TANGENCIES AND LINKS

TANGENTS

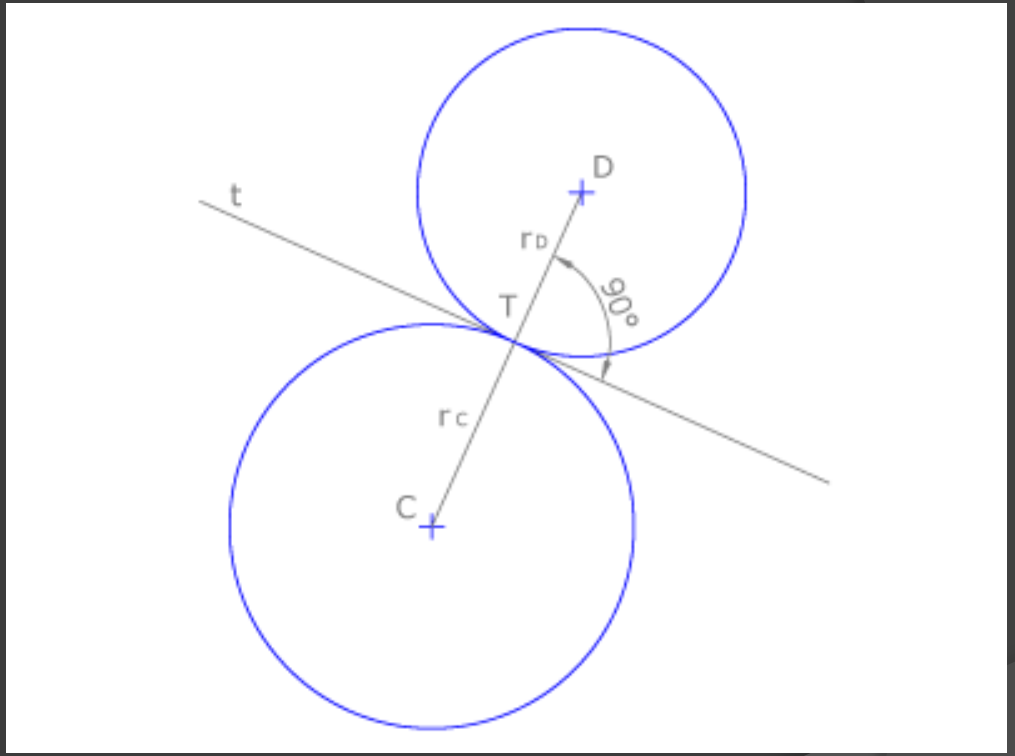
Two elements are tangent when they have a common point called the point of tangency. These elements are circles (or circumference arcs, in some cases also conic curves) and straight lines.

A link is the harmonious union point of curves with straight or curved corners. Links are the practical application of tangents.

Properties of tangencies

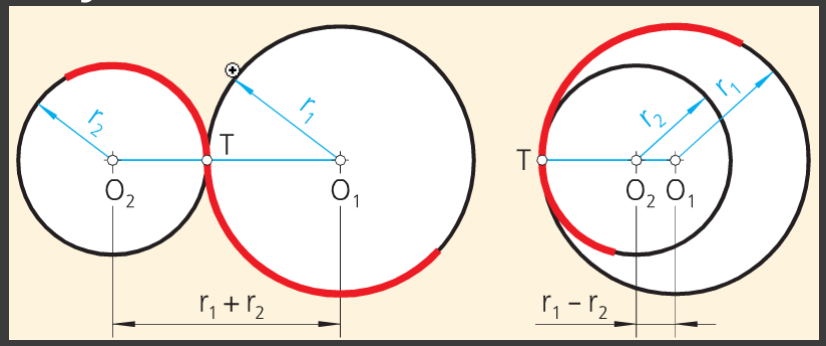
- Properties of tangencies:
- The point of tangency “T” of two circunferences is on the rect which joins their centers.

- A line tangent “t” to a circle is always perpendicular to the radius corresponding to the point of tangency.

