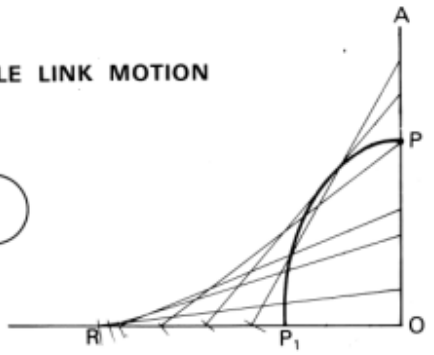
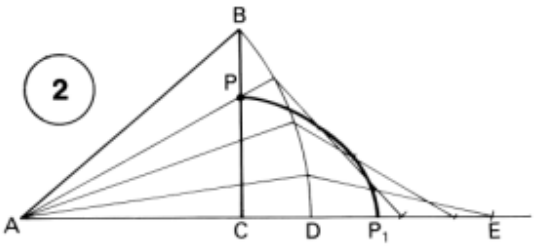
SINGLE LINK MOTION



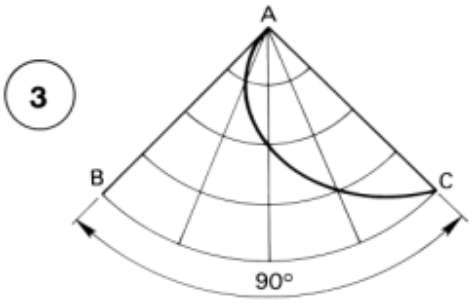
P REPRESENTS A POINT ON THE BAR **AO**. THE **A** END OF THE BAR SLIDES VERTICALLY DOWNWARDS AS THE **O** END SLIDES HORIZONTALLY TOWARDS **R**. WHILE THE BAR IS SLIDING THUS THE LOCUS OF THE POINT MOVES FROM **P** TO P_1.

DOUBLE LINK MOTION



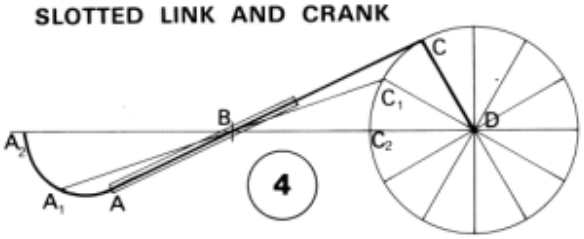
P REPRESENTS A POINT ON THE BAR **BC**. **AB** IS ANOTHER BAR WHICH PIVOTS AT **A** AND IS HINGED TO **BC** AT **B**. AS **C** MOVES TOWARDS POSITION **E**, **B** HAS MOVED DOWN TO POSITION **D**. DURING THIS MOVEMENT POINT **P** ON BAR **BC** MOVES TO P_1, ITS LOCUS BEING THE CURVED LINE.

SWINGING LINK MOTION



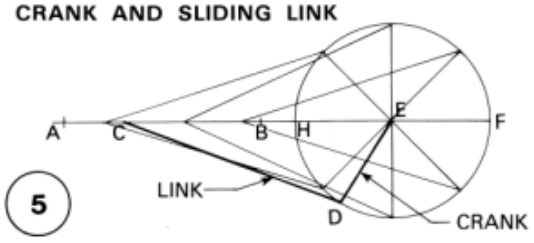
AB IS A BAR OR LINK WHICH IS PIVOTED AT **A** AND WHICH SWINGS THROUGH 90° TO POSITION **AC**. A POINT MOVES ALONG THE FULL LENGTH OF THE LINK AS IT ROTATES. THE CURVED LINE SHOWS THE LOCUS OF THE POINT.

