

Fundamentals of Drafting - Principles of Tangency

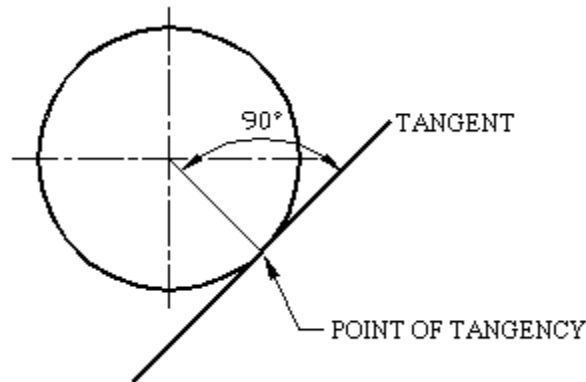
Objectives:



1. To define a tangent.
2. To draw a tangent using geometrical constructions.
3. To recognise the general principles of tangency.
4. To apply the principles of tangency to drawing problems.

The definition

A **tangent** is a straight line which touches a circle at the point of tangency without intersecting it. At the point of tangency any radius forms a right angle with a tangent.

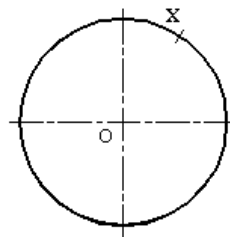


Geometrical constructions of tangent

1. To draw a tangent to a given point on the circumference of the circle.

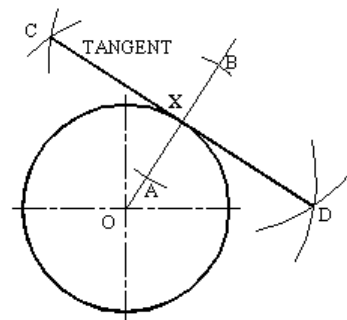
1. Given:

A point X is given on the circumference of a circle of any radius.



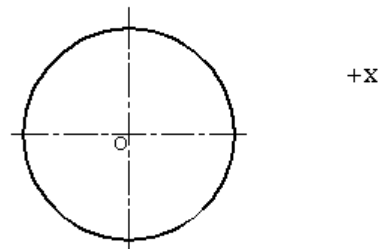
2. Construction

- i) Join OX and produce the line outside the circumference of the circle.
- ii) Mark points A and B, such that $AX=XB$.
- iii) Draw perpendicular bisector CD.
- iv) CD is the required tangent.



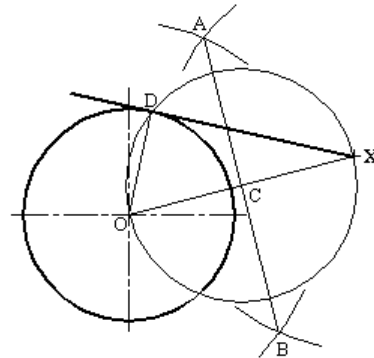
2. To draw a tangent to a circle from a given point outside the circle.

1. Given:
 A point X is given outside the circle of any radius.



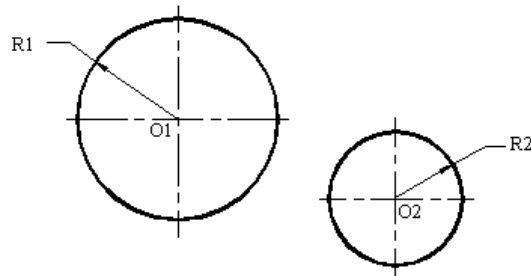
2. Construction

- i) Join OX.
- ii) Bisect OX at C.
- iii) Draw a circle with centre C, radius CX.
- iv) The circle intersects the given circle at D.
- v) Join DX, which is the required tangent.



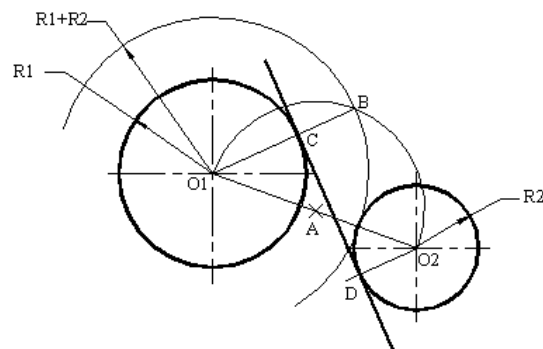
3. To draw an internal tangent to two given circles.

