(d) Including the Circle with Radius R_2 and Outside to the Circle with Radius R_1

- Draw circles with O_1 and O_2 as their centers, R_1 and R_2 as their radii respectively. The relative positions of O_1 and O_2 are also given. *(Figure 2.35(a))*
- Draw arcs with O_1 as center and $R + R_1$ as radius and O_2 as center and $R - R_2$ as radius respectively. Intersection of these arcs gives the center O of the required arc. *(Figure 2.35(b))*
- Join O and O_1 to get the point of tangency A. Similarly join O and O_2 and extend to get the point of tangency B. *(Figure 2.35(c))*
- Draw the required arc with O as center and OA (= OB = R) as radius. *(Figure 2.35(d))*
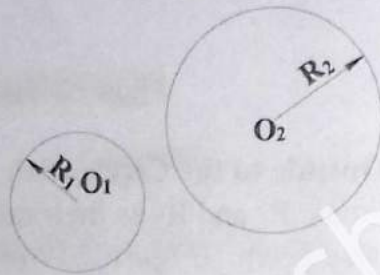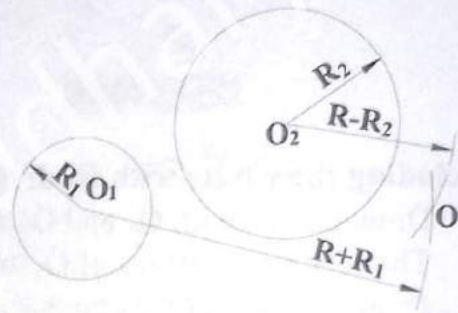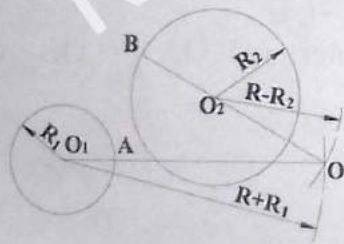

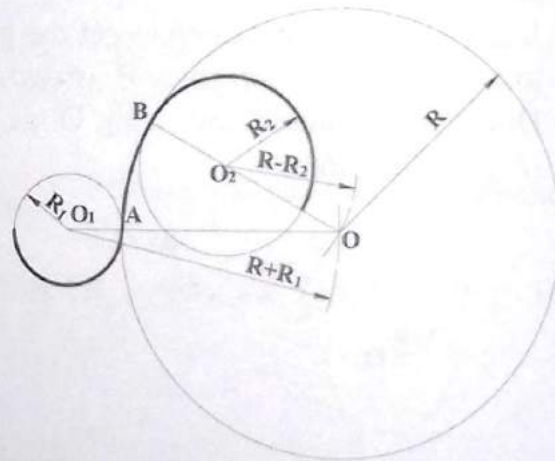Figure 2.35(a)

Figure 2.35(b)

Figure 2.35(c)

Figure 2.35(d)

2.3.7 To Draw Common Line Tangents to Given Two Circles

(a) Open Belt Tangent

- Draw circles with O_1 and O_2 as their centers, R_1 and R_2 as their radii respectively. The relative positions of O_1 and O_2 are also given. *(Figure 2.36(a))*
- Draw a circle with O_2 as center and $R_2 - R_1$ as radius. *(Figure 2.36(b))*
- Join O_1 and O_2 and draw it perpendicular to locate its midpoint A. *(Figure 2.36(c))*
- With A as center and O_1A (= O_2A) as radius draw a circle which intersects the circle with radius $R_2 - R_1$ at point B. *(Figure 2.36(d))*
- Join O_2 and B and extend it to get point of tangency T_2 on the circle with radius R_2. *(Figure 2.36(e))*