SLOTTED LINK AND CRANK



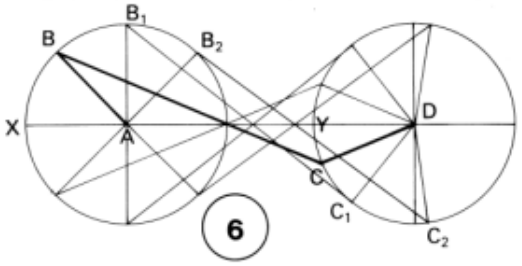
CD IS A CRANK PIVOTED AT **D**. **AC** IS A SLOTTED LINK WHICH KEEPS IN TOUCH WITH **B** AS IT SLIDES. AS **C** MOVES ALONG THE ARC THROUGH C_1 TO POSITION C_2 THE LOCUS OF **A** MOVES THROUGH A_1 TO A_2. FROM THE CONSTRUCTION IT MAY BE DEDUCED HOW TO PLOT THE LOCUS OF **A** WHEN THE CRANK **CD** MAKES A COMPLETE REVOLUTION.

CRANK AND SLIDING LINK

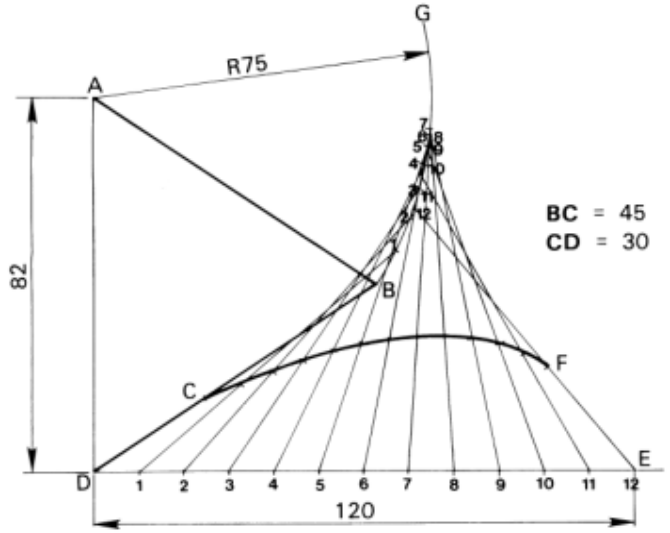


DE IS A CRANK AND **CD** IS A LINK. THE CRANK ROTATES ABOUT **E** AND POINT **C** OF LINK **CD** SLIDES ALONG THE HORIZONTAL LINE. THE LOCUS OF THIS POINT GOES FROM **A** TO **B**. NOTICE THAT LENGTH **BF** = **CD** AND THAT **AH** = **CD**.

LINK CONNECTED TO TWO CRANKS



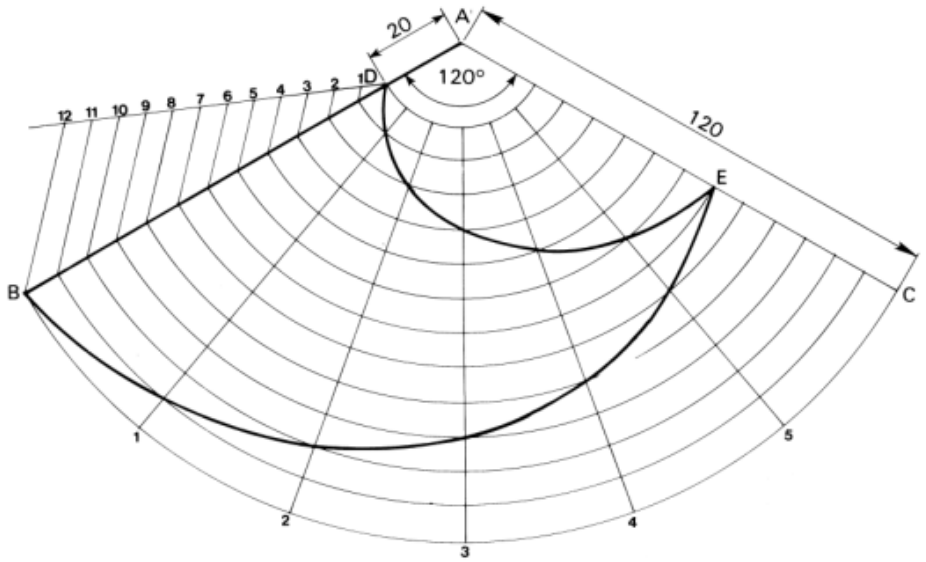
AB AND **CD** ARE TWO CRANKS. **BC** IS THE CONNECTING LINK. **A** AND **D** ARE FIXED PIVOTS. AS **B** MOVES TO POSITION B_1, **C** MOVES TO POSITION C_1. THIS PATTERN OF MOVEMENT CONTINUES WITH B_2 AND C_2 BEING THE NEXT POSITIONS OF THE LINK **BC**. IN THIS LINKAGE LENGTH **BC** MUST EQUAL DISTANCE **XY**.



