Dynamic Mechanisms 2

Linkages
Cams
Gears

Types of Link Mechanisms

Sliding link

End A of the link slides along a set line forcing end B to slide along its set path.

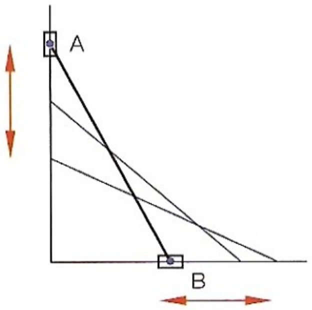


Fig. 17.74

Swinging and sliding link

As the rod swings about point A, the link C is sliding down.

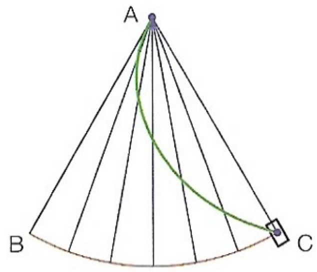


Fig. 17.75

Crank and sliding link

The rod AB rotates about point A. This is a crank. The rotating of the crank causes link C to slide over and back.

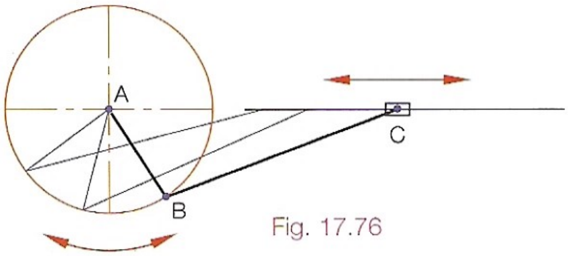


Fig. 17.76

Double crank

This mechanism only works if the length of BC equals that between the centres of A and D. Crank AB rotates. The link between B and C forces C to rotate about D.

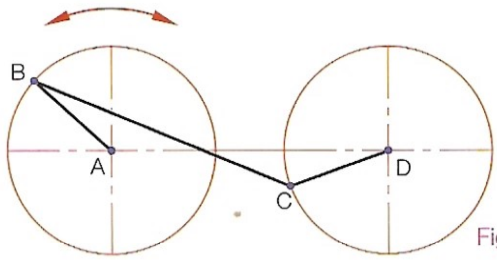


Fig. 17.77

Crank and rocker

As crank AB rotates, rocker arm CD moves forwards and backwards.

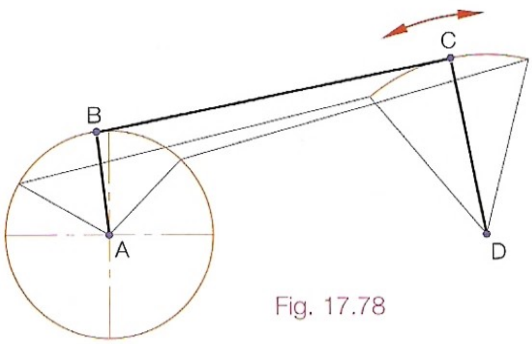


Fig. 17.78

Crank and fixed through link

C is fixed in position but allows BC to slide through it.

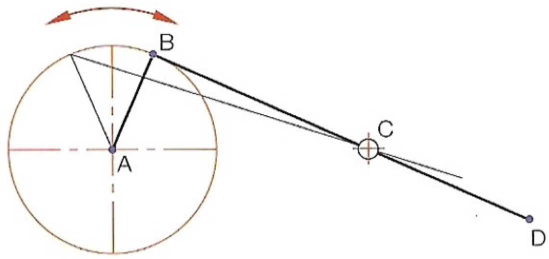


Fig. 17.79

A ladder AB is leaning against a wall, with one end against the wall and the other on the floor. Plot the locus of the midpoint of the ladder as it slides to the floor.

(1) Draw the problem placing the ladder at a steep angle.
(2) Divide the distance from A to the corner into a number of parts.
(3) Draw the ladder in each position and locate point P in each case.
(4) Join all the plotted points to form the locus. This locus is called a **glisette**.

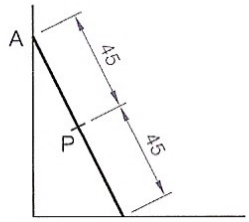


Fig. 17.80

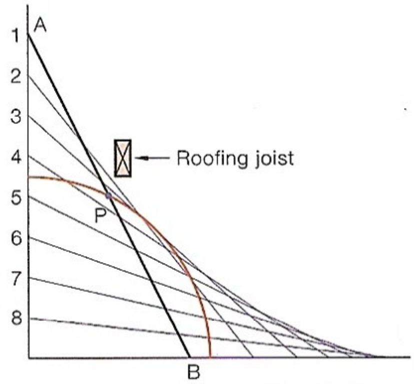


Fig. 17.81

Alternate method
Many of these loci problems can be solved using a trammel.
(1) Mark off the length of the ladder AB and the position of point P.
(2) By moving the trammel so that A slides along the vertical line and B slides along the horizontal line, the locus of point P can be plotted.
This construction may be used to see if a ladder will fit between a gap in roofing joists or if a long object will fit through a doorway.

