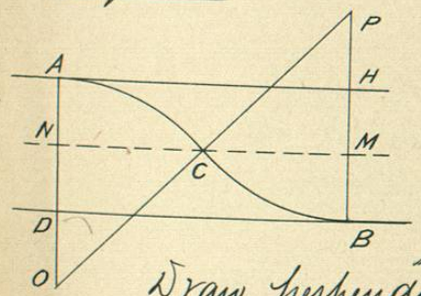
Reversed Curves.

It is very undesirable that reversed curves should be used on main lines or where trains are to be run at any considerable speed. The marked change in direction is objectionable, and an especial difficulty is that there is no opportunity to elevate the outer rail at the P.R.C. The use of reversed curves on lines of railroad is therefore very generally condemned by Engineers. For yards and stations, reversed curves may often be used to advantage, also on street railways and perhaps for other purposes.

Problem Given the perpendicular distance between parallel tangents, and the common radius of the reversed curve.

Required the central angle of each curve.



Let AH and BD be the parallel tangents.

ACB the reversed curve.

$HB = p$ = perpendicular distance between tangents.

Draw perpendicular NM

Let $AOC = BPC = I_r$

Then $\text{vers } AOC = \frac{AN}{AO} = \frac{BM}{PB} = \frac{\frac{1}{2}HB}{AO} = \frac{\frac{p}{2}}{R} = \text{vers } I_r$ (65.)

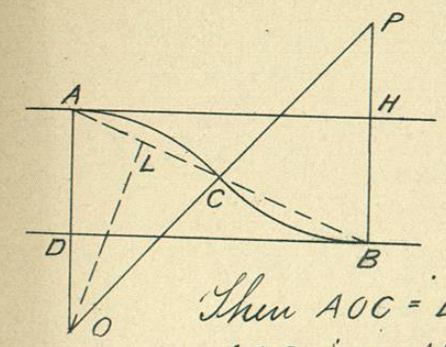
Problem. Given $p - I_r$

Required R

$$R = \frac{\frac{p}{2}}{\text{vers } I_r} \qquad (66.)$$

Problem Given the perpendicular distance between parallel tangents, and chord distance between P.C. and P.T.

Required the common radius of reversed curve to connect the parallel tangents.



Let AH and BD be the parallel tangents.
AB the reversed curve.
$BH = p$
$AB = d$.
Connect AC and CB

Then $AOC = BPC$ and $ACO = PCB$
$\therefore$ ACB is a straight line.

$$AO : AL = AB : HB$$
$$R : \frac{d}{4} = d : p$$
$$R = \frac{d^2}{4p} \qquad (67.)$$

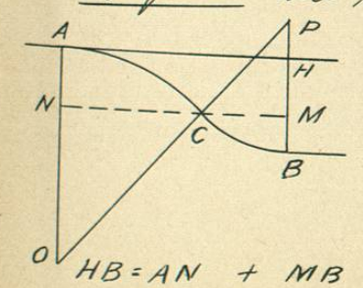
Problem Given R and p

Required d

$$d = \sqrt{4Rp} = 2\sqrt{Rp} \qquad (68.)$$

Problem Given the perpendicular distance between two parallel tangents and the central angle and radius of first curve of reversed curve.

Required the radius of second curve



Let AH and BD be parallel tangents
ACB = reversed curve
$HB = p$
$AO = R_1$
$AOC = CPB = I_r$
$PB = R_2$