1

THE RODS **AB** AND **BD** ARE HINGED AT **B**. **AB** IS PIVOTED AT **A**. TO PLOT THE LOCUS OF POINT **C** AS THE END OF THE ROD **BD** MOVES FROM **D** TO **E**.

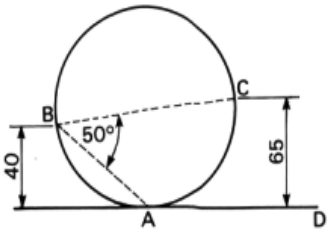
WITH **A** AS CENTRE DRAW ARC WITH **AB** (75 mm) AS RADIUS. DIVIDE **DE** INTO ANY NUMBER OF PARTS (SAY 12). WITH **DB** AS RADIUS AND WITH THE POINTS ALONG **DE** AS CENTRES DRAW ARCS TO INTERSECT ARC **BG**. JOIN INTERSECTIONS TO THE POINTS ON **DE**. MARK A DISTANCE **DC** FROM THE END OF EACH STRAIGHT LINE. THE LOCUS **CF** IS PLOTTED THROUGH THESE MARKS.



2

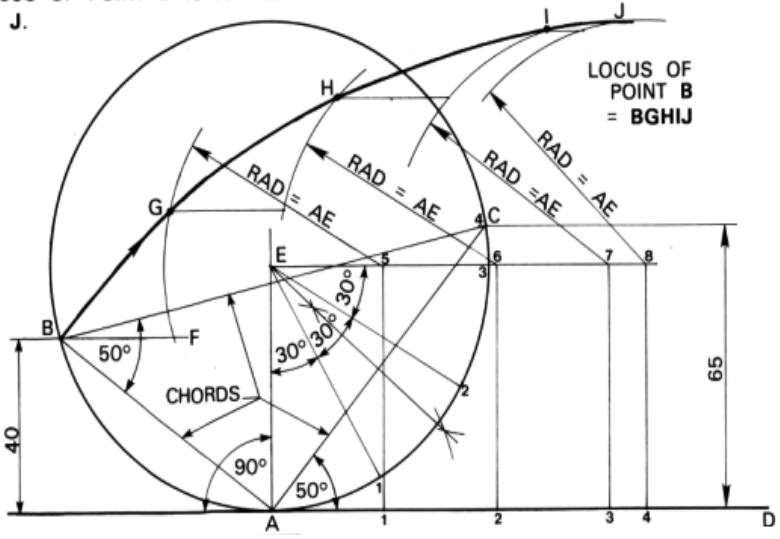
A ROD **AB** IS PIVOTED AT **A**. THE END **B** SWINGS FROM **B** TO **C** AND BACK AT CONSTANT SPEED. POINT **D** SLIDES FROM **D** TO **B** DURING THIS MOVEMENT. TO DRAW THE LOCUS OF THE PATH TRACED BY **D**.

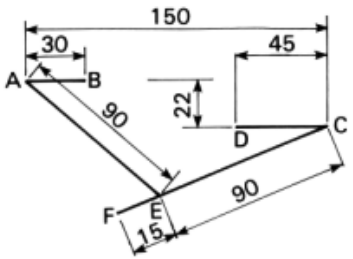
DIVIDE **DB** INTO AN EVEN NUMBER OF EQUAL PARTS. DIVIDE ANGLE **BAC** INTO HALF THAT NUMBER OF PARTS BY THE RADIATING LINES **A1**, **A2** ETC. DRAW ARCS FROM THE DIVISIONS ON **DB** TOWARDS LINE **AC** (WITH **A** AS CENTRE). DRAW THE FREEHAND CURVE FROM **D** TO **E** AND FROM **E** TO **B** AS SHOWN. **DEB** IS THE LOCUS OF THE PATH TRACED BY **D** DURING THE MOVEMENT.