- Draw a straight line passing through O_1 and parallel to O_2T_2 intersecting the circle with radius R_1 at point T_1, which is the other required point of tangency. *(Figure 2.36(f))*
- Joint T_1 and T_2 to get the required tangent *(Figure 2.36(g))*
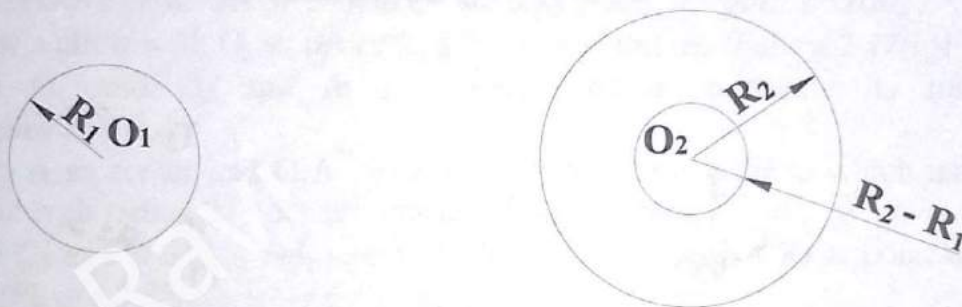- Repeat the same procedure to get the tangent on the bottom side. *(Figure 2.36(h))*