$HB = AN + MB$ Draw perpendicular NCM
$= AO \text{ vers } AOC + BP \text{ vers } BPC$
$p = R_1 \text{ vers } I_r + R_2 \text{ vers } I_r$

$$R_1 + R_2 = \frac{p}{\text{vers } I_r} \qquad (69.)$$

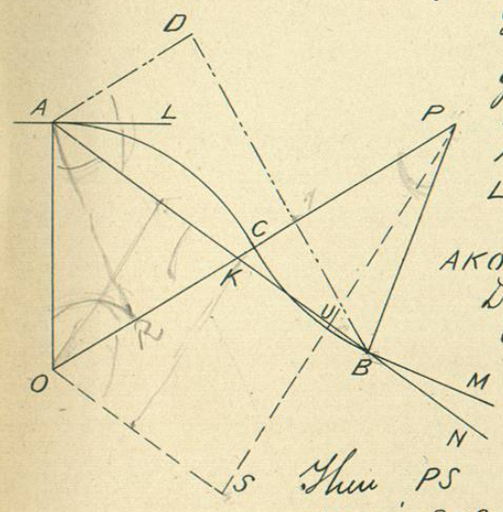
Problem Given $R_1 - R_2 - p$

Required I_r

$$\text{vers } I_r = \frac{p}{R_1 + R_2} \qquad (70.)$$

Problem Given, two points upon tangents not parallel, the length of line joining the two points, and the angles made by this line with each tangent.

Required, the common radius of a reversed curve to connect the two tangents at the given points



Let A and B be the given points.

AL, BM = given tangents.

ACB = required curve.

LAB = A and MBN = B

AB = l

AKO = PKB = K.

Draw PS perpendicular and OS parallel to AB

Also BD perpendicular and AD parallel to OP

Then PS = PU + SU

$$OP \sin POS = PB \cos BPU + AO \sin OAB$$

$$2R \sin K = R \cos B + R \cos A$$

$$\sin K = \frac{\cos A + \cos B}{2}$$

$$AOK = O = 180° - OKA - OAK$$
$$= 180° - K - (90° - A) = 90° + A - K.$$

$$BPK = P = 180° - BKP - PBK =$$
$$= 180° - K - (90° - B) = 90° + B - K.$$

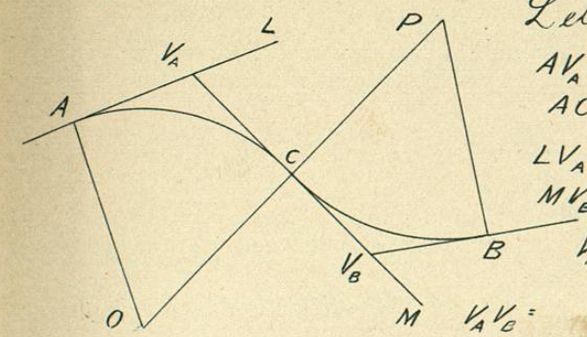
$$BD = AB \sin DAB = AO \sin AOK + BP \sin KPB$$

$$l \sin K = R \sin O + R \sin P$$

$$R = \frac{l \sin K}{\sin O + \sin P} \qquad (72.)$$

Problem. Given the length of the common tangent and the angles of intersection with the separated tangents.

Required the common radius of a reversed curve to join the two separated tangents.



Let $V_A V_B$ = Common tangent.
$AV_A - BV_B$ = Separated tangents
ACB = Required curve
$LV_A C = I_A$
$MV_B B = I_B$
$V_A V_B = l$

$$V_A V_B = V_A C + V_B C$$

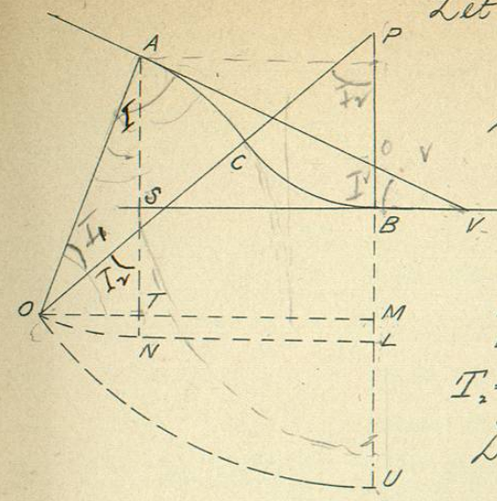
$$l = R \tan \tfrac{1}{2} I_A + R \tan \tfrac{1}{2} I_B$$

$$R = \frac{l}{\tan \frac{1}{2} I_A + \tan \frac{1}{2} I_B} \qquad (73.)$$

An approximate method is as follows:—
Find I_{A1} for a 1° curve; also I_{B2} (Table VI Scales)
Then $D_x = \dfrac{I_{A1} + I_{B1}}{V_A V_B}$