THE GIVEN CIRCLE IS ROLLED ALONG THE LINE **AD** UNTIL POINT **C** MAKES CONTACT WITH IT. TO PLOT THE LOCUS OF POINT **B** DURING THIS MOVEMENT.

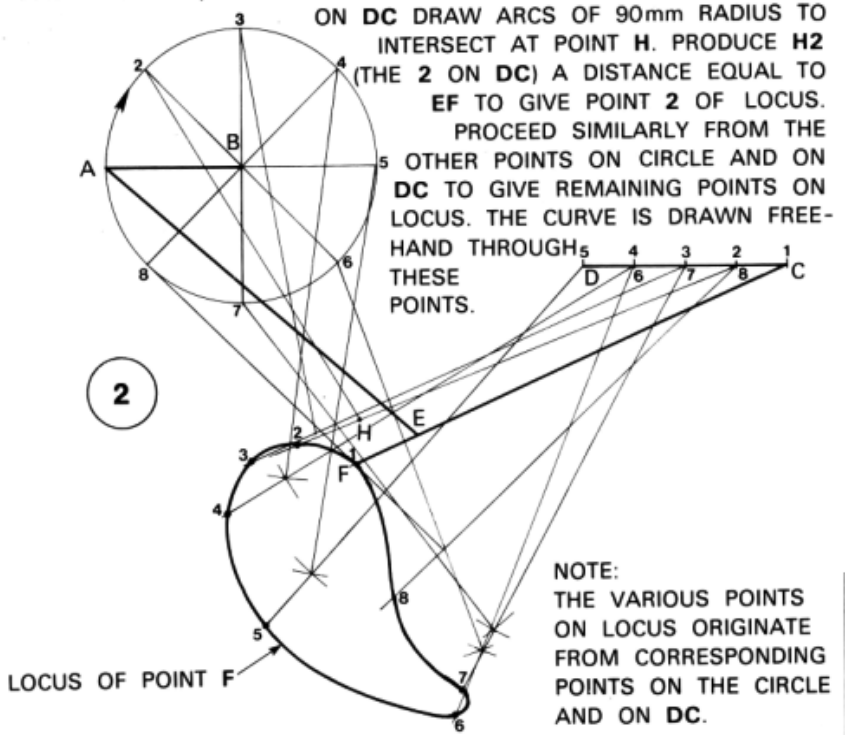
SEE PAGE ENTITLED 'DIAGONAL SCALES II'' FOR DETAILS OF THE PRINCIPLE WHICH IS APPLIED IN CONSTRUCTING THE CIRCLE FROM THE GIVEN INFORMATION. DRAW DISTANCE **A4** ALONG **AD** EQUAL TO ARC **AC**. PROJECT VERTICALLY FROM **1**, **2**, **3** AND **4** HEIGHTS EQUAL TO **AE** TO GIVE POINTS **5**, **6**, **7** AND **8**. WITH EACH OF THESE POINTS AS CENTRES DRAW ARCS WITH **AE** AS RADII. PROJECT HORIZONTALLY FROM **B** TO INTERSECT ARC **F**. TAKE A DISTANCE **A1** FROM POINT **F** ALONG ARC TO GIVE POINT **G** WHICH IS A POINT ON THE LOCUS. LOCATE POINTS **H**, **I** AND **J** IN A SIMILAR WAY. THE LOCUS OF POINT **B** IS A FREEHAND CURVE THROUGH **G**, **H** AND **I** TO **J**.