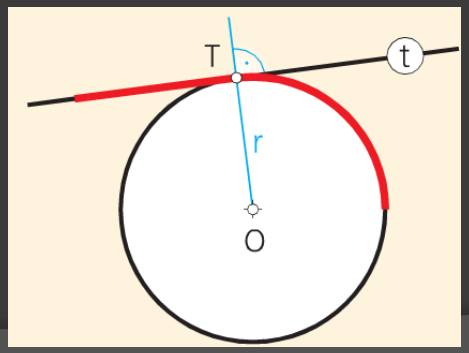


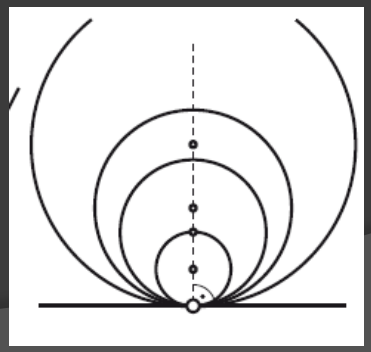
1. FUNDAMENTAL PROPERTIES OF TANGENTS

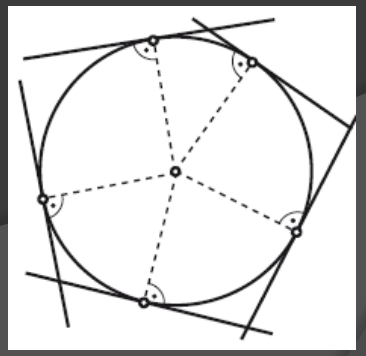
1.1- The centers of two circles tangent to each other are aligned with the point of tangency.



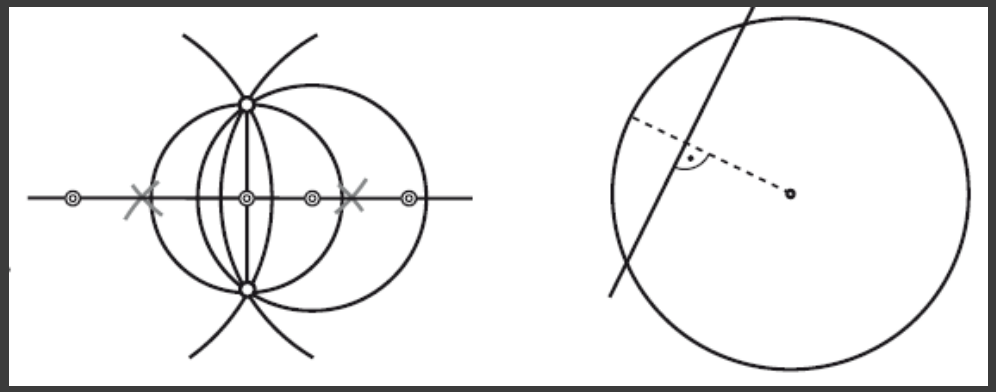
1. 2- A line tangent to a circle is always perpendicular to the radius corresponding to the point of tangency.