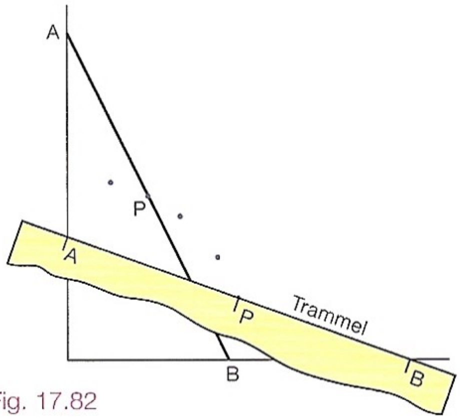


Fig. 17.82

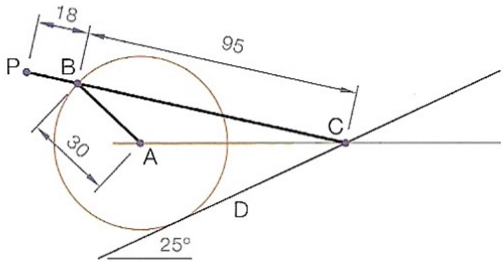


Fig. 17.83

Fig. 17.83 shows a crank AB which revolves in a clockwise direction around pivot A. Link PC is pin-jointed at B. End C slides on line DE. Plot the locus of point P for one revolution of the crank.

(1) Set up the problem.
(2) Divide the circle into twelve equal parts.
(3) For each division draw in the link BC ensuring that C is always on the line DE and 95 mm long.
(4) Point P can be found for each position of the crank arm. The first six steps are shown.
(5) This problem can more easily be solved with a trammel as shown in Fig. 17.85

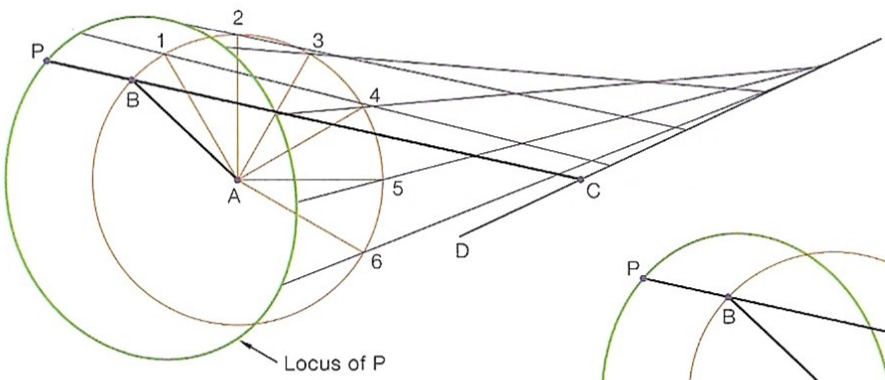


Fig. 17.84

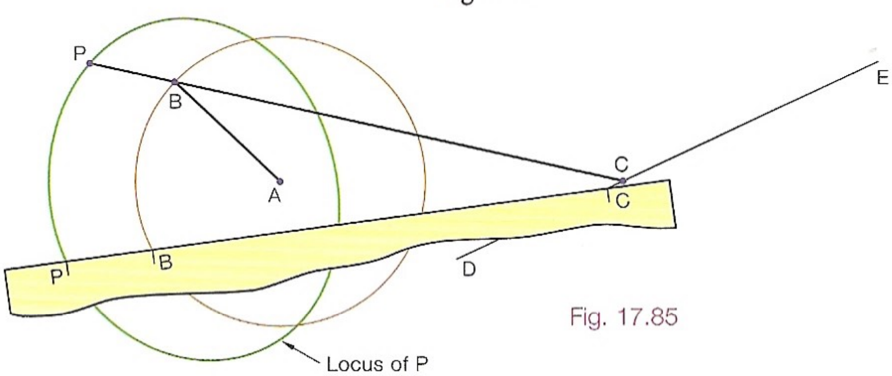


Fig. 17.85

Fig. 17.86 represents an up-and-over garage door in a partly open position. Pivot C slides along line AF while A and B can pivot. Draw the locus of both E and D as the door opens and closes.

(1) Set up the problem as given.
(2) Cut a suitable trammel and on it mark the door length D to E. Mark the pivot points B and C.
(3) Pivot C follows the line AF and pivot B will follow a circular path with A as centre.
(4) Use the trammel to plot all the points.

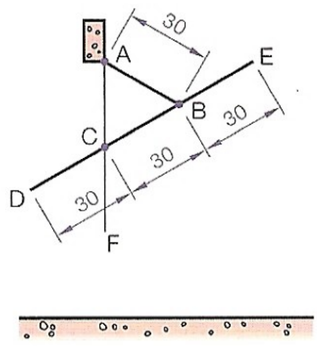


Fig. 17.86

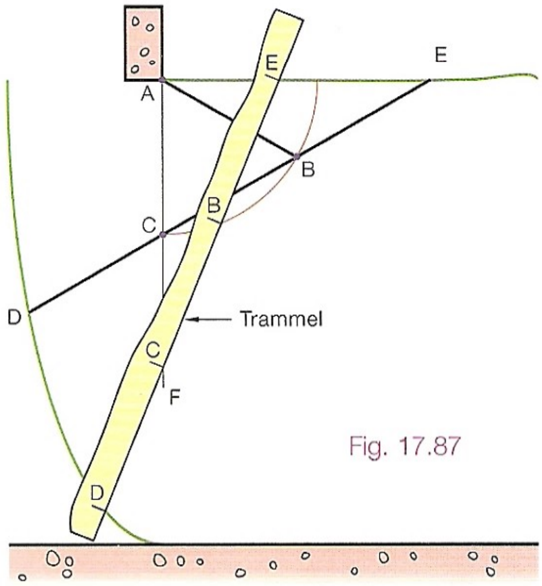


Fig. 17.87

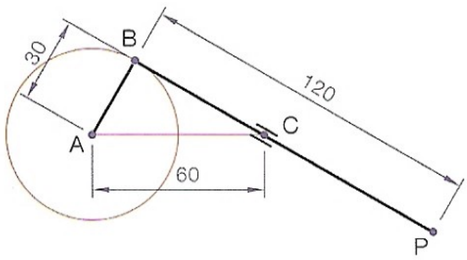


Fig. 17.88

Fig. 17.88 shows a crank AB which rotates about point A. Link BP can slide through the pivot C. Plot the locus of P for one revolution of the crank.