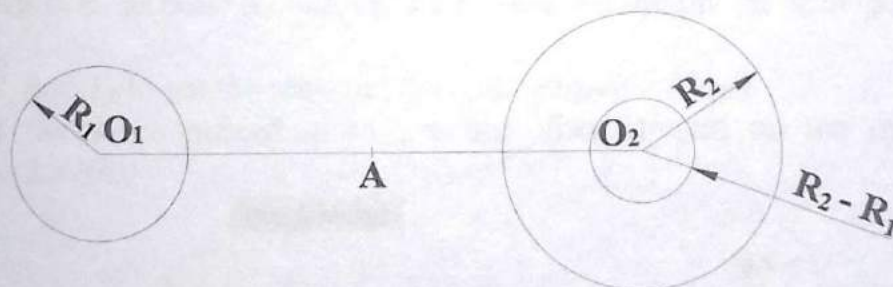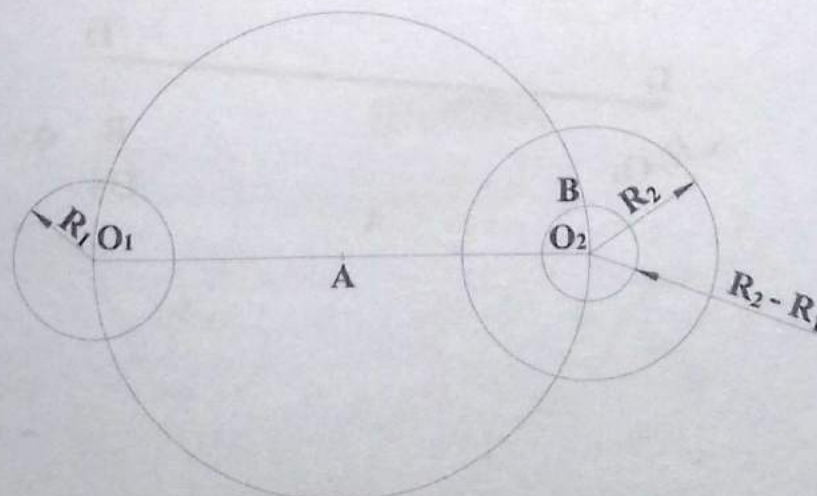
Figure 2.36(a)
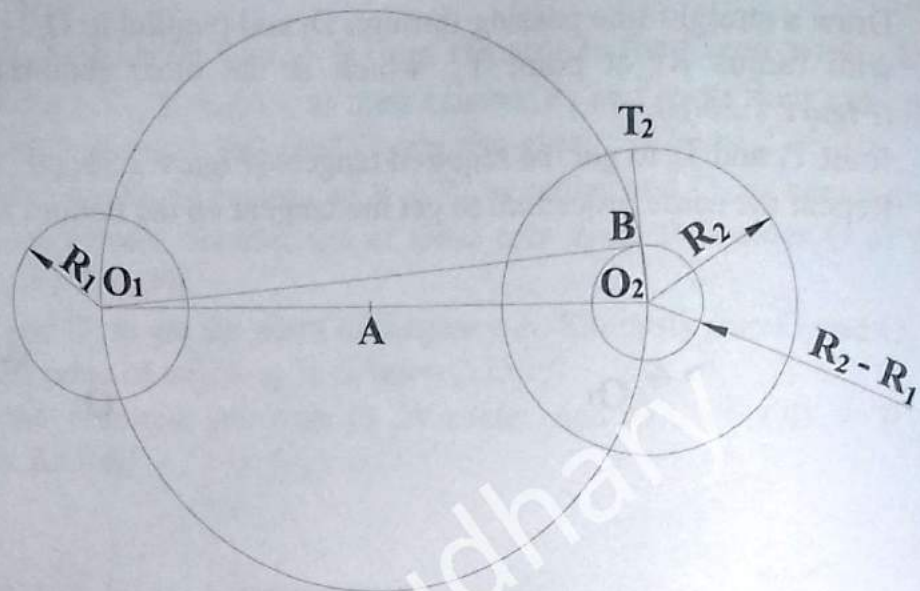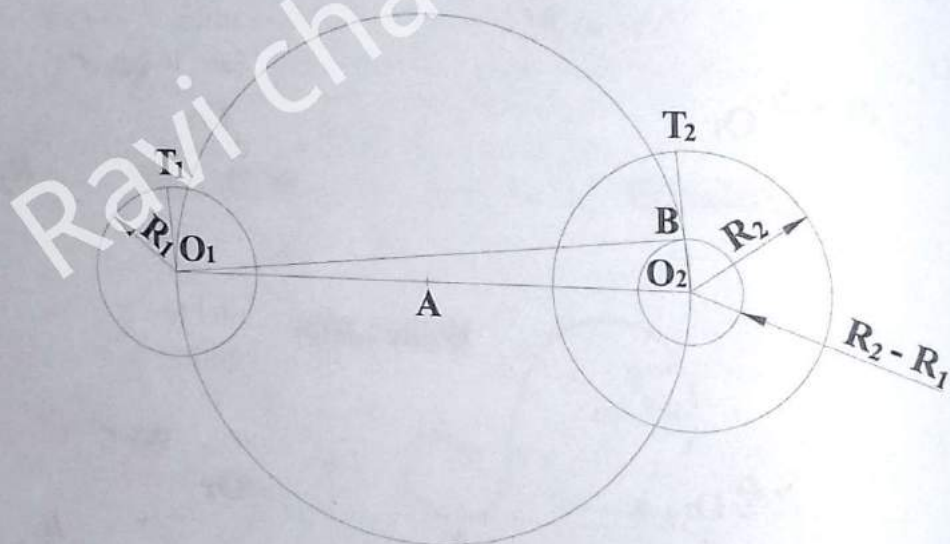
Figure 2.36(b)
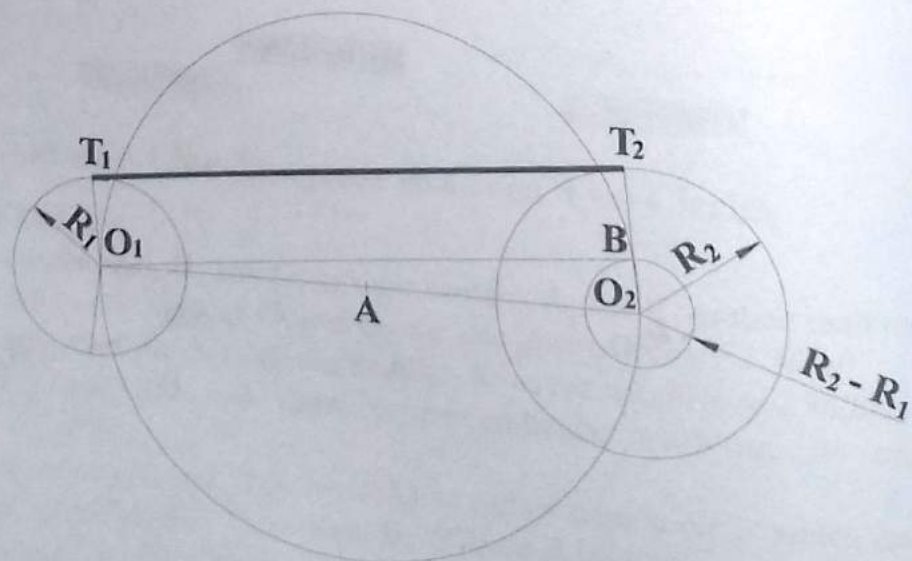
Figure 2.36(c)
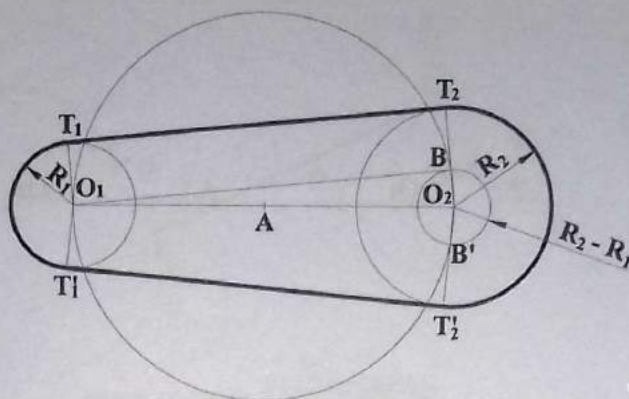
Figure 2.36(d)

