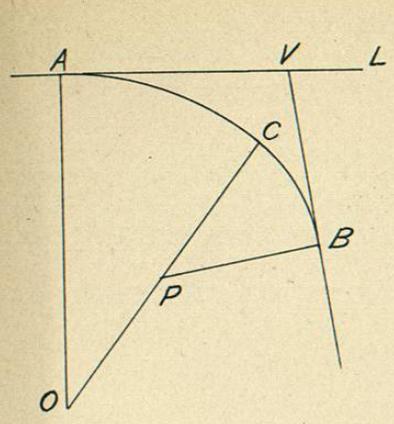


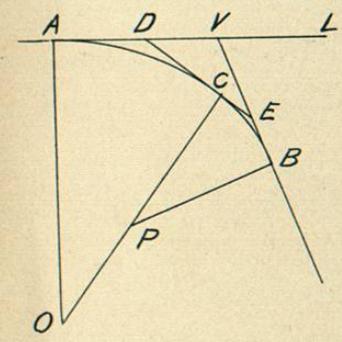
Data Used in Compound Curve Formulas.



In the curve of larger radius
 $OA = R_2$
 $AOC = I_2$
 $AV = I_2$

In the curve of shorter radius.
 $PB = R_1$
 $BPC = I_1$
 $VB = I_1$
 $LVB = I$

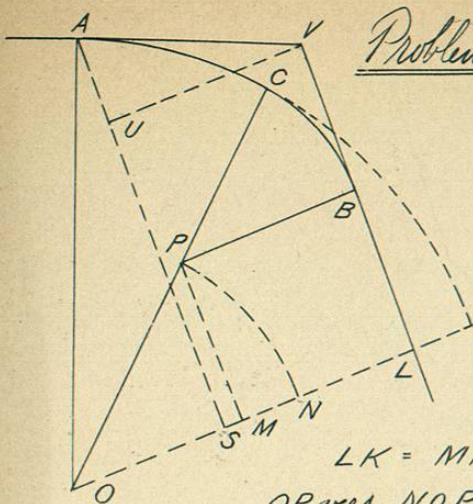
Problem. Given $R_2 - R_1 - I_2 - I_1$
 Required $I - I_2 - I_1$



Draw the common tangent DCE
 Then $I = I_2 + I_1$
 $AD = CD = R_2 \tan \frac{1}{2} I_2$ } or use Tables
 $EB = CE = R_1 \tan \frac{1}{2} I_1$ } Table VI and
 Cor. Table V.
 In the triangle DVE we have
 $DE = R_2 \tan \frac{1}{2} I_2 + R_1 \tan \frac{1}{2} I_1$
 $VDE = I_2$
 $VED = I_1$
 $DVE = 180 - I$

Solve for VD and VE
 $AV = AD + VD = I_2$
 $VB = BE + VE = I_1$

$\frac{1}{2} FB = FG \sin F$
 $\frac{1}{2} (b) = FG \sin F$
 $R = \frac{b}{2 \sin F}$
 $R = \frac{b}{2 \sin F}$
 $\frac{1}{2} FB = FG \sin F$
 $FG = \frac{\frac{1}{2} FB}{\sin F}$



Problem Given $T_2 - R_2 - R_s - I$.

Required $I_s - I_2 - I_s$.

Draw arcs NP - KC

" Perpendiculars OK - AS - PM - VU

Then $LM = BP = KN$

$MN = LM - LN = KN - LN = KL$

$$LK = MN = KS - LS$$

$$OP \text{ vers } NOP = AO \text{ vers } AOK - AV \sin VAS$$

$$(R_2 - R_s) \text{ vers } I_s = R_2 \text{ vers } I - T_2 \sin I$$

$$\text{vers } I_s = \frac{R_2 \text{ vers } I - T_2 \sin I}{R_2 - R_s} \quad (48)$$

$$I_2 = I - I_s$$

$$VB = AS - PM - AU$$

$$I_s = R_2 \sin I - (R_2 - R_s) \sin I_s - T_2 \cos I \quad (49)$$

Problem Given $T_2 - R_2 - I_2 - I$.

Required $I_s - R_s - I_s$.

$$I_s = I - I_2$$

$$R_2 - R_s = \frac{R_2 \text{ vers } I - T_2 \sin I}{\text{vers } I_s} \quad (50)$$

$$I_s = R_2 \sin I - (R_2 - R_s) \sin I_s - T_2 \cos I \quad (51)$$

Problem Given $T_2 - I_s - R_2 - I$.

Required $R_s - I_2 - I_s$.