(1) Set up the problem.
(2) Cut a trammel and on it mark B and P.
(3) Use the trammel to plot the points by keeping B on the circle and the line BP passing through C.

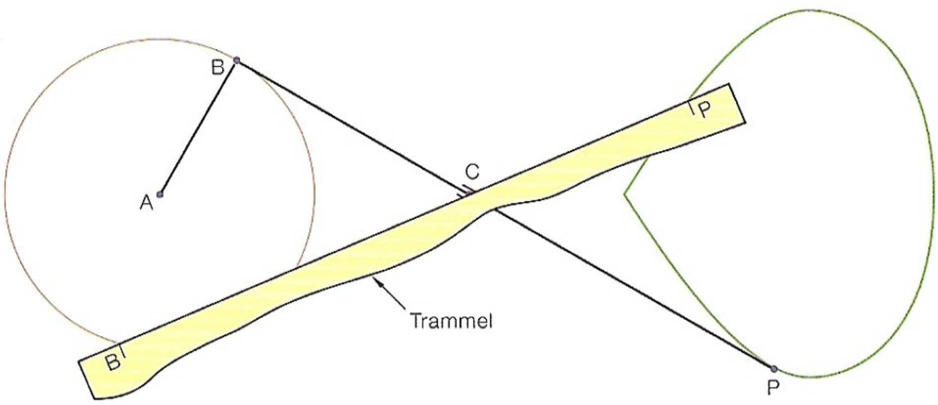


Fig. 17.89

Fig. 17.90 shows a crank DC which rotates about D. AB can rotate about A and is linked to the crank by BC. Plot the locus of point P for one full revolution of the crank.

(1) CD is a crank and AB will be a rocking arm. Set up the problem.
(2) Draw the full circular path of point C.
(3) Draw the arc that point B will follow.
(4) Set up the trammel equal in length to BC and mark the position of point P.
(5) Plot the locus of P by keeping the point C on the trammel on the circle and by keeping the point B on the trammel on the arc.

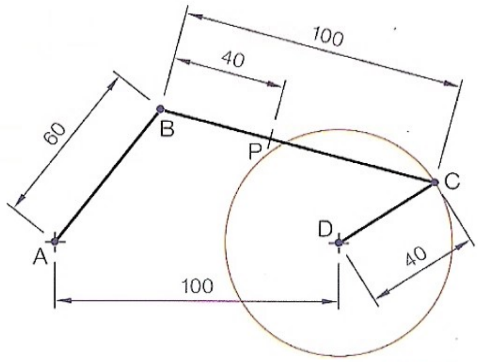


Fig. 17.90

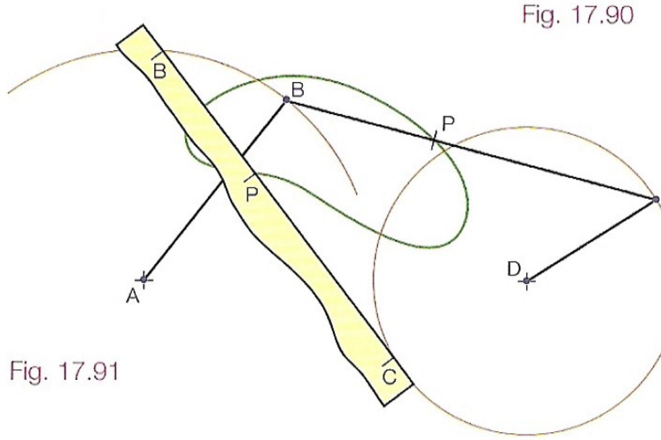


Fig. 17.91

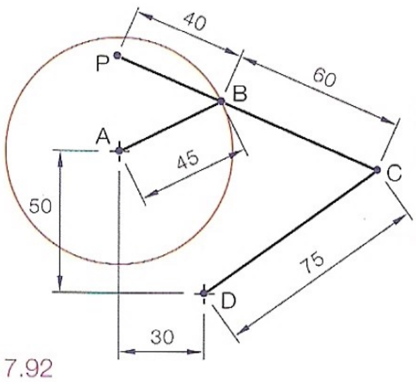


Fig. 17.92

Fig. 17.92 shows a crank AB which rotates for a complete revolution. Link DC rotates about fixed centre D. Plot the locus of point P for the movement.

(1) AB is a crank and DC will be a rocker arm. Set up the problem.
(2) Draw the circle to show the movement of point B.
(3) Draw the arc to show the movement of point C.
(4) The trammel will represent the link CBP.
(5) Point C on the trammel must run along the circle. Point B on the trammel must travel along the arc.
(6) Numerous points on the locus can b[e] plotted and the path drawn.