1. Given:
 Two circles of radii R1 and R2.
 (internal tangent is also known as transverse common tangent)



2. Construction

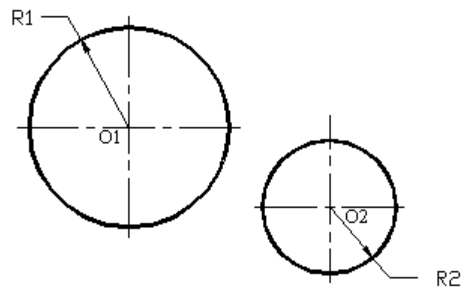
- i) Join O1 and O2.
- ii) Bisect line O1O2 at A.
- iii) Draw a semi-circle with centre A, radius AO1.
- iv) Draw a circle, centre O1 and radius R1+R2.
- v) This circle intersects the circle (centre A) at B.
- vi) Join O1B, which cuts the circumference at C.
- vii) Join O1C.
- viii) Through O2, draw a line O2D parallel to O1C.
- ix) Join CD, which is the required internal tangent.



4. To draw an external tangent to two given circles.

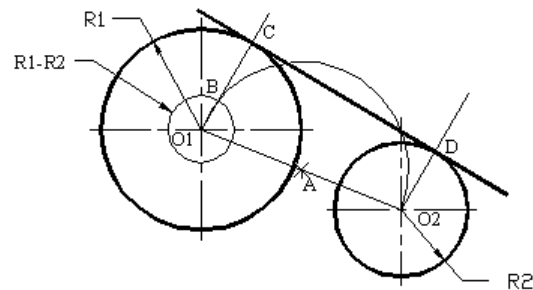
1. Given:

Two circles of radii R_1 and R_2 .
 (external tangent is also known as direct common tangent)



2. Construction

- i) Join O_1 and O_2 .
- ii) Bisect line O_1O_2 at A .
- iii) Draw a semi-circle with centre A , radius AO_1 .
- iv) Draw a circle, centre O_1 and radius $R_1 - R_2$.
- v) This circle intersects the circle (centre A) at B .
- vi) Join O_1B , and produce it until it cuts the circumference at C .
- vii) Through O_2 , draw a line O_2D parallel to O_1C .
- viii) Join CD , which is the required external tangent.



General principles of tangency

In geometrical construction, it is common to join arcs with straight lines and arcs with other arcs. To do this with accuracy, it requires a knowledge of the principles of tangency.

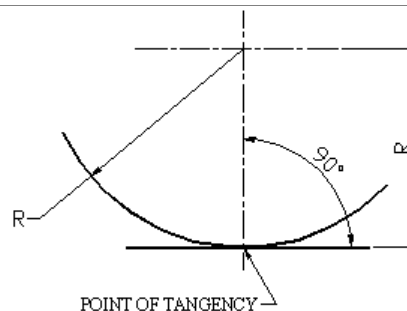
There are three general principles:

1. To join an arc with a straight line

Principle 1: To join an arc with a straight line

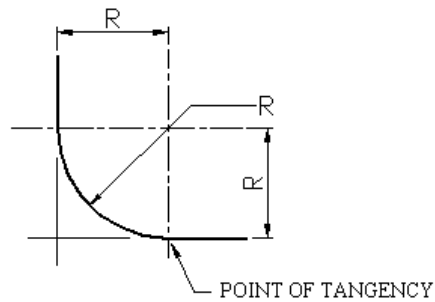
1. The principle

To draw an arc of given radius to touch a given straight line, then the point of tangency is the point that lies on a line through the centre of the arc, at a distance equals to the given radius, and at 90° to the given straight line.