Problem Given a P.C. upon one of two tangents not parallel, also the tangent distance to the second tangent, also the angle of intersection, also the unequal radii of a reversed curve to connect the tangents

Required, the central angles of the simple curves, also the tangent distance from V to P.T.



Let $AV = T_1$ = given tang. dist.
A = given P.C.
V = vertex
$AVS = I$
$AO = R_1$, $PB = R_2$ } given radii
VS = Second tangent.
ACB = required curve.
$AOC = I_1$, $BPC = I_2$ } required angles
$T_2 = BV$ = required tang. dist.

Draw arcs OU - ON
" perpendiculars AN-OM-NL

Then $AO = BU = R_1$

$LU = BU - BL = AN - SN = AS$

$AS = LU = MU - ML$ OAN

$AV \sin AVS = PO \text{ vers } BPC - AO \text{ vers } AON$

$T_1 \sin I = (R_1 + R_2) \text{ vers } I_2 - R_1 \text{ vers } I$

$$\text{vers } I_2 = \frac{R_1 \text{ vers } I + T_1 \sin I}{R_1 + R_2} \qquad (74.)$$

$$I_1 = I_2 - I$$

$$T_2 = T_1 \cos I + R_1 \sin I - (R_1 + R_2) \sin I_2 \qquad (75.)$$

<u>Problem</u> <u>Given</u> BV instead of AV, and other data as above

<u>Required</u> I_1 I_2 etc

Turnouts.

A turnout is a track leading from a main or other track

Turnouts may be for several purposes.

I. Branch Track (for line used as a Branch Road for general traffic)

II. Siding. (for passing trains at stations, storing cars, loading or unloading, and various purposes)

III. Spur Track (for purposes other than general traffic, as to a quarry or warehouse.)

IV. Cross Over (for passing from one track to another, generally parallel.)

The essential parts of a turnout, are

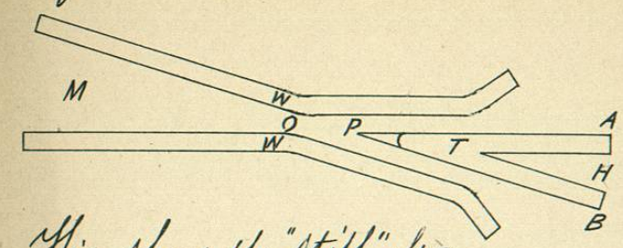
1. The Switch. 2. The Frog. 3 The Guard Rail

1. Some device is necessary to cause a train to turn from the main track; this is called the "Switch".

2. Again, it is necessary that one rail of the turnout track should cross one rail of the main track; and some device is necessary to allow the flange of the wheel to pass this crossing; this device is called a "Frog".

3. Finally, if the flange of the wheel were allowed to bear against the point of the frog, there is danger that the wheel might be turned to the wrong side of the frog point; therefore a Guard Rail is set opposite to the frog and prevents the flange from bearing against the frog point.

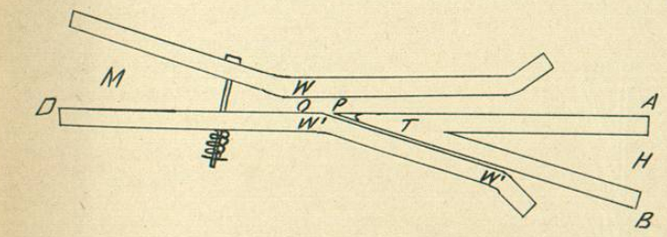
Frogs are of various forms and makes, but are mostly of this general shape, and the parts are named as follows:



M = mouth.
O = throat.
WW = wings.
P = point.
T = tongue.
H = heel.

