Worked Examples on Loci

In the Figure 17.44 the circle rolls clockwise for one revolution along the line AB. At the same time point P is moving to point C. Draw the path of point P for the combined movement.

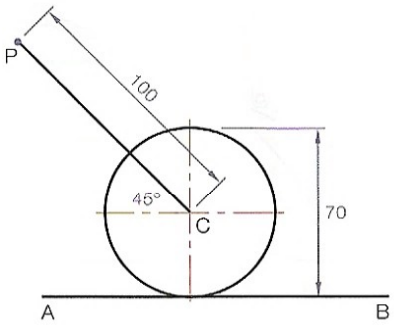

Fig. 17.44

(1) There are two movements occurring simultaneously. We will deal with one movement and then combine it with the other.

(2) Since we usually divide the rolling circle into twelve equal portions, it is easiest to break all the movements into twelve equal steps. We divide PC into twelve equal steps and index them. This is one movement. By the time the circle has travelled for half a revolution, point P will have moved to P_6.

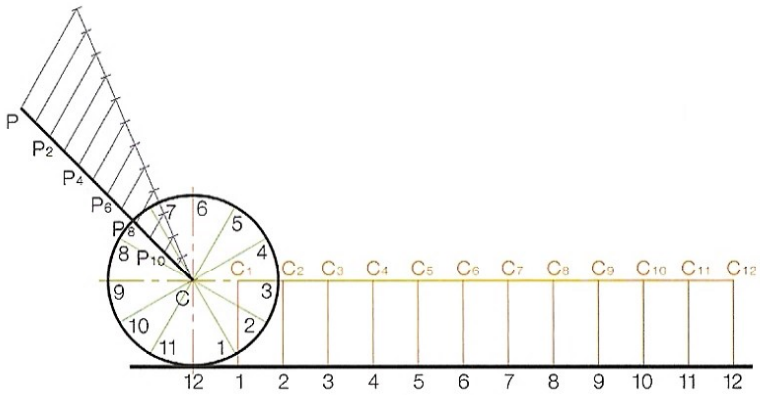

Fig. 17.45

(3) Divide the circle and index.

(4) Step out the twelve steps and index.

(5) Locate the twelve centres, see Fig. 17.45.

(6) The points on the locus are located as before using arcs. We are not measuring to P at the end of the line, we are measuring to P_1, then P_2, then P_3 etc. For example: Take from 4 on the circumference of the circle to P_4 as radius. Place the compass on 4 on the base line and draw an arc. Take from the centre C of the circle to P_4 as radius. Place the compass on C_4 and draw an arc. Where the two arcs cross locates the fourth point on the locus, see Fig. 17.46.

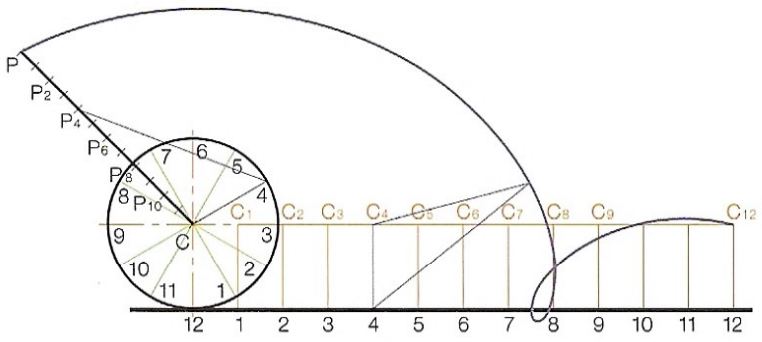

Fig. 17.46

HIGHER LEVEL

Fig. 17.47 shows a large circle B which rolls for half a revolution clockwise along the base line. At the same time the small circle A rolls for half a revolution around the circumference of the circle B, in a clockwise direction. Meanwhile point P moves to point D. Plot the locus of point P for the combined movements.