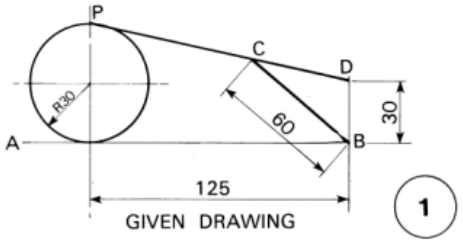
THE ROD **AB** PIVOTS ABOUT **B** IN A CLOCKWISE DIRECTION. DURING ONE REVOLUTION OF **AB**, THE END **C** OF ROD **FC** SLIDES FROM **C** TO **D** AND BACK TO **C**. THE ROD **AB** IS PIN-JOINTED AT **A** AND AT **E**. TO DRAW THE LOCUS OF POINT **F** DURING ONE REVOLUTION OF THE ROD **AB**.

DRAW OUTLINE TO ABOVE DIMENSIONS. WITH **B** AS CENTRE AND **AB** AS RADIUS DRAW CIRCLE. DIVIDE CIRCUMFERENCE INTO 8 EQUAL PARTS. DIVIDE **DC** INTO 4 EQUAL PARTS (4 FROM **C** TO **D** AND 4 RETURN). FROM POINT **2** ON CIRCUMFERENCE AND POINT **2** ON **DC** DRAW ARCS OF 90mm RADIUS TO INTERSECT AT POINT **H**. PRODUCE **H2** (THE **2** ON **DC**) A DISTANCE EQUAL TO **EF** TO GIVE POINT **2** OF LOCUS. PROCEED SIMILARLY FROM THE OTHER POINTS ON CIRCLE AND ON **DC** TO GIVE REMAINING POINTS ON LOCUS. THE CURVE IS DRAWN FREE-HAND THROUGH THESE POINTS.



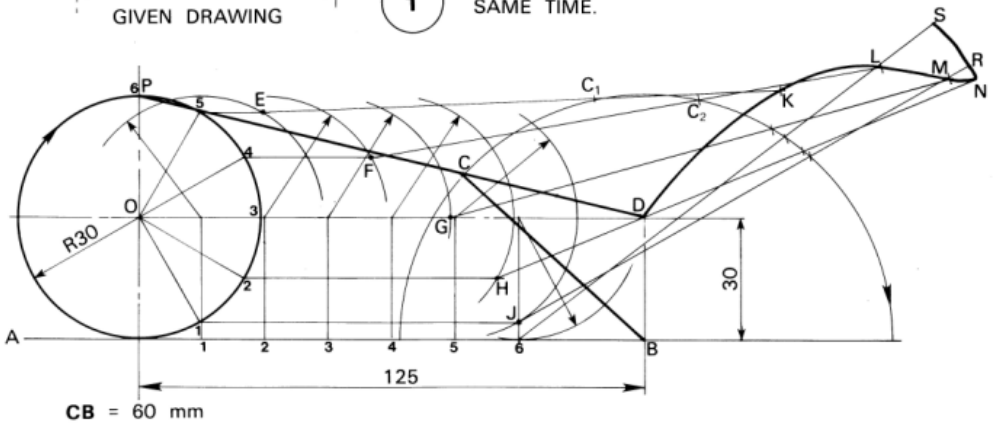
NOTE:
THE VARIOUS POINTS ON LOCUS ORIGINATE FROM CORRESPONDING POINTS ON THE CIRCLE AND ON **DC**.

A DISC ROLLS ALONG THE LINE **AB** UNTIL POINT **P** TOUCHES LINE **AB**. THE ROD **PCD** IS ATTACHED TO THE DISC AND IS PIVOTED AT **C** AND **P**. THE ROD **BC** ROTATES ABOUT POINT **B**. TO DRAW THE LOCUS OF POINT **D** DURING THE MOVEMENT OF THE DISC.



1

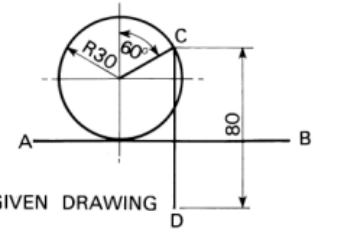
THE DISC ROLLS UNTIL POINT **P** REACHES POINT **6** ON LINE **AB**. ON ITS WAY POINT **P** PASSES THROUGH POINTS **E**, **F**, **G**, **H** AND **J**. THE CENTRE OF THE DISK MOVES HORIZONTALLY FROM **O** AT THE SAME TIME.