This shows the "stiff" frog.

The "spring" frog is often used where the traffic on the main line is large, and on the turnout, small. In the spring frog W'W' is movable.



AD represents the main line. and W'W' is pushed aside by the wheels of a train passing over the turnout.

The "frog angle" is the angle between the sides of the tongue of the frog = APB.

Frogs are made of certain standard proportions and are classified by their number.

The "number" n of a frog is found by dividing the length of the tongue by the width of the heel, that is, $n = \frac{PH}{AB}$

Problem Given n. Required, Frog Angle F.

$$\tan \tfrac{1}{2} F = \frac{\frac{1}{2} AB}{PH} = \frac{AB}{2PH}$$

$$\cot \tfrac{1}{2} F = 2n \qquad (76.)$$

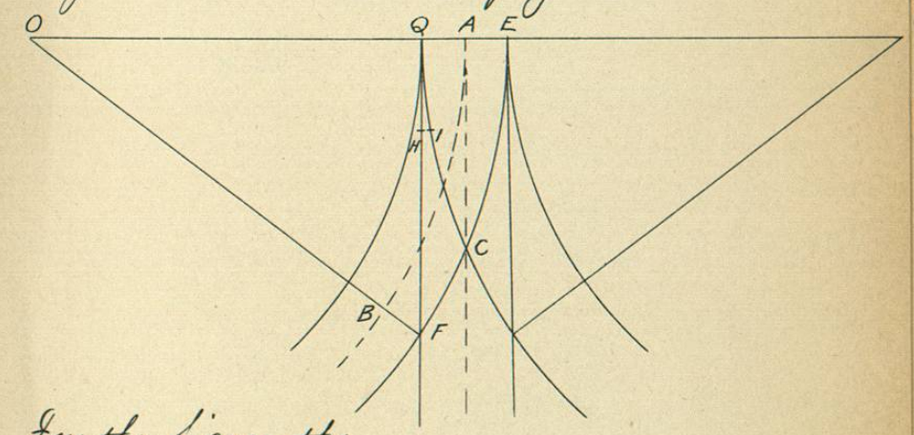
A form of switch in common use is the "Stub-Switch", which is formed by two rails, one on each side of the track, called the "Switch Rails". One end of the rail for a short distance (often about 5 feet) is securely spiked to the ties, the rest of the rail being free to slide on the ties, so that it may meet the fixed rails of either main track or turnout, as desired. These fixed rails are held by a casting or piece of metal called the "Head Block", and upon which the switch rail slides. A "Switch rod" connects the ends of the switch rails with the "Switch Stand". One end of the rail being spiked down, when the free end is drawn over by the switch rod, the rail is sprung into a curve which may with slight error be considered a circular curve, tangent to the main line (if this be straight.) The distance through which the free end of the rail is drawn or "thrown" by the switch rod is called the "Throw" of the Switch. The free end of the rail is called the "Toe" and the P.C. of the curve, the "Heel" of the switch.

Knowing the "throw" t and the length l of of the Switch rail, we can deduce the radius R, or degree of curve D, and continuing this curve to the point of frog, we can readily deduce

the angle between the rails or the "Frog Angle" necessary.

It is more customary, however, having given the throw (5" - 5½" - 6" are used in different roads) to assume either (1.) the radius (or degree) of turnout curve and from this find F (or n) and l; or (2.) the number n (or angle F) of frog, and from this find R and then l.

When there are two turnouts at the same point, one on each side of the main line, three frogs are necessary, the middle one being called the "crotch frog".



In the figure the

Heel of Switch is at	E or Q	Length of Switch Rail	= QH
Toe " "	H	Throw of Switch	= HI
Head Block	H and I	Lead	= HF
Crotch Frog	C	Frog is at	F
Center of turnout curve	AB		

It is necessary that there should be two numbers of frog, one for the ordinary turnout frog, and another for the "Crotch frog." It is advisable