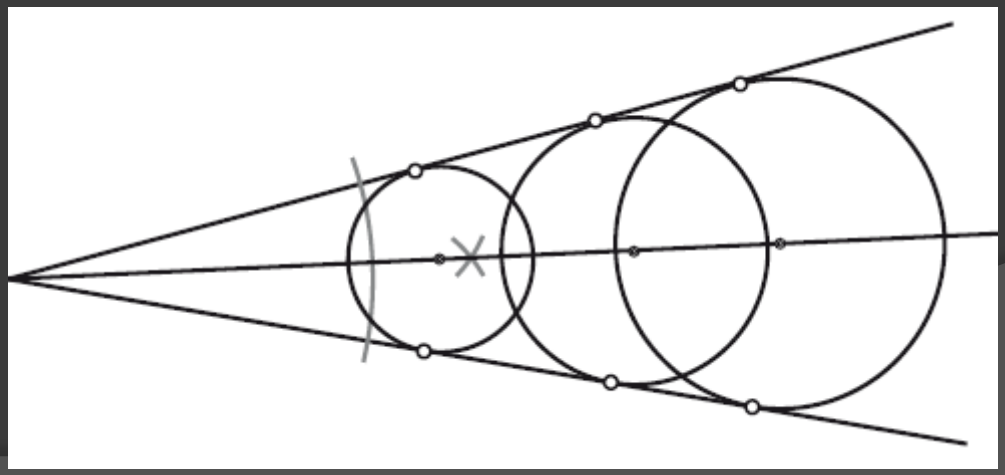




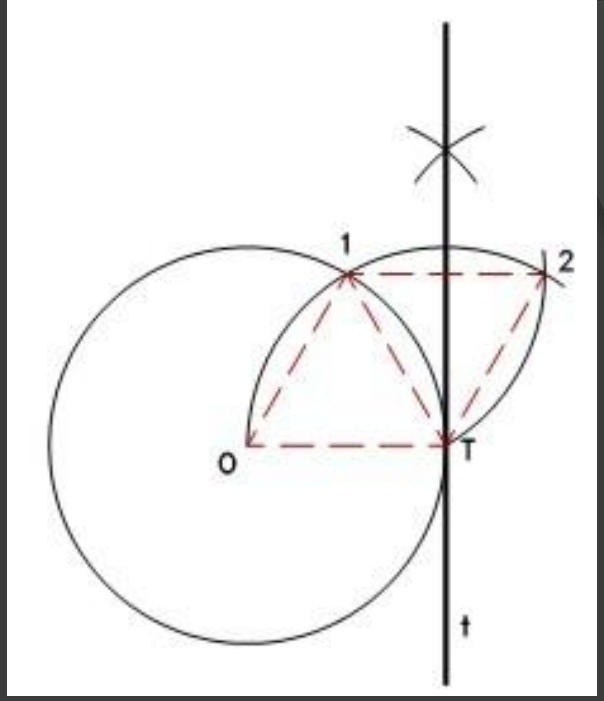
1. 3- The center of any circle through two points is on the bisector of the segment defined by those two points. Any radius perpendicular to a chord of a circle divides it into two equal halves.



1. 4- The center of any circle tangent to two lines is always in the bisector of the angle that the two tangent lines form.



1. Tangent line to a circumference through a point:
   - Join the center O and the point T with a segment line.
   - Trace a rect perpendicular to that radius.



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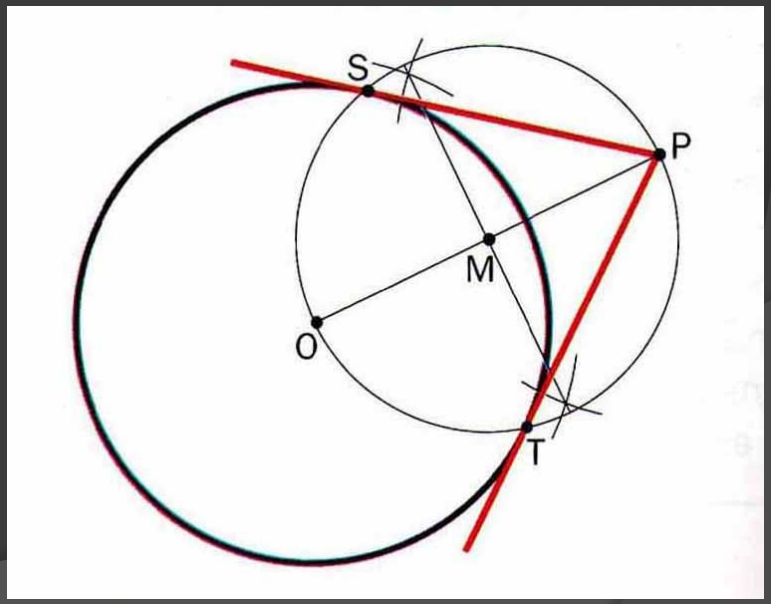
2. Tangent straight lines through an outer point:
   - Join the circumference center O wiht the outer point P .
   - Draw the segment bisector pbtaining the segment´s middle point M.
   - With center on M and radius MP trace a circumference that cuts the given one in two points (S y T)
   - Trace two straight lines from teh outer point to both tangency points