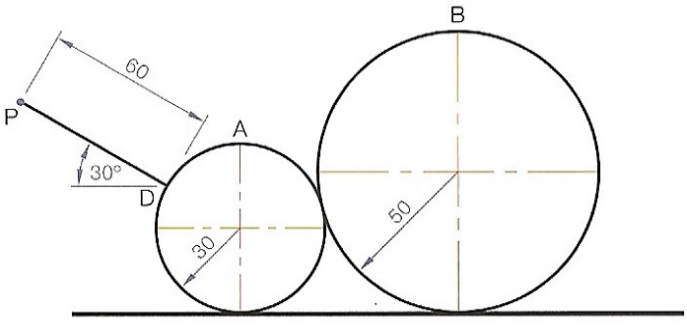

Fig. 17.47

There are three movements occurring simultaneously in this problem. Complete one movement, combine it with the second and finally combine the first two with the third to give the full answer.

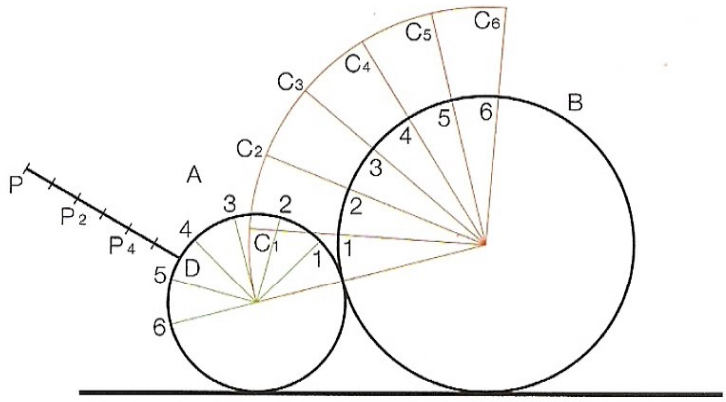

Fig. 17.48

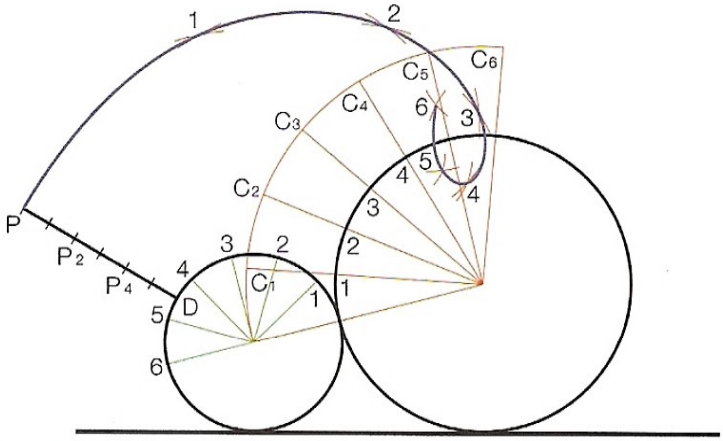

Fig. 17.49

(1) Join the centres of the two circles.

(2) The small circle does a half turn. We divide half of it into six equal parts relative to the line joining the centres. Index these points.

(3) Step these steps off around the large circle.

(4) Locate the centres C_1 to C_6 by radiating from the centre of circle B.

(5) The line PD is now divided. It is divided into six equal parts because the next movement is in six steps.

(6) Plot the path of these two movements combined. Take the radius from 1 on the small circle to P_1. Scribe an arc from 1 on the large circle. Take a second radius from the centre of the small circle to P_1. Scribe an arc, to cross the first arc, from C_1, Fig. 17.49.

(7) We must combine these movements with the movement of the large circle. The large circle rotates for half a turn. Divide the half-circle into six equal parts.

(8) Step these off along the base line.

(9) Locate the six centres.

(10) The points on the locus are located by measuring to the first locus. Take from 1 on the large circle to point 1 on the locus as radius. Scribe an arc from point 1 on the base line. Take from the centre of the large circle to point 1 on the locus as radius. Scribe an arc from C_1 to cross the first arc etc., Fig. 17.50.

(11) Join the points with a smooth curve.