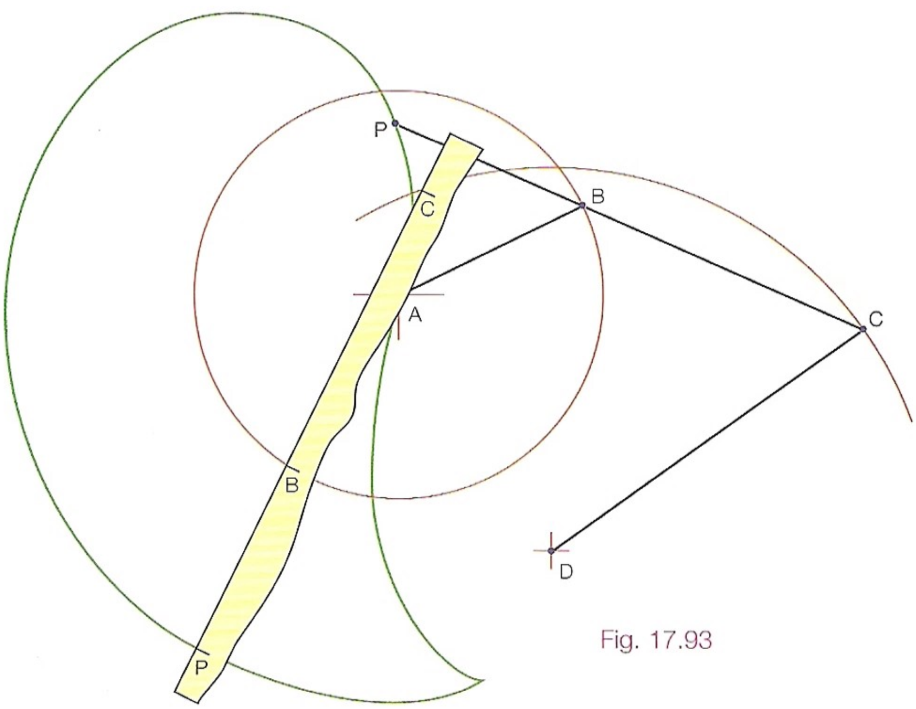


Fig. 17.93

Fig. 17.94 shows a circle, which rolls for one revolution along the line DE. B is a pivot and C is a fixed through pivot. Plot the locus of point P for the motion.

(1) The path of point B must be found first. The locus of B will be a superior trochoid. Construct as explained in Dynamic Mechanisms 1 (first half of this chapter).
(2) Locate point C.
(3) Make the trammel match link BCP.
(4) The locus is plotted by placing point B on the superior trochoid and the edge of the trammel must touch point C at all times.

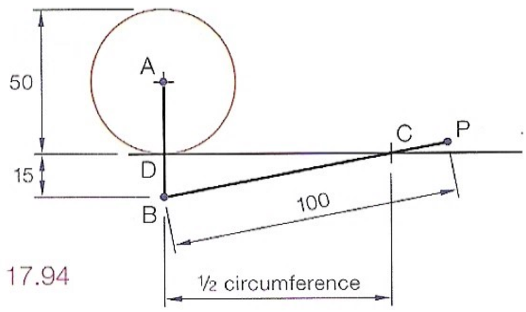


Fig. 17.94

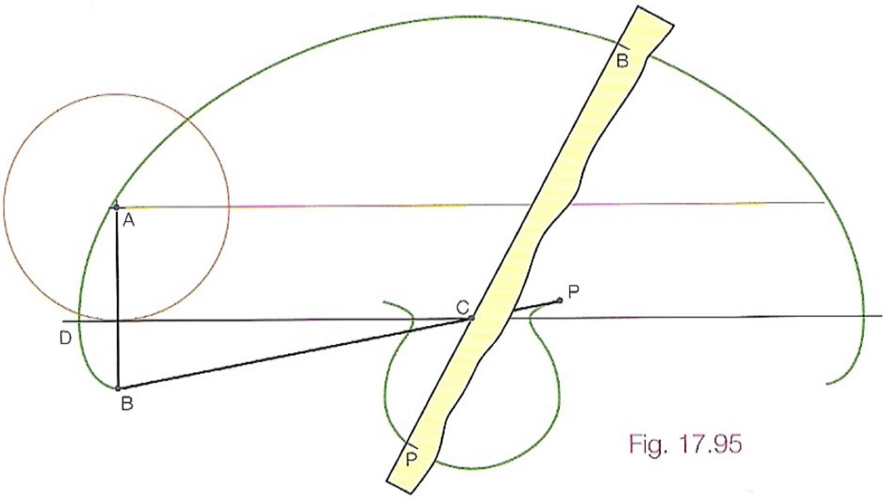
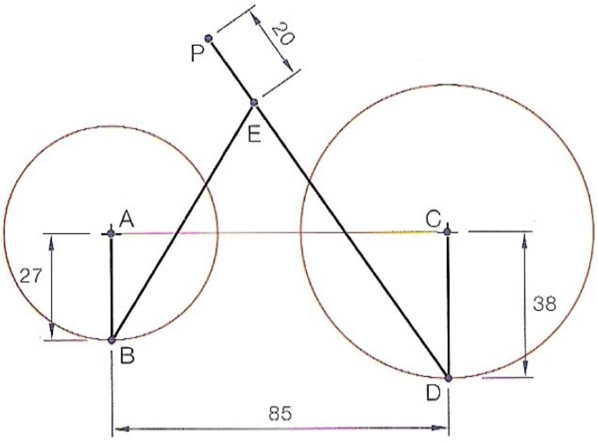


Fig. 17.95



BE = 70 mm BE = 85 mm

Fig. 17.96

Fig. 17.96 shows a crank AB which rotates anti-clockwise about pivot C. Another crank CD rotates clockwise about pivot C. Link BE pivots at B and E. Link DEP pivots at D and E. Plot the locus of point P for one revolution of the cranks. (Both cranks rotate at the same rate.)