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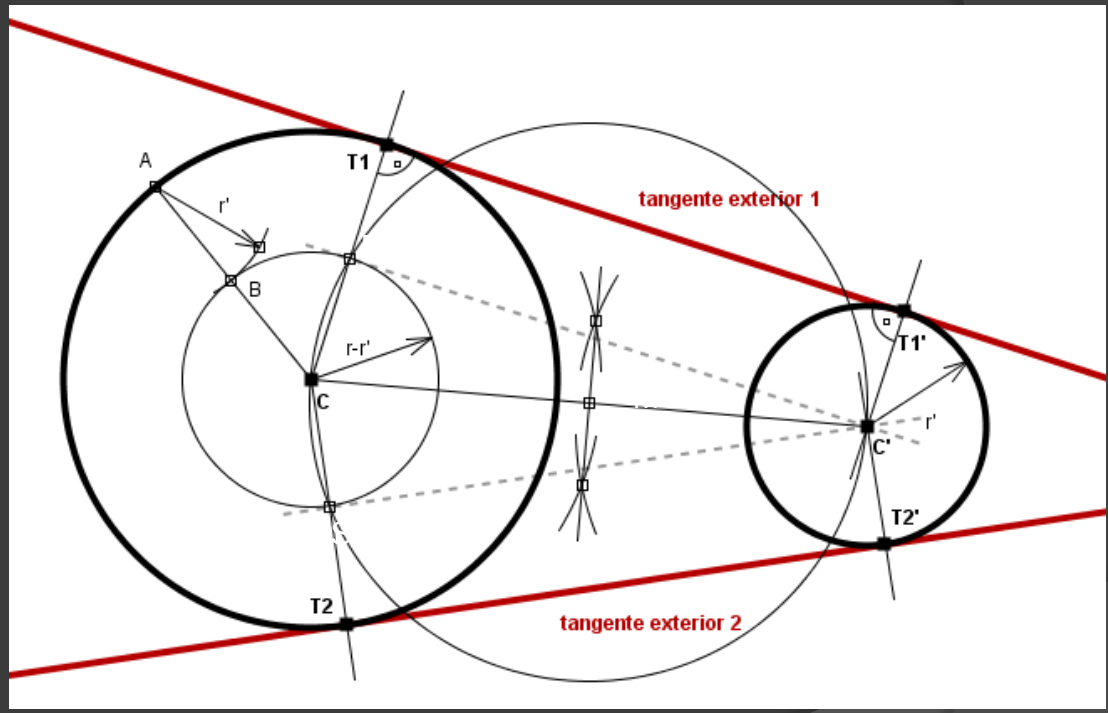
OUTER TANGENT LINES TO TWO CIRCUMFERENCES

- Trace the segment joining both centers.
- On the segment, substract the smaller radius to the bigger obtaining a smaller circunference inside the big one.

  THIS WAY WE HAVE REDUCED THE PROBLEM TO TANGENT LINES TO A CIRCUMFERENCE THROUGH AN OUTER POINT
- Solve the reduced problem, tracing radius to T1 and T2 enough to cut the initial formulation circumference.
- Trace parallel radius through the smaller circumference center. So the four points obtained in the intersections of both initial circumferences are the tangent points.
- Join the tangency points obtaining the tangent lines.



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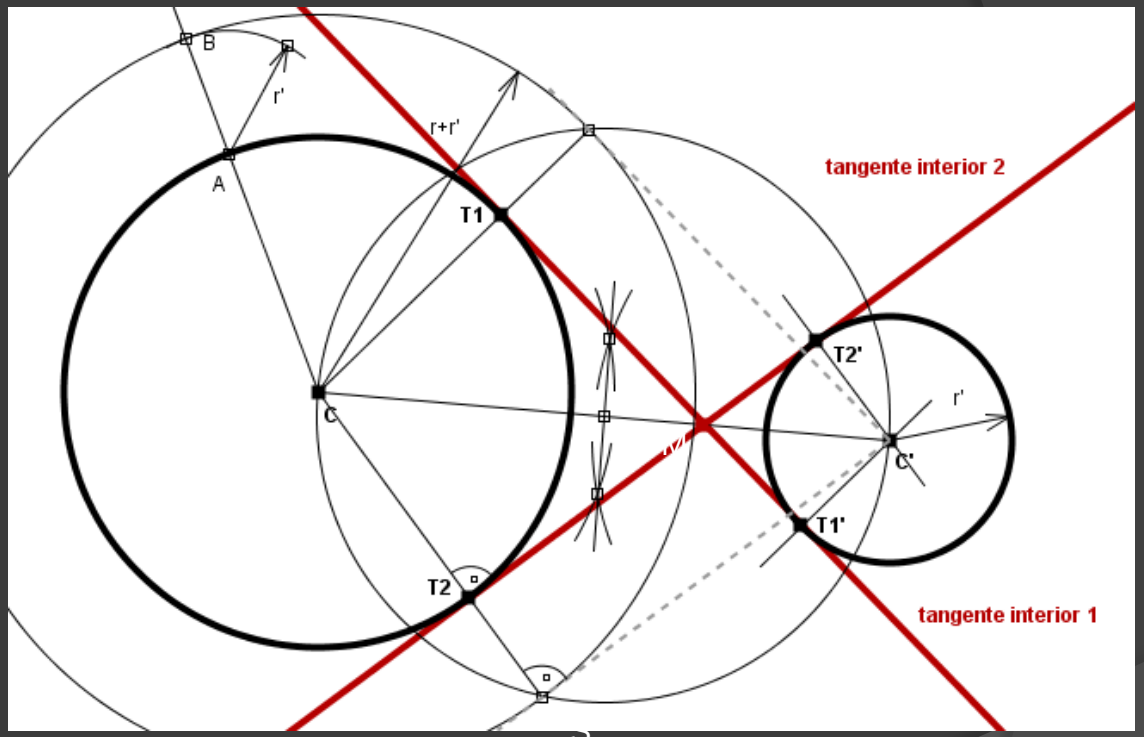
INNER TANGENT LINES TO TWO CIRCUMFERENCES