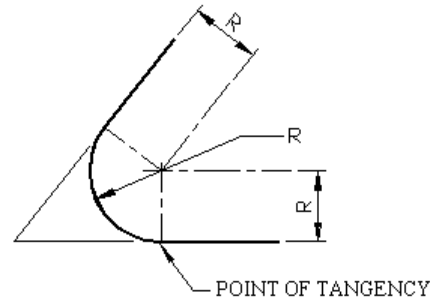


2. Practical applications

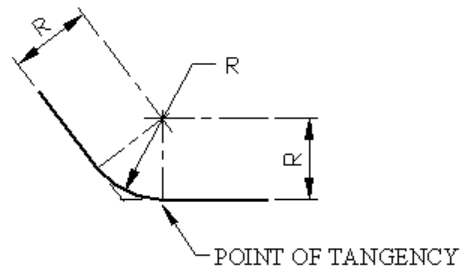
- (i) To draw an arc of radius R tangential to the arms of a right angle.



- (ii) To draw an arc of radius R tangential to two straight lines forming an acute angle.



- (iii) To draw an arc of radius R tangential to two straight lines forming an obtuse angle.

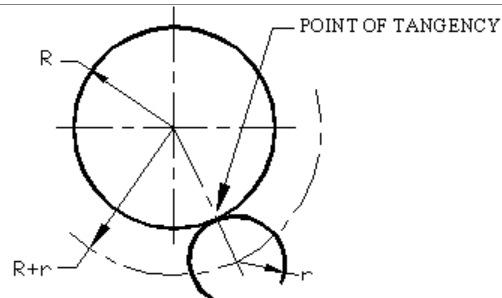


2. To join two arcs externally

Principle 2: To join two arcs externally

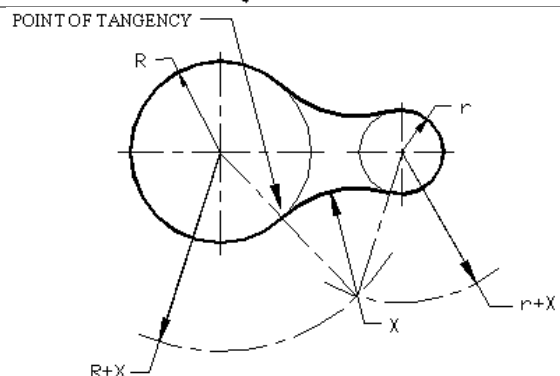
1. The principle

To draw an arc of a given radius r to touch a second arc, radius R , externally, then the point of tangency lies on a line joining the centres of the two arcs. The distance between the centres of the arcs is $R+r$.



2. Practical applications

- (i) To draw an arc of radius X blending two circles of radii R and r respectively.

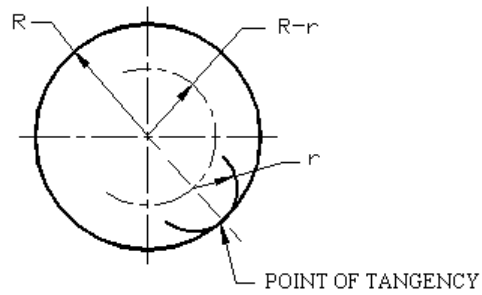


3. To join two arcs internally

Principle 3: To join two arcs internally

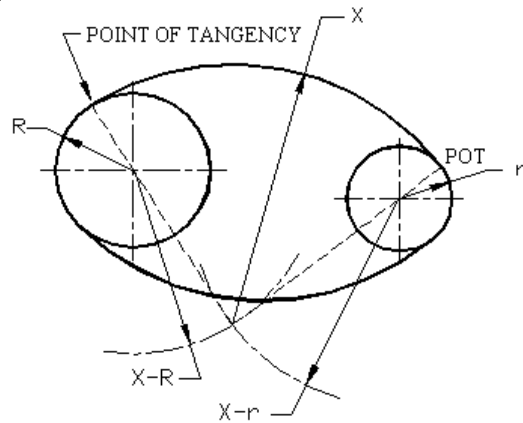
1. The principle

To draw an arc of a given radius r to touch a second arc, radius R , internally, then the point of tangency lies on a line joining the centres of the two arcs. The distance between the centres of the arcs is $R-r$.