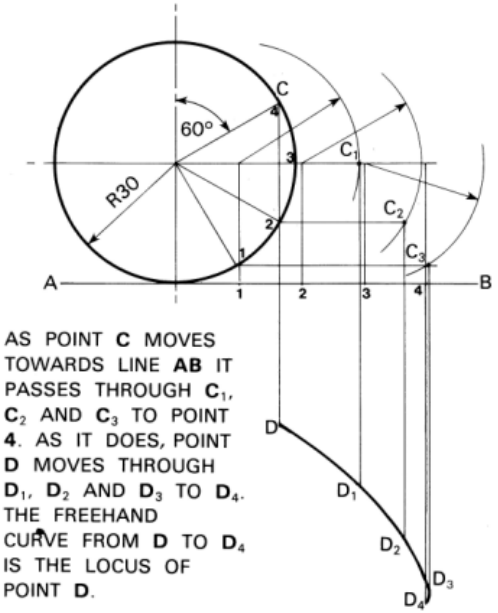


CB = 60 mm

AS POINT **P** MOVES ALONG, ROD **PD** MOVES TO POSITIONS **EK**, **FL**, **GM**, **HN**, **JR** AND **6S**. THESE POSITIONS ARE DETERMINED BY **C** AS IT MOVES ALONG THE ARC TO C_1, C_2 ETC. THEREFORE POSITIONS SUCH AS EC_1 AND FC_2 MUST FIRST BE DRAWN WITH LINES EC_1 PRODUCED TO **K** AND FC_2 PRODUCED TO **L**. THE LOCUS OF POINT **D** IS THAT FREEHAND CURVE WHICH GOES FROM **D** TO **S** THROUGH **D**, **K**, **L**, **M**, **N** AND **R**.

A METAL DISC ROLLS ALONG **AB**. ROD **CD** IS ATTACHED AT **C** AND REMAINS VERTICAL. TO DRAW THE LOCUS OF POINT **D** AS **C** ROLLS ON TO TOUCH **AB**.



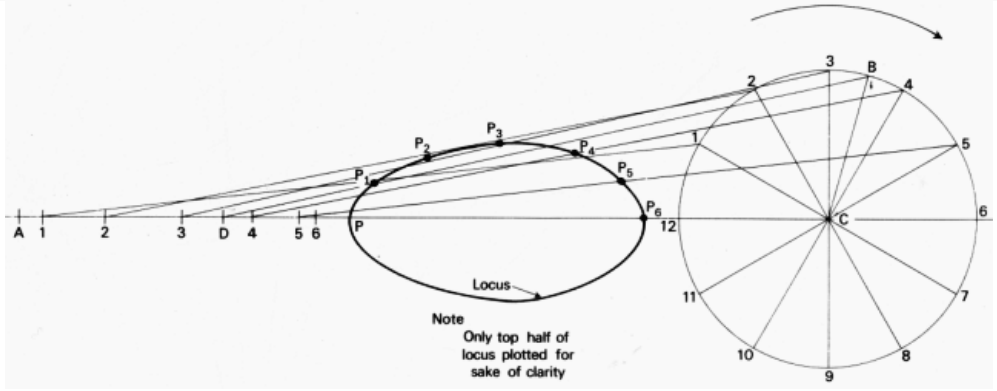


AS POINT **C** MOVES TOWARDS LINE **AB** IT PASSES THROUGH C_1, C_2 AND C_3 TO POINT **4**. AS IT DOES, POINT **D** MOVES THROUGH D_1, D_2 AND D_3 TO D_4. THE FREEHAND CURVE FROM **D** TO D_4 IS THE LOCUS OF POINT **D**.