(1) It should be noted that this mechanism has a number of moving parts and is not easily solved using a trammel.
Divide both crank circles into twelve equal parts and index, remembering that AB rotates anti-clockwise and CD rotates clockwise.
(2) At each position on the circles the full mechanism is constructed finding a point on the locus (construction for P_0, P_3 and P_7 shown).
(3) Join the twelve points on the path with a smooth curve.

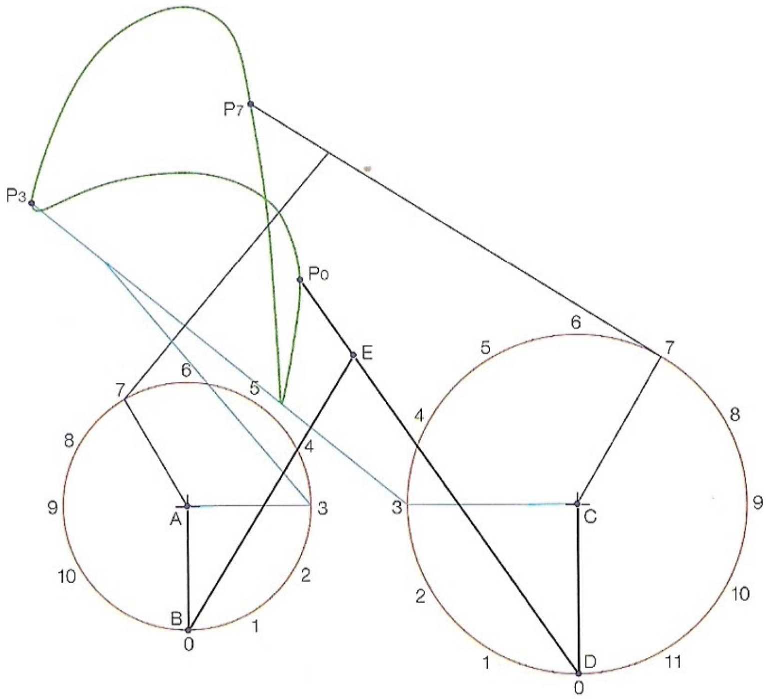


Fig. 17.97

Displacement Diagram

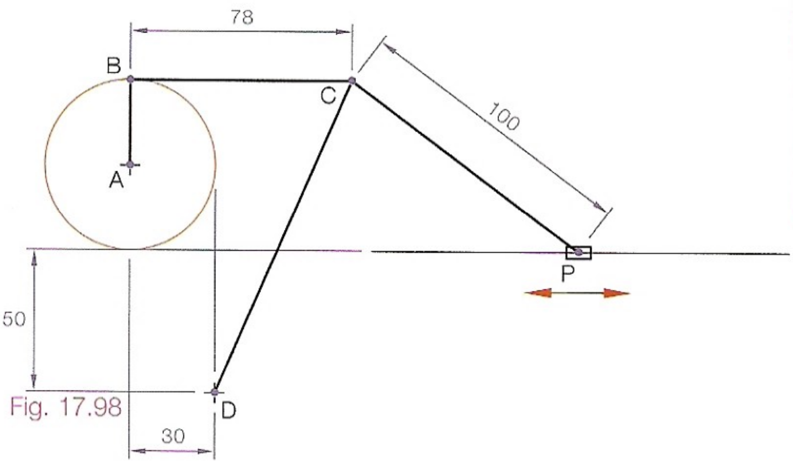


Fig. 17.98

Fig. 17.98 shows a crank AB which pivots about A. A rocker arm DC pivots about D. B and C are pivots and P is a sliding link. Plot the displacement diagram for point P for one complete clockwise revolution of the crank.

The movement of P is linear. The displacement diagram allows the position of P to be plotted for any degree of revolution of the crank. The position of P can also be related to time. If we know how long it takes for one revolution of the crank we can easily calculate the exact location of point P for any moment in time.