Figure 2.36(e)

Figure 2.36(f)

Figure 2.36(g)

Figure 2.36(h)

(b) Cross Belt Tangent

- Draw circles with O_1 and O_2 as their centers, R_1 and R_2 as their radii respectively. The relative positions of O_1 and O_2 are also given. (Figure 2.37(a))
- Draw a circle with O_2 as center and $R_1 + R_2$ as radius. (Figure 2.37(b))
- Join O_1 and O_2 and draw it perpendicular to locate its midpoint A. (Figure 2.37(c))
- With A as center and O_1A (= O_2A) as radius draw a circle which intersects the circle with radius $R_1 + R_2$ at point B. (Figure 2.36(d))
- Join O_2 and B and which intersect the circle with radius R_2 at point of tangency T_2. (Figure 2.37(e))
- Draw a straight line passing through O_1 and parallel to O_2T_2 intersecting the circle with radius R_1 at point T_1, which is the other required point of tangency. (Figure 2.37(f))
- Joint T_1 and T_2 to get the required tangent. (Figure 2.37(g))
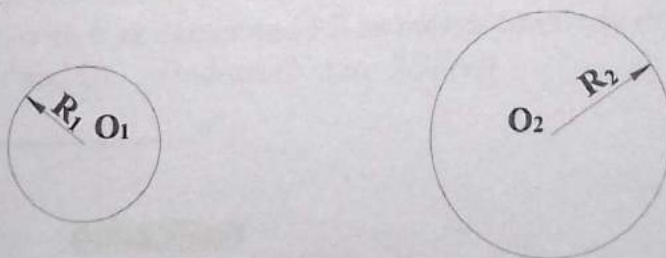- Repeat the same procedure to get the other tangent on the opposite side. (Figure 2.37(h))
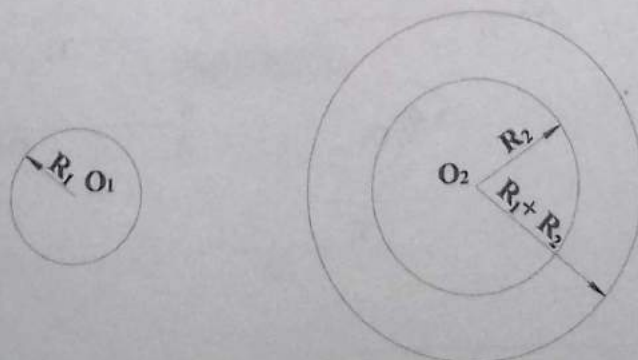

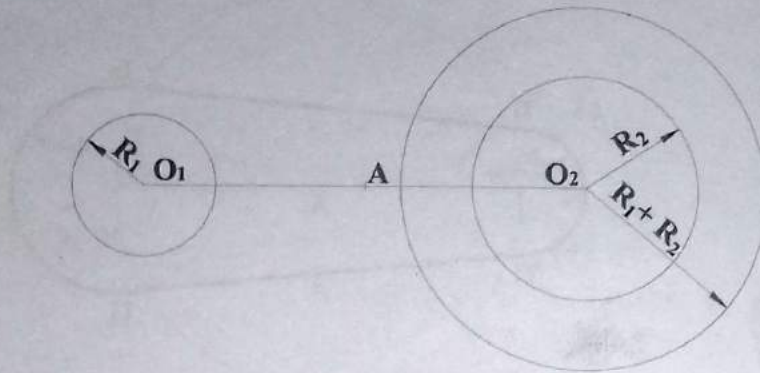Figure 2.37(a)

Figure 2.37(b)