- Trace the segment joining both centers.
- On the segment, add the smaller radius to the bigger one one obtaining a bigger circumference out of the big one. The smaller given one turns into a point.
- THIS WAY WE HAVE REDUCED THE PROBLEM TO TANGENT LINES TO A CIRCUMFERENCE TRHOUGH AN OUTER POINT
- Solve the reduced problem, tracing radius to T1 and T2. These cut the initial formulation bigger circumference in two tangency points part of the final solutions.
- From the center of the initial amaller circumference, trace two radius parallel to the first pair traced, but this time, inverting the position directions upside down.
- The points where these radius cut the circumference are the other pair of tangency points wanted.
- Join T1' with T1 and T2' with T2



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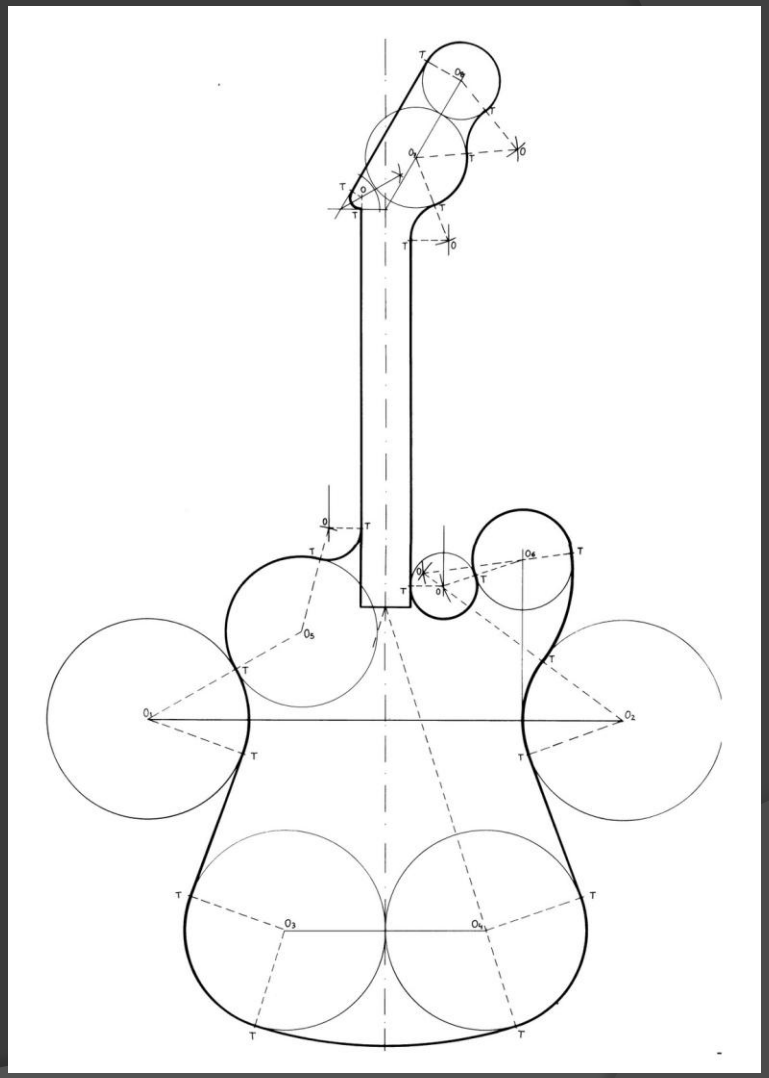
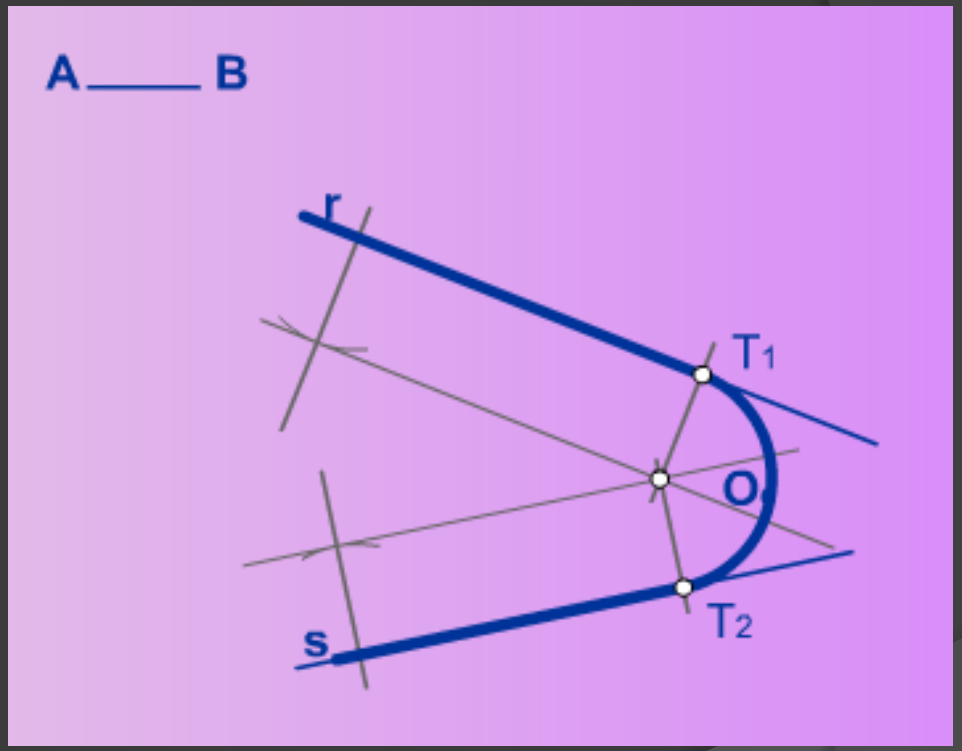
LINKS

- A link is the harmonious union of curves with straight or curved corners.
- Links are the practical application of tangencies