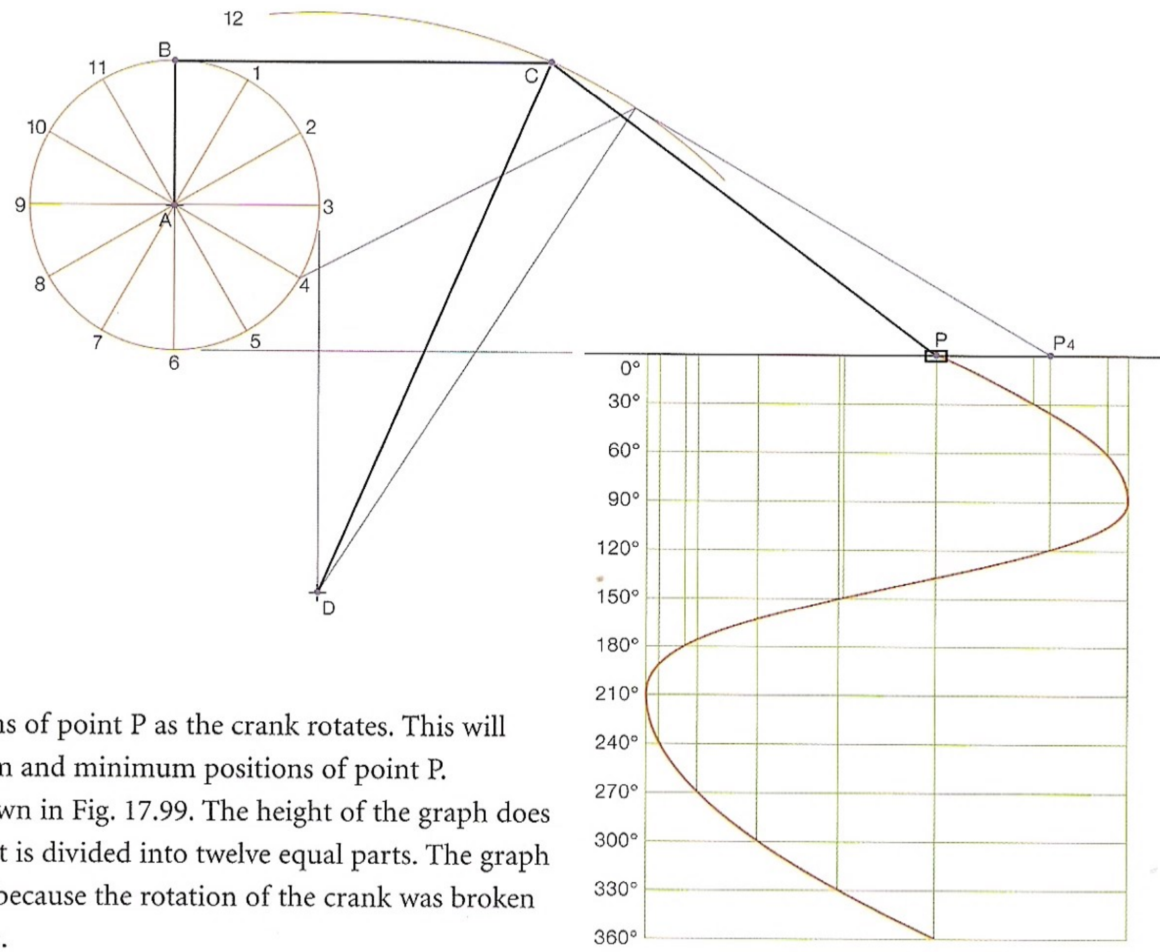


Fig. 17.99

Method

(1) Plot all twelve positions of point P as the crank rotates. This will establish the maximum and minimum positions of point P.

(2) Set out a graph as shown in Fig. 17.99. The height of the graph does not matter as long as it is divided into twelve equal parts. The graph is divided into twelve because the rotation of the crank was broken into twelve equal steps.

(3) The position of point P is plotted for each 30° rotation. This point is plotted on the graph, (P_4 shown.)

(4) Repeat for each of the twelve steps of the crank's rotation.

Activities

Q1. The line AB represents a ladder leaning against a wall. Plot the locus of point P as the ladder falls. End A runs along the wall and end B runs along the floor.

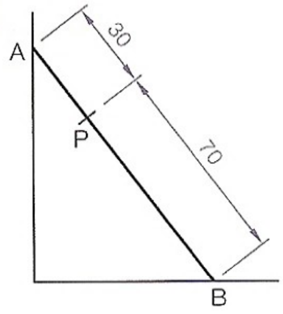


Fig. 17.100

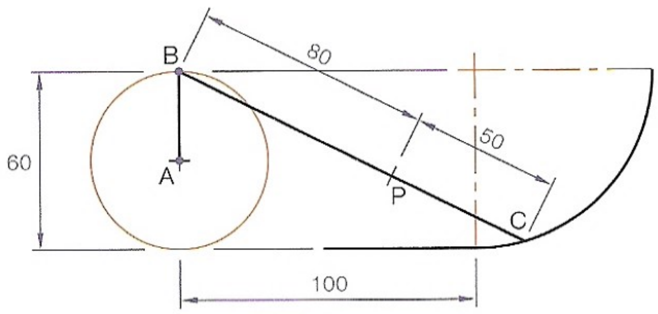


Fig. 17.101

Q2. Fig. 17.101 shows a crank AB which rotates for one complete revolution. Link BC is pin-jointed at B and end C is restricted to the path shown. Plot the locus of P for the movement.

Q3. Crank AB rotates about point A. Link BP is pin-jointed at point B. Point C is a fixed-through pivot. Plot the locus of point P for one full revolution of the crank.

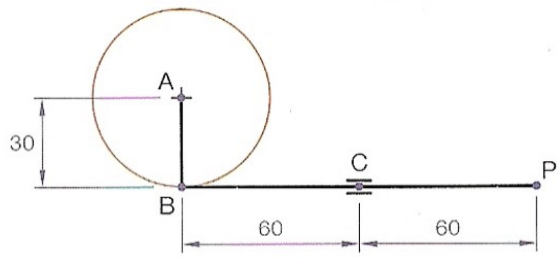


Fig. 17.102

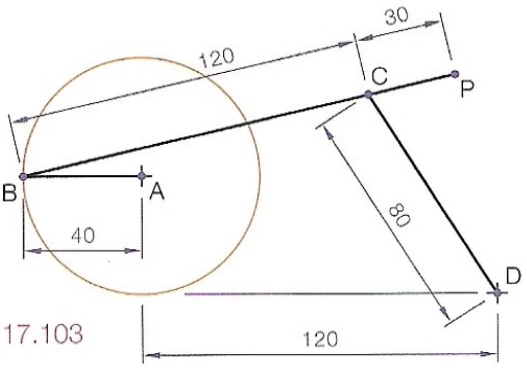


Fig. 17.103

Q4. Crank AB rotates about A. Rocker arm DC rotates about D. Link BCP is pin-jointed at B and C. Plot the locus of point P for one complete revolution of the crank.