One of the commonest locus questions deals with various types of slide crank mechanisms. Consider Fig. 8.4, which shows a crank moving in a circle; connected to the crank at B is a straight rod BD. If we are required to plot the mid point of the red BD, we proceed as follows.

1. With centre C and radius equal to the given crank radius, draw the crank circle.
2. Divide this circle into twelve equal parts and number as shown.
3. Through C, draw a horizontal line passing through points 6 and 12 and continue the line to the left of point 12.
4. With point 12 as centre and radius equal to the length of the straight rod BD, draw an arc to cut the horizontal line. Mark the intersection A as shown.
5. Bisect the length A–12 to fix one of the required points on the locus. Mark the point P.
6. Proceed in a similar manner for crank points 2 to 6 and so obtain points P_1 to P_6.
7. Join these points by a smooth curve.
8. Points 7 to 12 on the crank can now be used as in steps 4 and 5 to obtain points P_7 to P_{12}.

It can be seen that the locus of any point along the length of the connecting rod can be plotted by applying the same method.



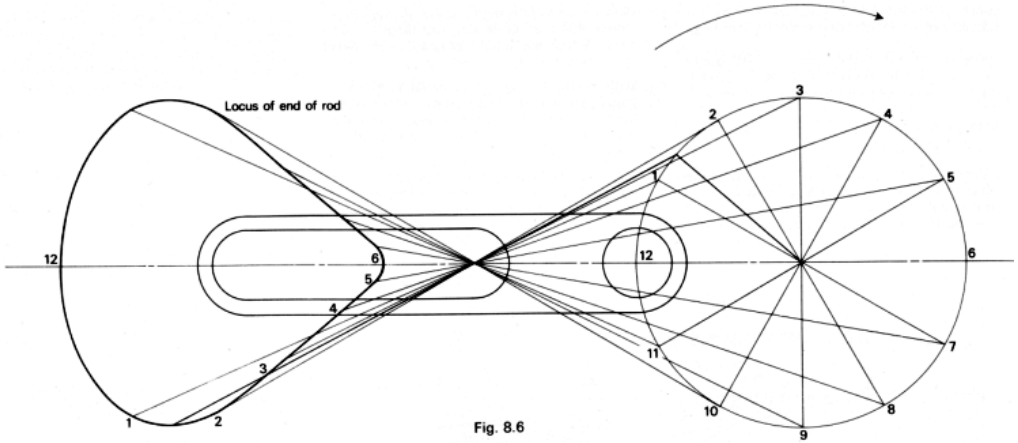


Fig. 8.6

The outlines of two gears are shown in fig. 8.22, where the pitch circle of the larger gear is twice the pitch circle of the smaller gear. As a result, the smaller gear rotates twice while the larger gear rotates once. The mechanism has been drawn in twelve positions to plot the path of the pivot point C, where links BC and CA are connected. A trammel method cannot be applied successfully in this type of problem.