2. Practical applications

(i) To draw an arc of radius X blending two circles of radii R and r internally.

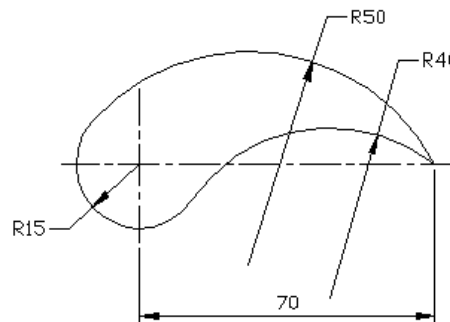


Applications of the principles of tangency

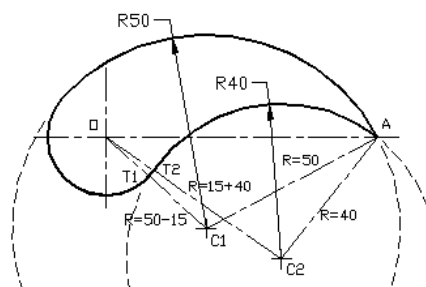
In applying the principles of tangency, it should be noted that the intersection of two lines is always required to find the centre of an arc.

Example 1

Draw the following figure and determine the points of tangency.

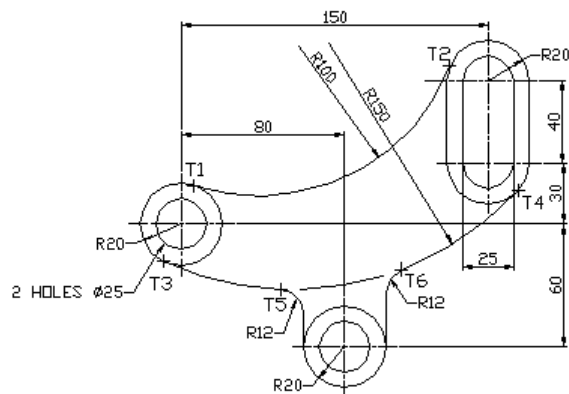


Solution



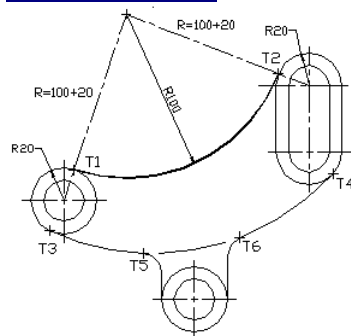
Example 2

Draw the following swivel link connector and determine all the tangent points.

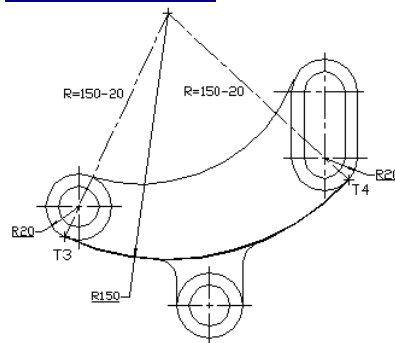


Solution

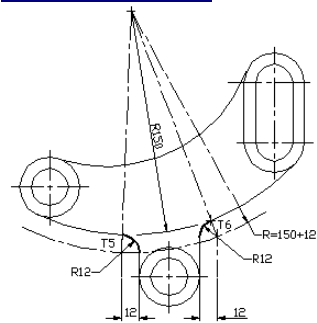
Solution to T1, T2



Solution to T3, T4



Solution to T5, T6



Assignment 1

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Question No. 6

Draw separately (a) an external and (b) an internal tangent to two circles of 50 mm and 30 mm diameters and 80 mm apart (distance between centres).