Q5. Fig. 17.104 shows a circle which rolls along the line DE for one complete revolution. B is a pivot and C is a fixed through pivot. Plot the locus of point P.

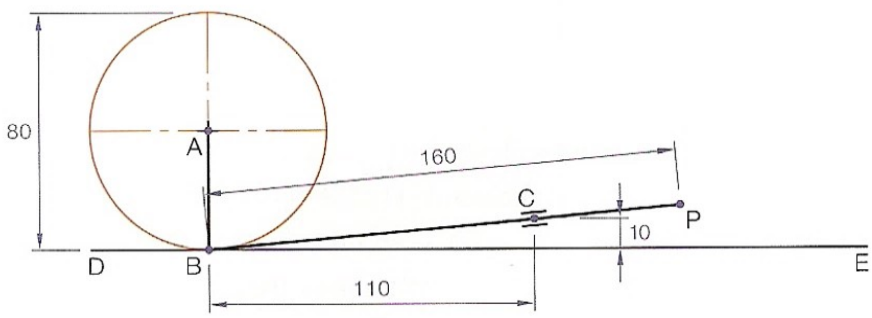


Fig. 17.104

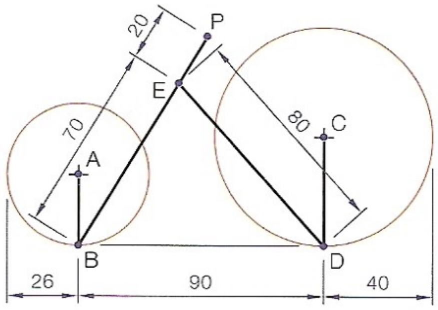


Fig. 17.105

Q6. Fig. 17.105 shows a crank AB which rotates about A. Another crank CD rotates about C. Both cranks rotate at the same rate and in the same direction. Links DE and BEP are pivot-jointed at B, D and E. Plot the locus of point P for one complete revolution of the cranks.

Q7. Fig. 17.106 shows a crank AB which rotates about A. Another crank CD rotates about C. Crank AB rotates clockwise and crank CD rotates anti-clockwise. Both cranks rotate at the same rate. Joint B, E and D are pivot joints. P is a sliding link. Draw the locus of E for one revolution of the cranks.
Draw a displacement diagram for P for the full movement.

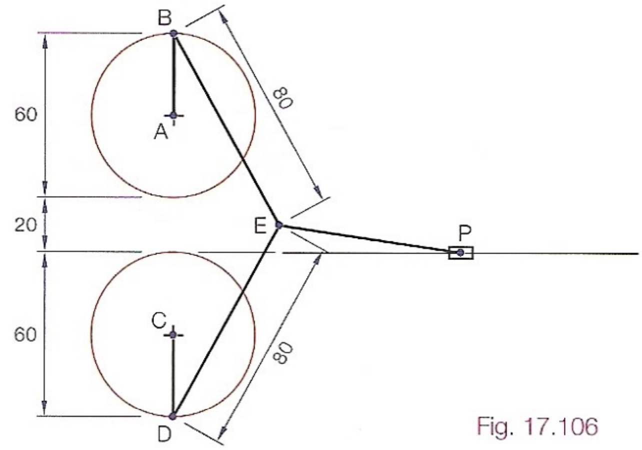


Fig. 17.106

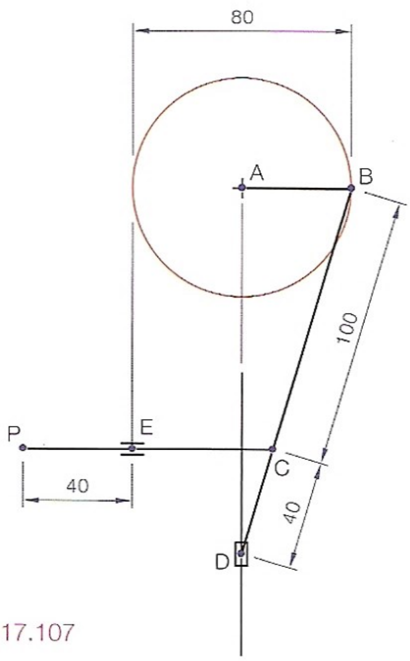


Fig. 17.107

Q8. Crank AB rotates about A. D is a sliding link and B is a pivot. Plot the locus of C for one revolution of the crank. CEP is connected at point C by a pivot joint. E is a fixed-through link. Plot the locus of P for the combined movement.

Q9. Crank AB rotates clockwise for one revolution. During the turning of the crank, D slides at a constant speed to E and back to D again. C and B are pivot joints. Plot the locus of P for one revolution of the crank.