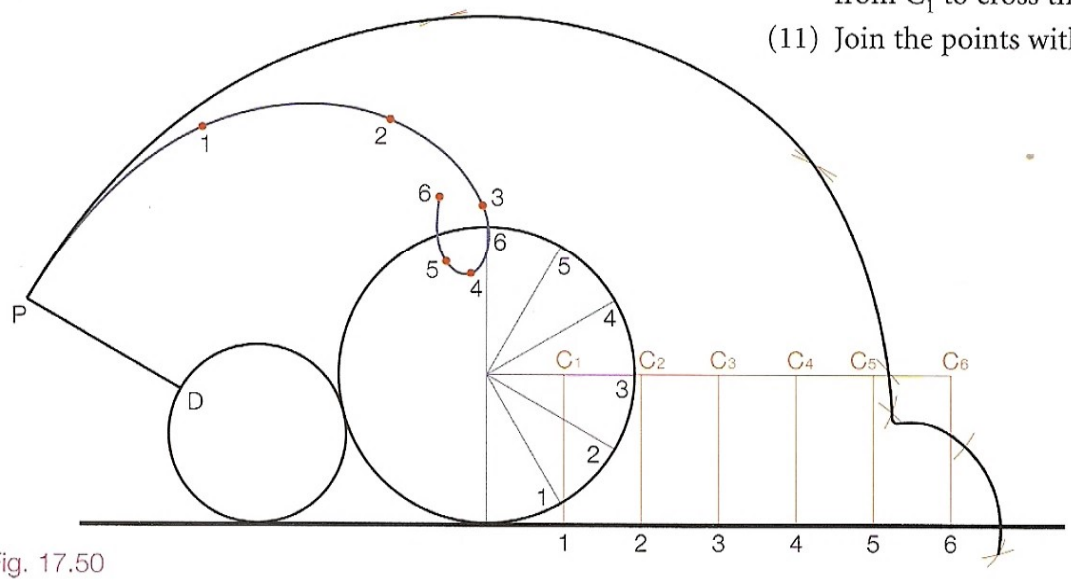

Fig. 17.50

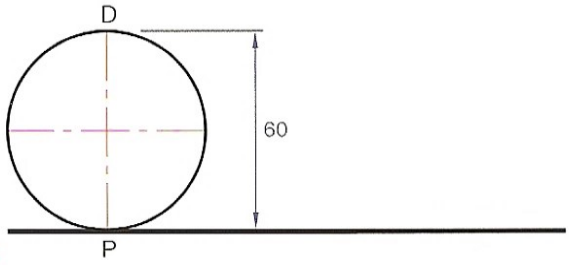

Fig. 17.51

Fig. 17.51 shows a circle which rolls clockwise for one revolution on the given line. During the rolling of the circle an involute is unwound from P to D. Draw the locus of P for the combined movement.

There are two movements involved, the involute and the rolling circle. We start with the involute.

(1) Divide the half-circle into six equal portions. Construct a tangent at the end of each division.

(2) The string is unwinding from P to D, so at D it will be six units long. It shortens by one unit for each tangent moving toward point P.

(3) Divide the circle into twelve.

(4) Step the divisions out on the line.

(5) Index every second point as this will give us six steps, like we have in the involute.

(6) Locate C_1 to C_6.

(7) Plot the points on the combined locus. Take from 1 on the circle to the first point on the involute, point a, as radius. Scribe an arc from 1 on the base line. Take from the centre of the circle to point a on the involute as radius. Scribe an arc from C_1 to cross the first arc etc.