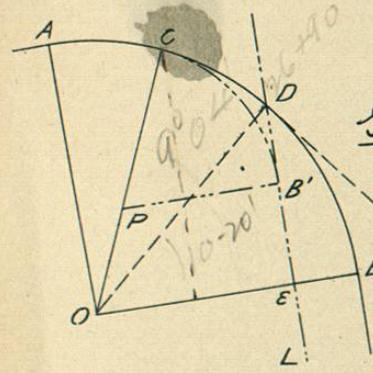
Show that $\tan \frac{1}{2} I_2 = \frac{R_2 \text{ vers } I - T_2 \sin I}{R_2 \sin I - T_2 \cos I - I_s} \quad (52)$

$$R_2 - R_s = \frac{R_2 \sin I - T_2 \cos I - I_s}{\sin I_s} \quad (53)$$

Let AB be the given curve of radius R_2 .
 C be the P.C.C.
 CB' the second curve of radius R_5 .
 BE = p = distance between tangents
 Then vers $COB = \frac{p}{R_2 - R_5}$ (56.)

It may sometimes be more convenient or quicker to run in a simple curve first and change to a compound curve by the method of this problem, rather than to run in the compound curve at first.

When it is impossible or inconvenient to run in the curve as far as B (P.T.) the point of intersection D between the curve and the tangent may be found, the angle LDN measured and BE calculated
 $BE = DO \text{ vers } DOB$
 $p = R_2 \text{ vers } LDN$ (57.)



Example

Given Notes of Curve 5 curve R.
 22 + 20 P.C.

Proposed tangent intersects curve at 26 + 90.

Angle between tangent and curve = 10° 20'

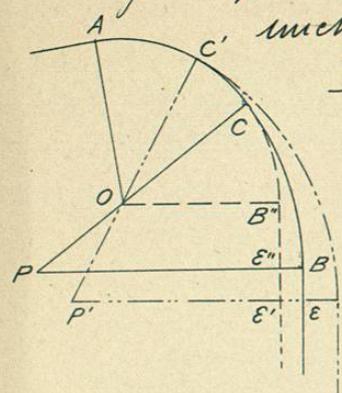
Required station of P.C.C. to join proposed tangent.

$p = R_5 \text{ vers } 10^\circ 20'$

| | | |
|-----------------------------|----------|------------------------------------|
| $R_5 \log$ | 3.059290 | vers $COB = \frac{p}{R_5 - R_7}$ |
| $10^\circ 20' \text{ vers}$ | 8.210028 | |
| $p \log$ | 1.269318 | |
| | | $R_5 = 1146.28$ |
| | | $R_7 = 819.02$ |
| | | $p \log$ |
| | | 1.269318 |
| | | $\rightarrow \log$ |
| | | 2.514893 |
| | | vers |
| | | 8.754425 |
| | | |
| | | $\frac{327.26}{19^\circ 24'}$ |
| | | $\frac{10^\circ 20'}{9^\circ 04'}$ |
| | | $= \frac{9.0667}{181.3}$ (5°) |

$\frac{26 + 90}{1 + 81.3} = 25 + 08.7$ P.C.C.

Problem Given a compound curve ending in a tangent
Required, to change the P.C.C. so as to end in a given parallel tangent, the radii remaining unchanged.



I. When the new tangent lies outside the old tangent, and the curve ends with curve of larger radius.

Let ABC be the given compound curve.
 AC'B' the required curve.

Produce arc AC to B''

Draw OB'' parallel to PB and B''E'' perpendicular to P'B'.
 Let B'E = p = perpendicular distance between tangents.

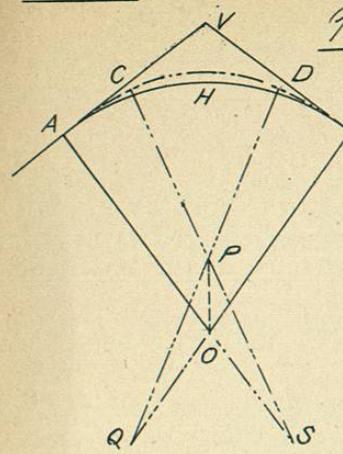
Then $B'E = B'E' - B'E''$
 $B'E = (R_2 - R_1) \text{vers } C'OB' - (R_2 - R_1) \text{vers } COB''$
 $p = (R_2 - R_1) \text{vers } I_2' - (R_2 - R_1) \text{vers } I_2$
 $\text{vers } I_2' = \text{vers } I_2 + \frac{p}{R_2 - R_1}$ (58.)
 $AOC = I - I_2$

II. When the new tangent lies inside the old tangent and the curve ends with the curve of larger radius. $\text{vers } I_2' = \text{vers } I_2 - \frac{p}{R_2 - R_1}$ (59.)

III. When the new tangent lies outside the old tangent, and the curve ends with curve of smaller radius. Show that $\text{vers } I_3' = \text{vers } I_3 - \frac{p}{R_2 - R_1}$ (60.)

IV. When the new tangent lies inside the old tangent and the curve ends with curve of smaller radius. Show that $\text{vers } I_3' = \text{vers } I_3 + \frac{p}{R_2 - R_1}$ (61.)