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Question No. 9

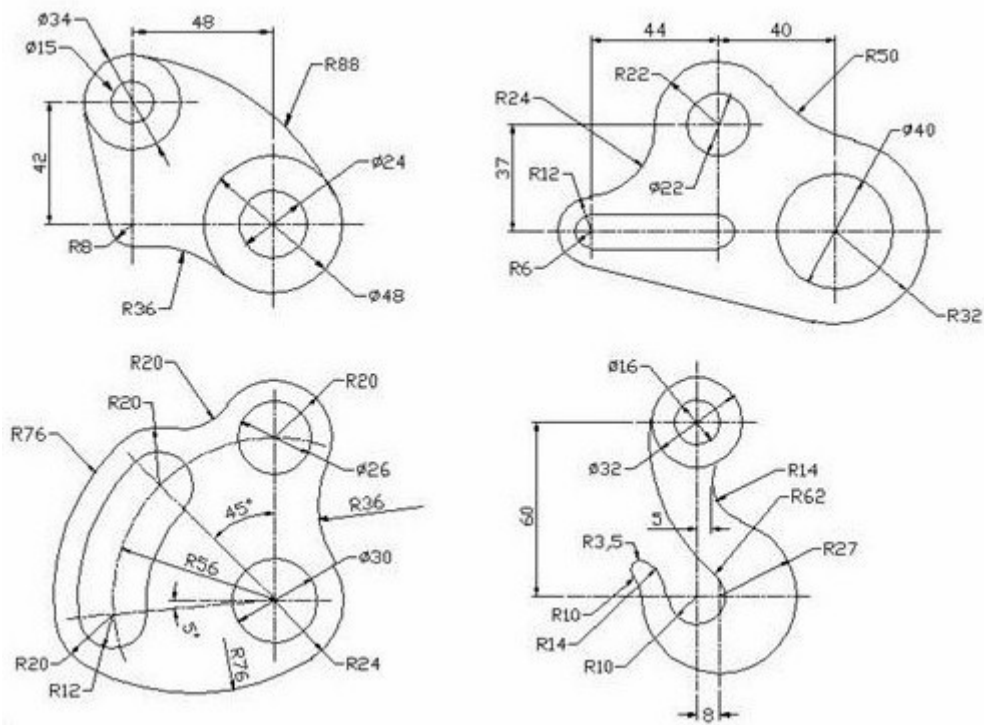
Draw a tangent to a circle of 60 mm diameter from a point P positioned 90 mm from the centre of the circle.

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Question No. 12 (Referring to Figure 14.24)

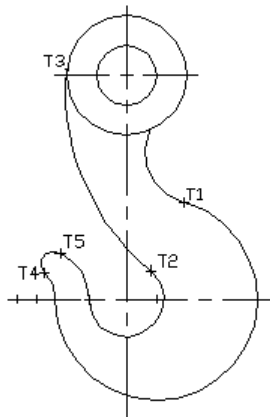
Draw accurately the figures shown in Figure 14.24. Mark all tangent points clearly with a cross (+) and retain all construction lines. Dimensioning of the figures is not necessary. Assume any dimensions which are not given.

(The following figure is extracted from textbook.)

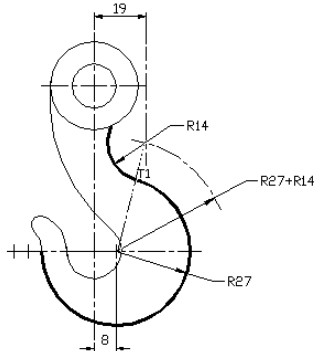


Drawing hints Question No. 12 Part 4 (the hook):

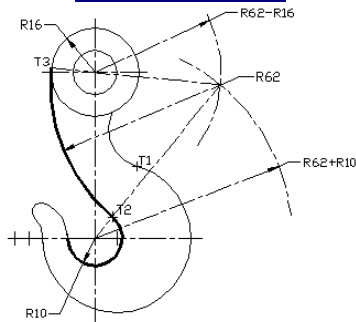
Solution



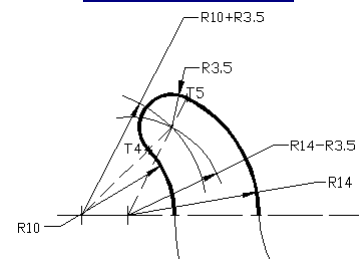
Solution to T1



Solution to T2, T3



Solution to T4, T5



You may download the assignment sheet from the "ACTION MENU".