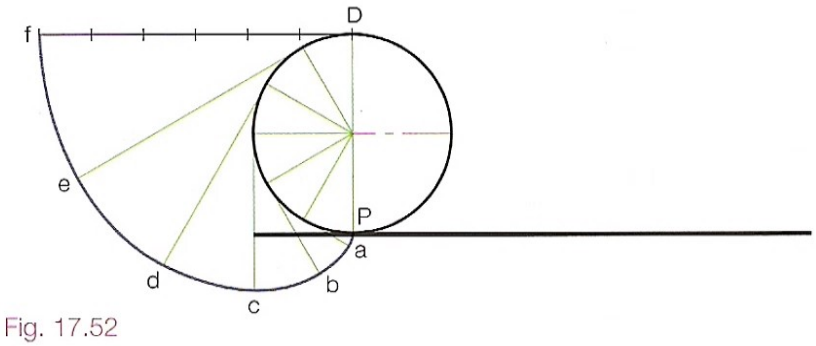

Fig. 17.52

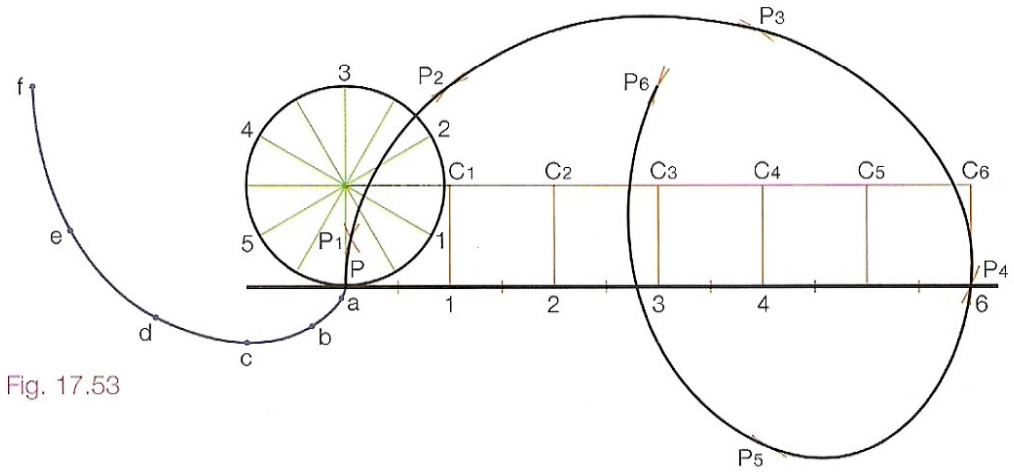

Fig. 17.53

Activities

INVOLUTES

Q1. Draw an involute to a square of 20 mm side.

Q2. Draw an involute to a hexagon of base 18 mm.

Q3. Draw an involute to a circle of 15 mm radius.

Q4. to Q7. Draw an involute to the given shapes. The involute should start at point P and unwind in a clockwise direction.

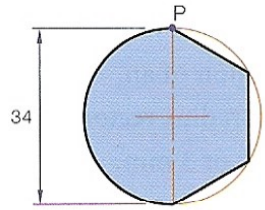

Fig. 17.54

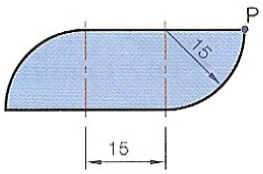

Fig. 17.55

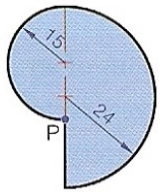

Fig. 17.56

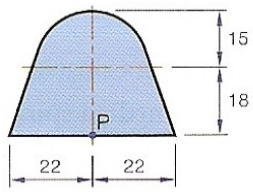

Fig. 17.57

HELICES

Q8. Given the plan and elevation of a cylinder. Draw a left-handed helix of two revolutions starting at point P.

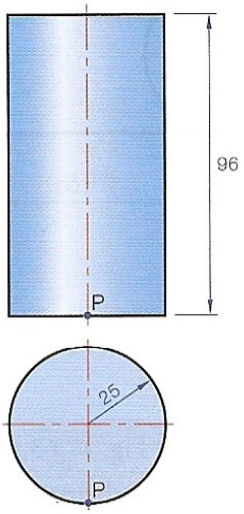

Fig. 17.58

Q9. Given the plan and elevation of a cylinder with two points A and B on its surface. Draw a helix to go from the bottom to the top of the cylinder and to pass through points A and B.

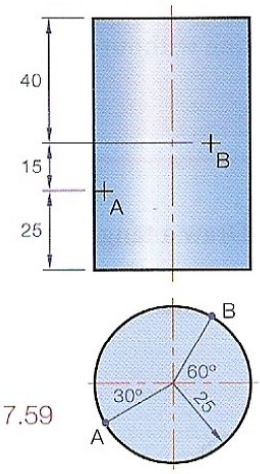

Fig. 17.59

Q10. Draw a single start, right-hand square, screw thread given the inside diameter of 50 mm, outside diameter of 80 mm and the lead of 72 mm.

Q11. Draw a double start, left-hand square, screw thread given the inside diameter of 50 mm, outside diameter of 80 mm and the pitch of 36 mm (lead of 72mm).

CONICAL SPIRALS

Q12. Draw a conical spiral to start at the base of the given cone at point P and to reach the apex in one revolution.

