; CP = R_y \\ AC = \tau; BD = m$$

The similar relation for $I_t; I_y; I_t; I_y$.

Produce BD to E .

$$\text{Then } AC = AE + EC$$

$$= AO \tan \frac{1}{2} AOB + CB \tan \frac{1}{2} CPD$$

$$l = R_t \tan \frac{1}{2} I_t + R_y \cot \frac{1}{2} I_t$$

$$l = I_t + I_y \quad (119.)$$

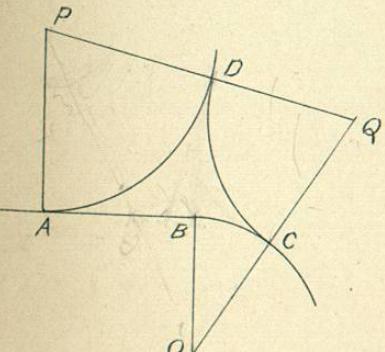
$$BD = ED - EB$$

$$= I_y - I_t \quad (120.)$$

Problem. In the accompanying sketch when

ABC = Main track.

AD = turnout



Given, $AB = l$
 $OB = R_m$
 $AP = R_t$
 $DQ = R_y$

Required, the points D and C .

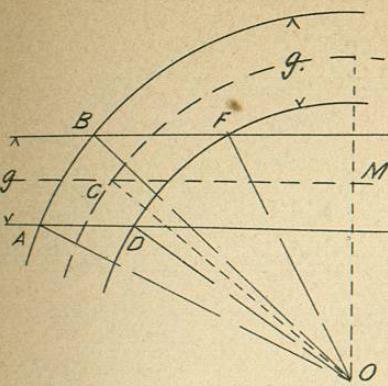
$$AP : AB = R_t : R_m$$

$$R_t : R_m = AB : BQ$$

$$AP : BQ = R_t : R_m$$

$$AP \times BQ = R_t \times R_m$$

$$AP \times BQ = R_t \times R_m$$

Crossings.

Problem. Given a curve crossing a tangent, R - g , and angle C between tangent and curve.

Required fog angles at $A - B - F - D$

Draw lines $AO - BO - FO - DO$
also MO perpendicular to CD

$$\text{Then } MO = R \cos C$$

$$\cos A = \frac{MO - \frac{g}{2}}{R + \frac{g}{2}}$$

$$\cos D = \frac{MO - \frac{g}{2}}{R - \frac{g}{2}}$$

$$\cos B = \frac{MO + \frac{g}{2}}{R + \frac{g}{2}}$$

$$\cos F' = \frac{MO + \frac{g}{2}}{R - \frac{g}{2}}$$