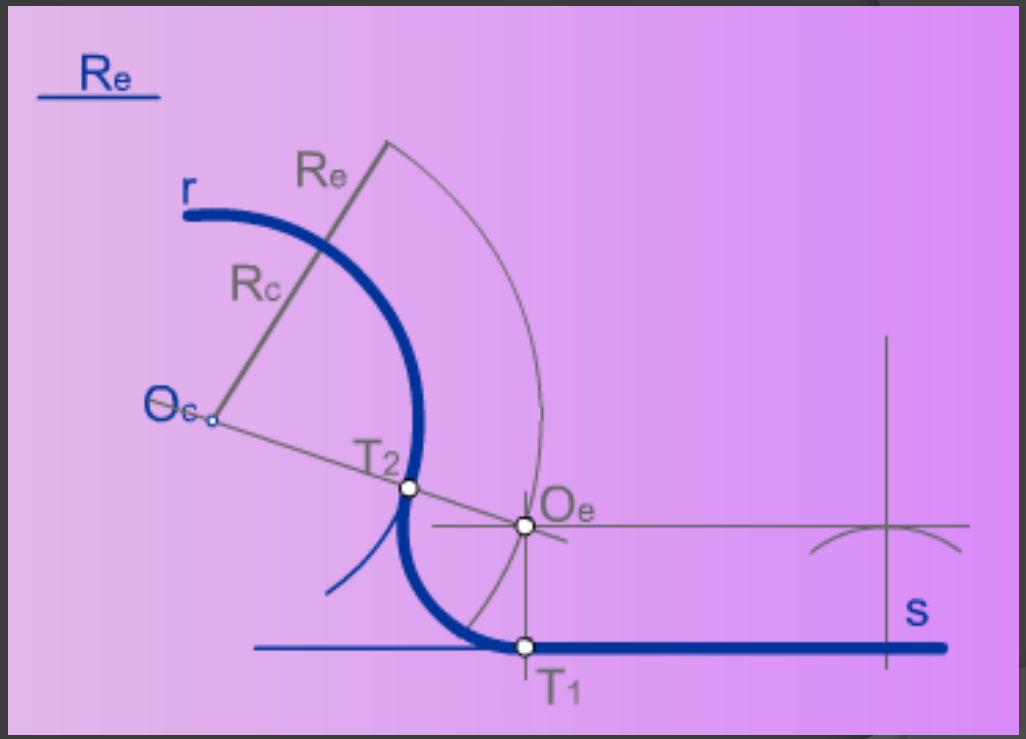
LINK BETWEEN TWO RECTS

- How to find the center of the link :
  - Trace two perpendicular rects to “r” and “s” .
  - Take a radius AB over them
  - Trace parallel rects to r and s from those points, and they cross at O, center of the link arc.
- Finding the tangency points :
  - Draw a perpendicular to “r” from O, to obtain T1.
  - Draw another perpendicular to “s” from O, to obtain T 2.
- Tracing the link arc:
  - With radio AB and center at O, trace an arc from T1 to T2.