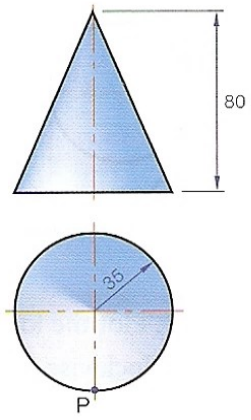

Fig. 17.60

Q13. Draw a conical spiral that passes through point P and completes exactly one convolution from base to apex.

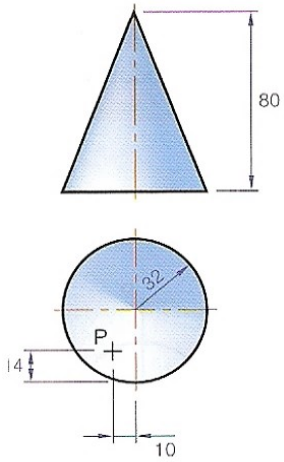

Fig. 17.61

Q14. Draw an Archimedian spiral having its longest radius vector of 50 mm, its shortest radius vector of 14 mm and completing one convolution.

Q15. Draw an Archimedian spiral having $1^1/_2$ convolutions. The spiral is to have a longest radius vector of 56 mm and a shortest radius vector of 20 mm.

Q16. Construct $1^1/_4$ convolutions of an Archimedian spiral given the longest vector as 60 mm and a decrease of 5 mm every 45°.

Q17. Construct $^3/_4$ of a convolution of an Archimedian spiral given the shortest radius vector of 15 mm and an increase every 15° of 3 mm.

CYCLOIDS, EPICYCLOIDS ETC.

Q18. The circle rolls clockwise along the given line without slipping. Plot the locus of point P for this movement.

HONOURS

Draw a tangent to the cycloid at the 6th point on the locus.

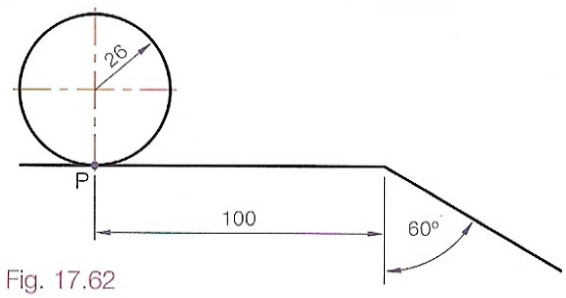

Fig. 17.62

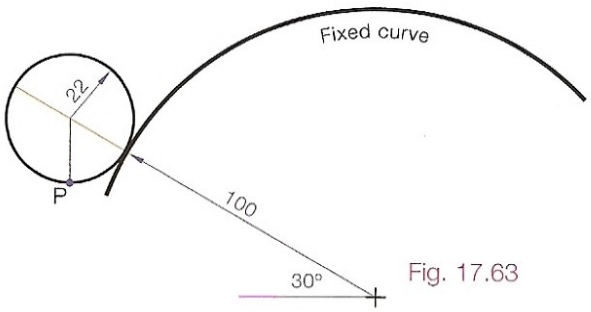

Fig. 17.63

Q19. In Fig. 17.63 the circle rolls clockwise along the fixed curve for one revolution. Plot the locus of point P for this movement.

HONOURS

Draw a tangent to the epicycloids from a point 30 mm from the fixed curve.

Q20. In Fig. 17.64 the small circle rolls round the inside of the larger circle for one revolution. Plot the locus of point P for this movement

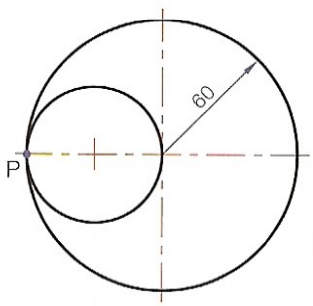

Fig. 17.64

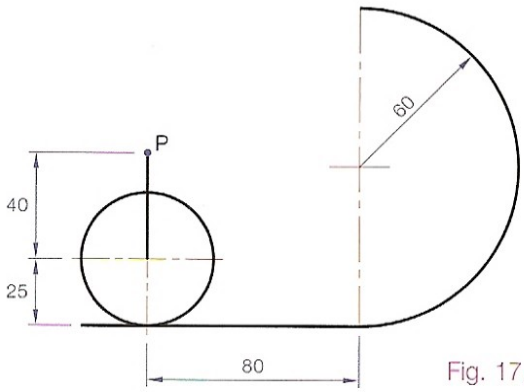

Fig. 17.65

Q21. Plot the locus of point P as the circle rolls clockwise for one complete revolution.