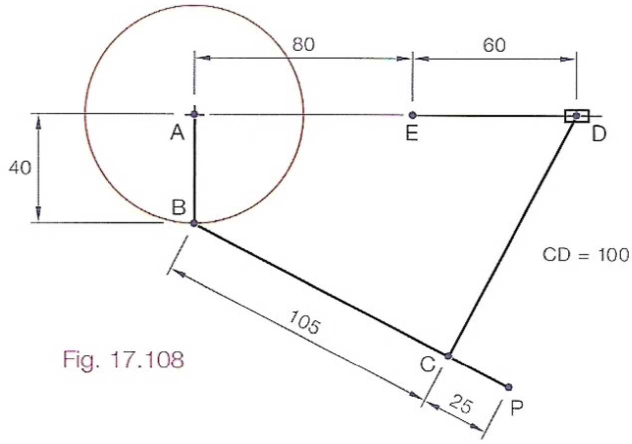


Fig. 17.108

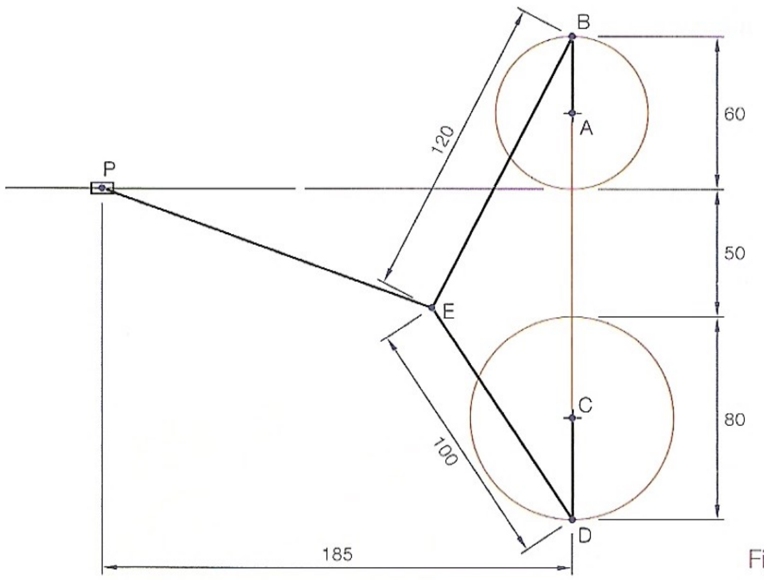


Fig. 17.109

Q10. Fig. 17.109 shows two cranks, AB and CD. AB rotates clockwise and rotates twice for every one revolution of CD, which rotates anti-clockwise. B, D and E are pivot joints and P is a sliding link. Plot the locus of E for one revolution of CD (two revolutions of AB). Draw a displacement diagram for P for the full movement.

Cams

A cam is a shaped component generally used to change rotary movement into linear movement. Cams are used regularly in engine parts and mechanisms. The most usual types are **radial plate cams**. A shaft rotating at uniform speed carries a disk, usually of irregular shape, called the cam. A **follower** presses against the curved surface of the cam, Fig. 17.110. Rotation of the cam causes the follower to move according to the shape of the cam profile. The follower is kept in constant contact with the cam by gravity, or by using a spring. The follower shown in the diagram is a **knife-edge follower**. There are other types of followers which we will look at later on in the chapter. A knife-edge follower can follow very complicated cam shapes but wears rapidly.

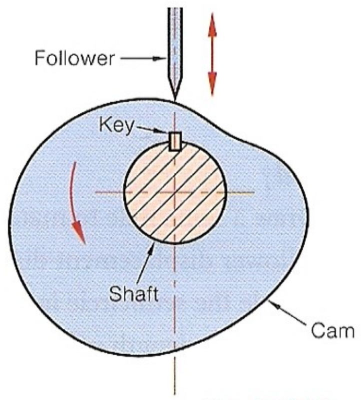


Fig. 17.110

Displacement Diagrams

The movement of the follower is an important consideration in cam design. Its rate of movement and position varies hugely according to the cam profile. A displacement diagram is a means of planning this follower movement before the cam is constructed. It is a graph plotting the movement of the follower for one full revolution of the cam.

Uniform Velocity

The follower rises or falls at a constant speed. The movement will plot as a straight line on a graph.

Uniform velocity gives constant follower speed but produces abrupt changes which may cause the follower to jump. It should be noted that

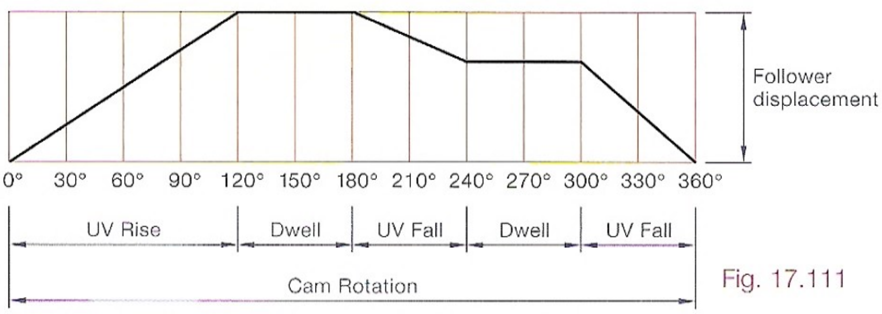


Fig. 17.111

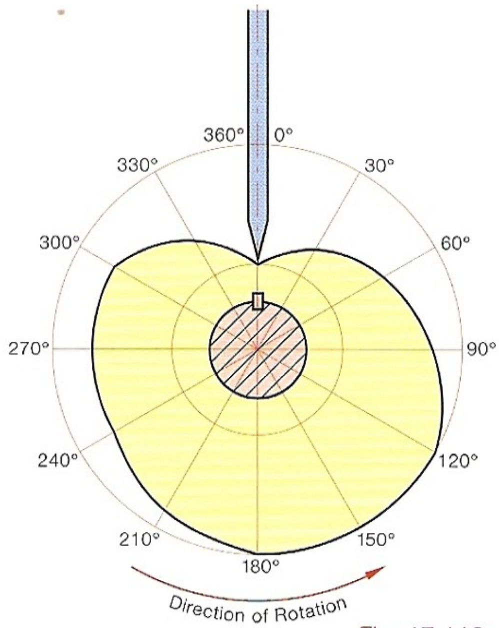


Fig. 17.112