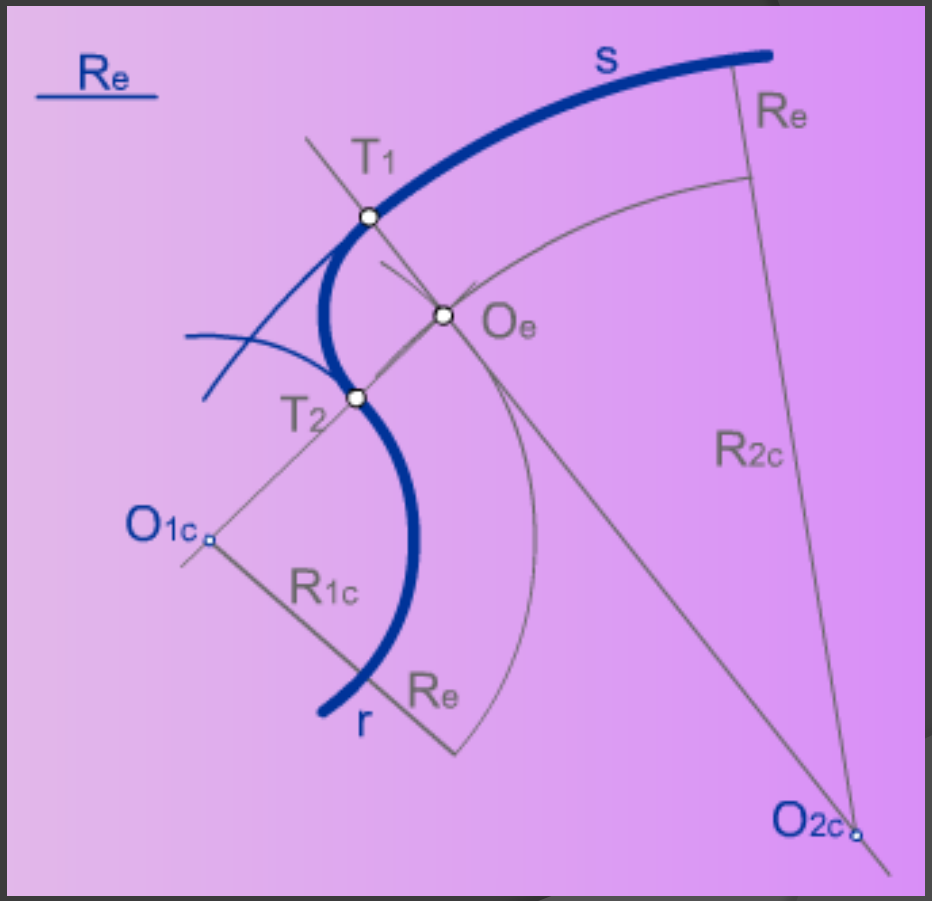
LINK BETWEEN A CURVE AND A RECT

- To find the center of the link:
  - Trace an arc from Oc, which radius is the addition of both radius Rc (circumference radius) and Re, (link radius)
  - Trace a perpendicular at any point of s and take Re over it. Draw a parallel to s on this point to obtain point Oe.
- To find the tangency points:
  - From Oe (center of the link) trace a perpendicular to s and a rect to Oc, obtaining points T1 y T2.
- With radius Re and center at Oe, draw an arc from T2 to T2.

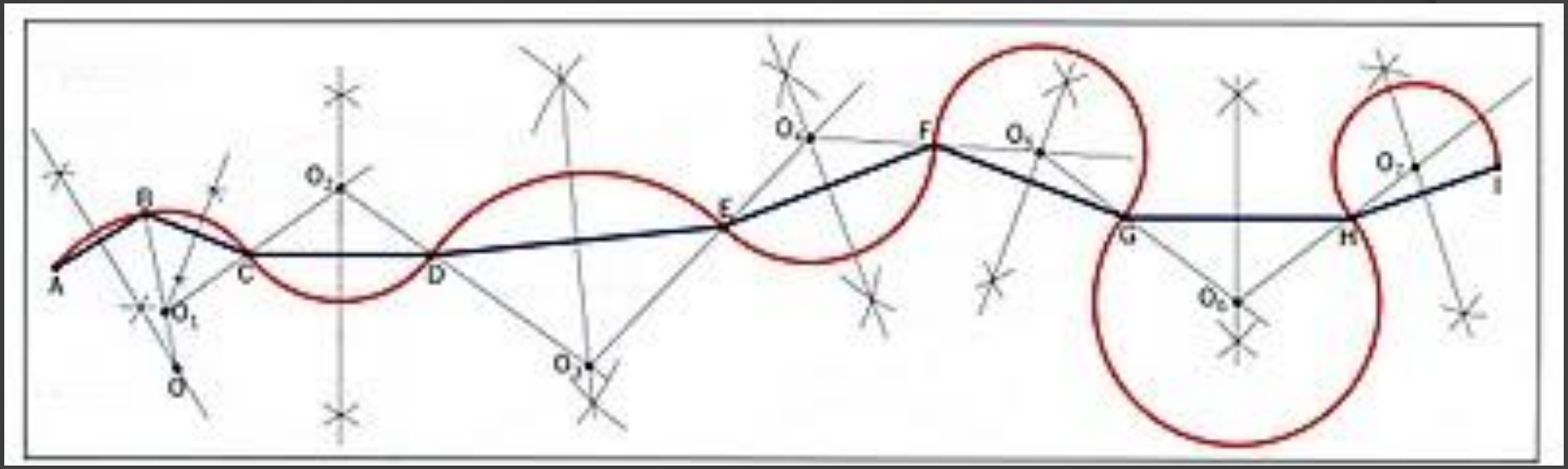


LINK BETWEEN TWO CURVES

- To find the link center:
  - Draw and acr from O1c and radius R1c + Re.
  - Draw an arc from O2c with radius R2c – Re.
  - These arcs cross at Oe (center of the link).
- Finding the tangency points:
  - Through two rects, join centers O1c and O2c with the link center Oe, obtaining points T1 and T2.
  - With radius Re and center Oe, trace an arc from T1 to T2.



LINK OF CIRCUMFERENCE ARCS ON A POLYGONAL LINE



- Draw the segment bisector of line AB and place O on any point of it. This will be the center of the first arc from point A to point B.
- Now draw the first arc AB from the center O.
- Next, draw a line from point B to point O and draw the segment bisector of the line BC. Where the segment bisector cuts the line BO, this point will be the center of the second arc from point B to point C. Now draw the second arc BC from the center O1.
- This process repeats in this same manner until the link is complete.