Q22. In Fig. 17.66 the large circle rolls round the small circle for one revolution. Plot the locus of point P for this movement.

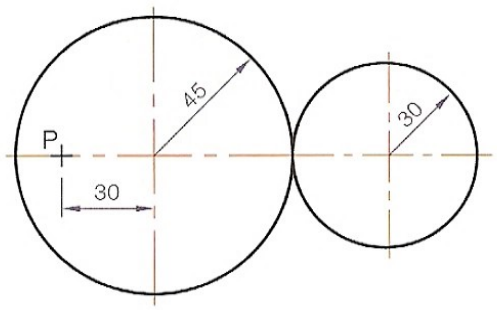

Fig. 17.66

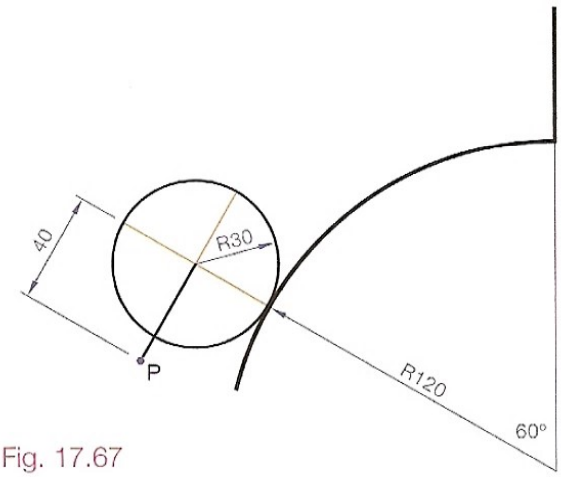

Fig. 17.67

Q23. Plot the locus of point P as the circle rolls without slipping for one revolution.

Q24. Fig. 17.68 shows a small circle which rolls round the large circle for one revolution. At the same time P is unwound as an involute in a clockwise direction for half a revolution to A. Draw the locus of P for the combined movement.

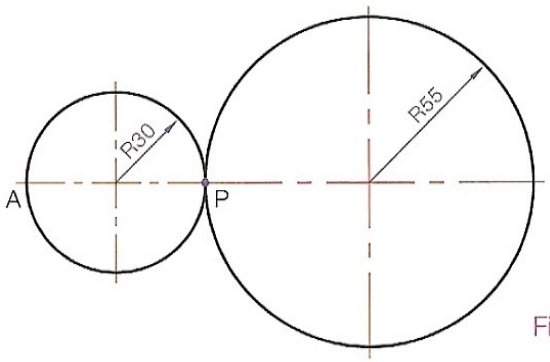

Fig. 17.68

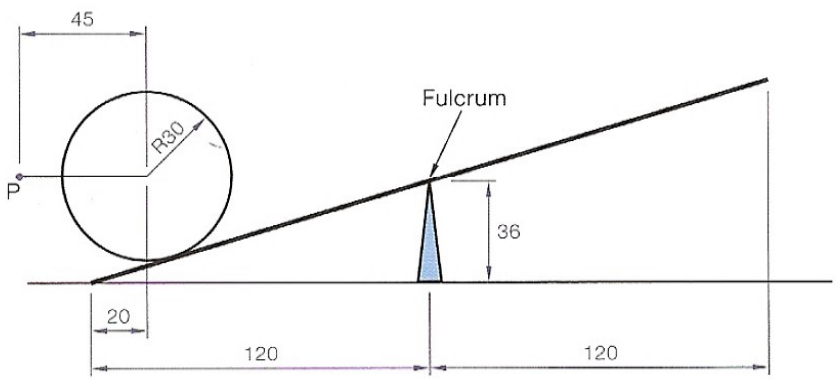

Fig. 17.69

Q25. Fig. 17.69 shows a circle rolling up a see-saw. When the circle reaches the fulcrum the see-saw tips so that the right-hand side touches the ground. Plot the locus of point P for 1½ turns of the circle.