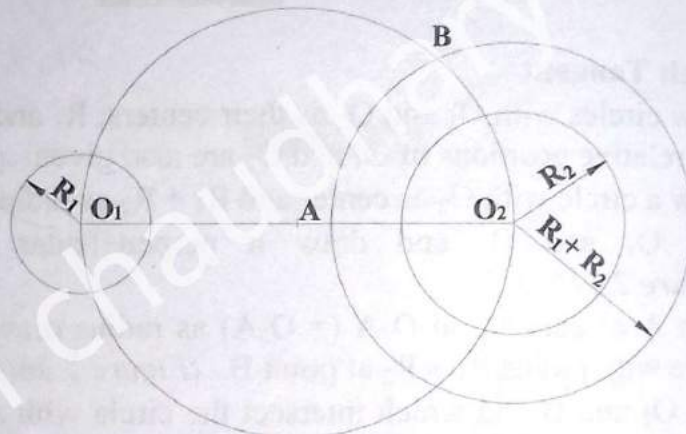Geometrical Construction 59

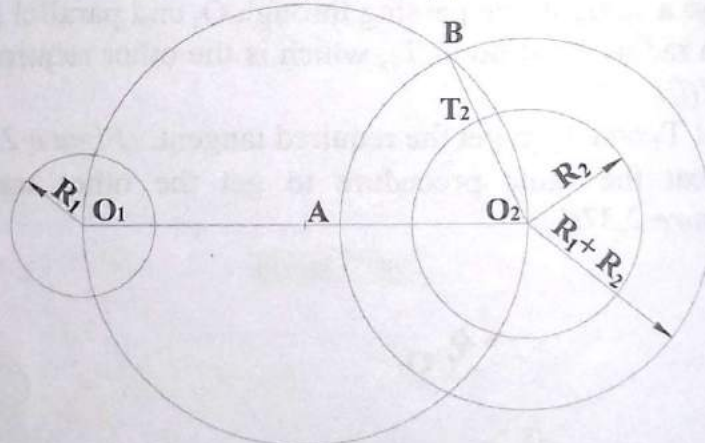Figure 2.37(c)

Figure 2.37(d)
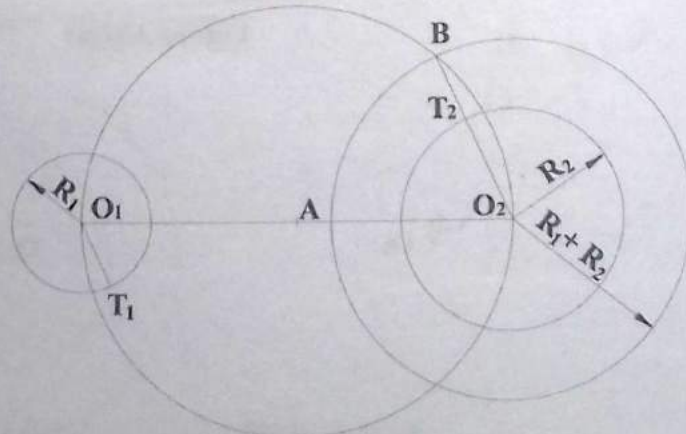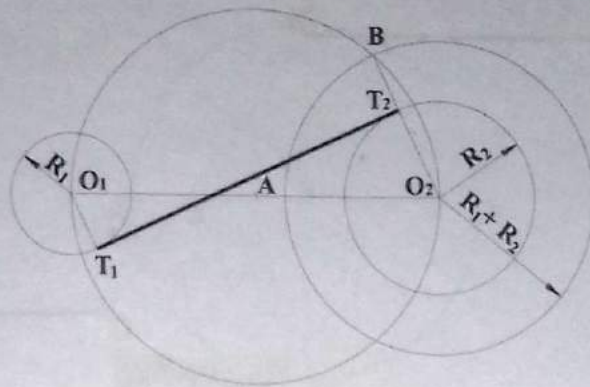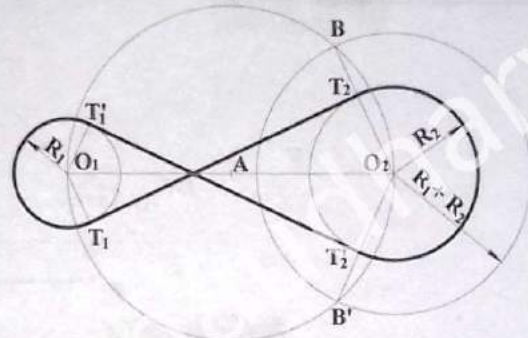

Figure 2.37(e)

Figure 2.37(f)

Figure 2.37(g)

Figure 2.37(h)

2.3.8 To Draw a Reverse Curve (Ogee Curve)

- AB and CD are the given lines. *(Figure 2.38(a))*
- Join B and C and take any point E on the line BC. *(Figure 2.38(b))*
- Draw perpendicular bisectors of line segments BE and EC. *(Figure 2.38(c))*
- Draw perpendicular from point B such that it intersects the perpendicular bisector of BE at point F. Similarly draw perpendicular from point C such that it intersects the perpendicular bisector of EC at point G. *(Figure 2.38(d))*
- Draw an arc BE with F as center and FB as radius. Similarly draw another arc EC with G as center and GC as radius. *(Figure 2.38(e))*

Figure 2.38(a)

Figure 2.38(b)

Geometrical Construction   61