Problem Given a simple curve joining two tangents
 Required to substitute a symmetrical curve with flattened ends, using the same P.C. and P.T.



Let AHB be the simple curve of radius R_c
 ACDB the required curve in which
 $BQ = AS = R_v$
 $PC = R_s$
 $ASC = BQD = I_v$
 $CPD = I_s$

Then $I = I_s + 2I_v$
 In the triangle POQ $PQ = R_v - R_s$
 $QO = R_v - R_c$
 $PQO = I_v$
 $POQ = 180 - \frac{1}{2}I$
 $OPQ = \frac{1}{2}I_s$

Then are Given I, R_c Required R_v, R_s, I_v, I_s .
 We may assume any two of the latter (except I_v and I_s) and readily calculate the others.

I. Assume R_v and I_v

$I_s = I - 2I_v$
 $PQ : QO = \sin POQ : \sin OPQ$
 $R_v - R_s : R_v - R_c = \sin \frac{1}{2}I : \sin \frac{1}{2}I_s$
 $R_v - R_s = \frac{(R_v - R_c) \sin \frac{1}{2}I}{\sin \frac{1}{2}I_s}$ (62.)

II. Assume R_v and R_s

$\sin \frac{1}{2}I_s = \frac{(R_v - R_c) \sin \frac{1}{2}I}{R_v - R_s}$ (63.)

III. Assume R_s and I_s

$$I_c = \frac{1}{2}(I - I_s)$$

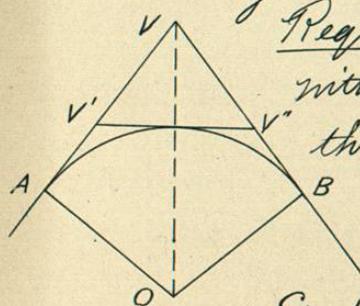
$$\frac{PQ + QO}{PQ - QO} = \frac{\tan \frac{1}{2}(POQ + OPQ)}{\tan \frac{1}{2}(POQ - OPQ)}$$

$$\frac{R_c - R_s + R_c - R_c}{R_c - R_s - R_c + R_c} = \frac{\tan \frac{1}{2}(180 - \frac{1}{2}I + \frac{1}{2}I_s)}{\tan \frac{1}{2}(180 - \frac{1}{2}I + \frac{1}{2}I_s)}$$

$$\frac{2R_c - R_s - R_c}{R_c - R_s - R_c + R_c} = \frac{\tan \frac{1}{2}(180 - \frac{1}{2}I + \frac{1}{2}I_s)}{\tan \frac{1}{2}(180 - \frac{1}{2}I + \frac{1}{2}I_s)}$$

$$2R_c - R_s - R_c = \frac{(R_c - R_s) \cot \frac{1}{4}(I - I_s)}{\cot \frac{1}{4}(I + I_s)} \quad (64)$$

Problem Given a simple curve joining two tangents



Required to substitute a curve with flattened ends to pass through the same middle point.

Let AB be the given simple curve and H the middle point.

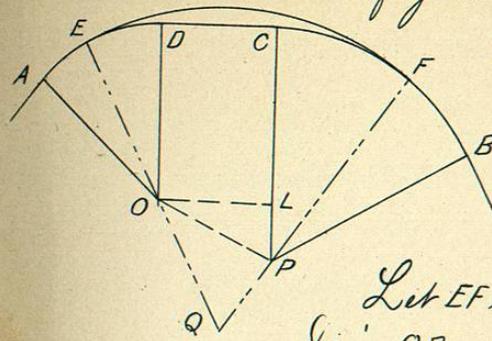
Erect an auxiliary tangent $V'HV''$ at H.

The auxiliary intersection angles at V' and V'' are readily calculated; also $V'H$ and $V''H$.

Sufficient additional data can be assumed, and the problem solved as a problem in Compound Curves.

It is not necessary that the curves on the two sides of H should be symmetrical.

Problem. Given two curves with connecting tangent
 Required to substitute a simple curve
 of given radius, to connect the two.



Let $DC = \tau$ - the given
 tangent, connecting the
 two curves AD and CB.
 of radii R_1 and R_2
 respectively.

Let EF be required curve of radius R_c

Join OP and draw perpendicular OL.

$$\text{Then } \tan LOP = \frac{LP}{OL} = \frac{R_2 - R_1}{\tau}$$

$$OP = \frac{\tau}{\cos LOP}$$

In the triangle OPQ we have given

$$OP = \frac{\tau}{\cos LOP} ; OQ = R_c - R_1 ; QP = R_c - R_2$$

Solve this triangle for $OPQ - QOP - OPQ$

$$\text{Then } \begin{aligned} CPF &= 180^\circ - (OPQ + OPL) \\ EOD &= 90^\circ - (QOP + LOP) \end{aligned}$$