Q26. Fig. 17.70 shows a circle which rolls clockwise along the arc for one revolution. During the rolling of the circle, point P moves at a constant pace to C and then A. Plot the locus of P for the combined movement.

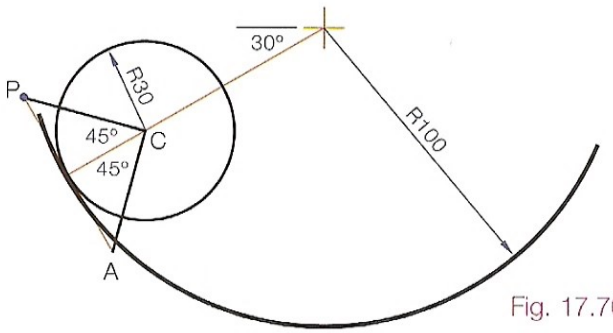

Fig. 17.70

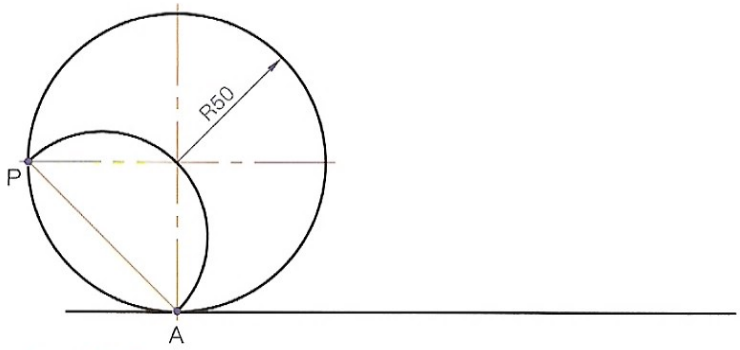

Fig. 17.71

Q27. Fig. 17.71 shows a circle which rolls clockwise along the straight line. During the rolling of the circle, P moves along a semi-circular path to A. Draw the locus of P for the combined movement.

Q28. In Fig. 17.72 the profile rolls for $^3/_4$ of a revolution in a clockwise direction. During the rolling of the profile P moves to A. Draw the locus of P for this combined movement.

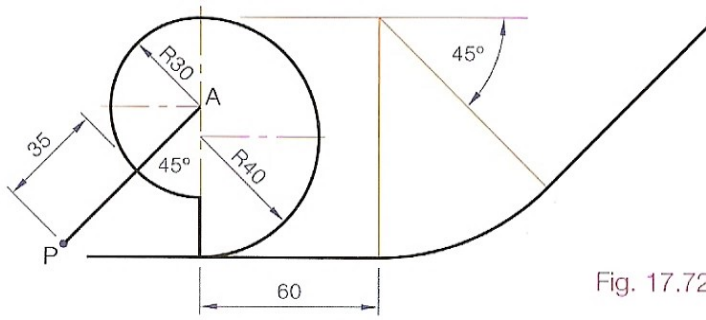

Fig. 17.72

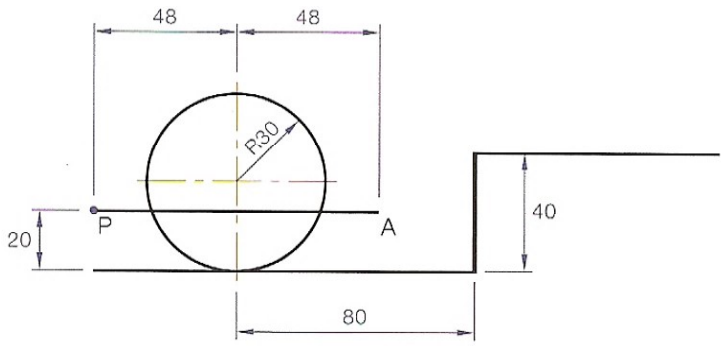

Fig. 17.73

Q29. In Fig. 17.73 the circle rolls clockwise for one revolution. During the rolling of the circle the point P moves to point A. Draw the locus of point P for the combined movement.