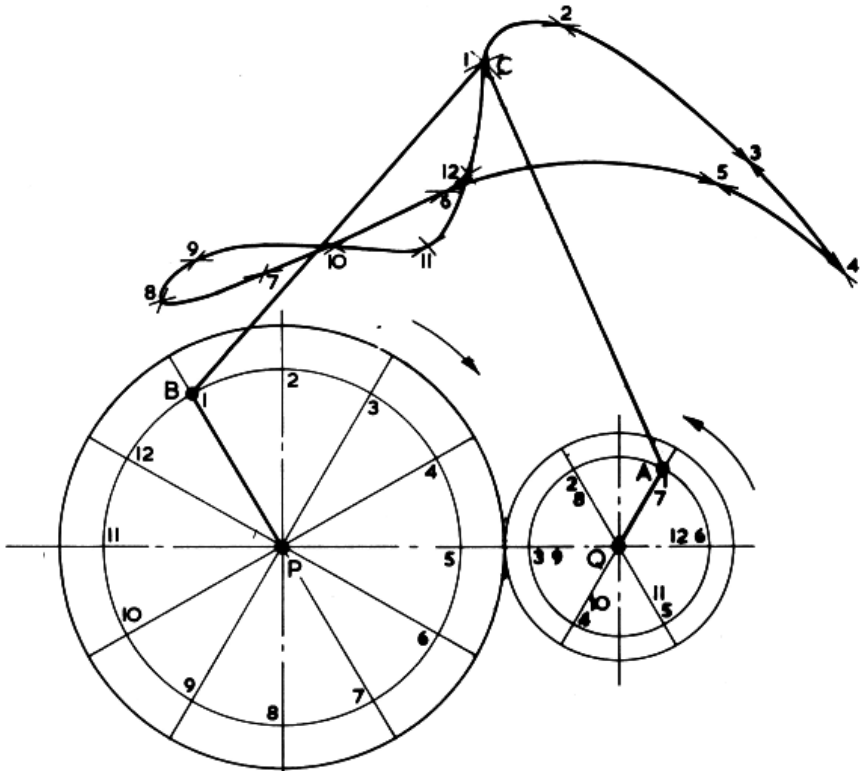
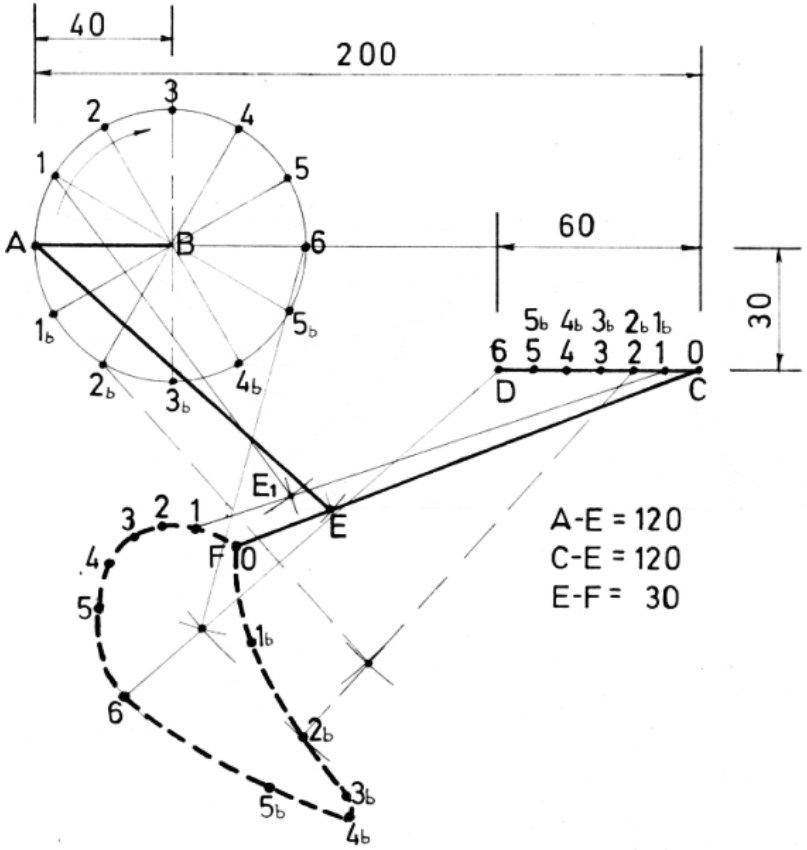


Fig. 299 Draw the given view as shown. During one revolution of rod *AB*, *FC* will slide to *D* and back. Therefore we may divide the revolution of *A* into 12 equal parts and divide *DC* into 6 equal parts. Taking the first movement of *A* to A_1, then *C* will move to *C*1 and *F* on the locus will move to *F*1 This is achieved by taking length *AE* and scribing an arc from *A*1. Next take length *CE* and scribe another arc with *C*1 as centre to intersect first arc from *A*1, this will give the new position of *E*, indicated as E_1. By extending line *C*1*E*1 the length *CF* is stepped off to give the new position of *F* (i.e.) *F*1. This process is repeated until *C* reaches *D*, as *C* moves back to its original position the same process is repeated which is indicated by points *F*5*b* to *F*1*b*.

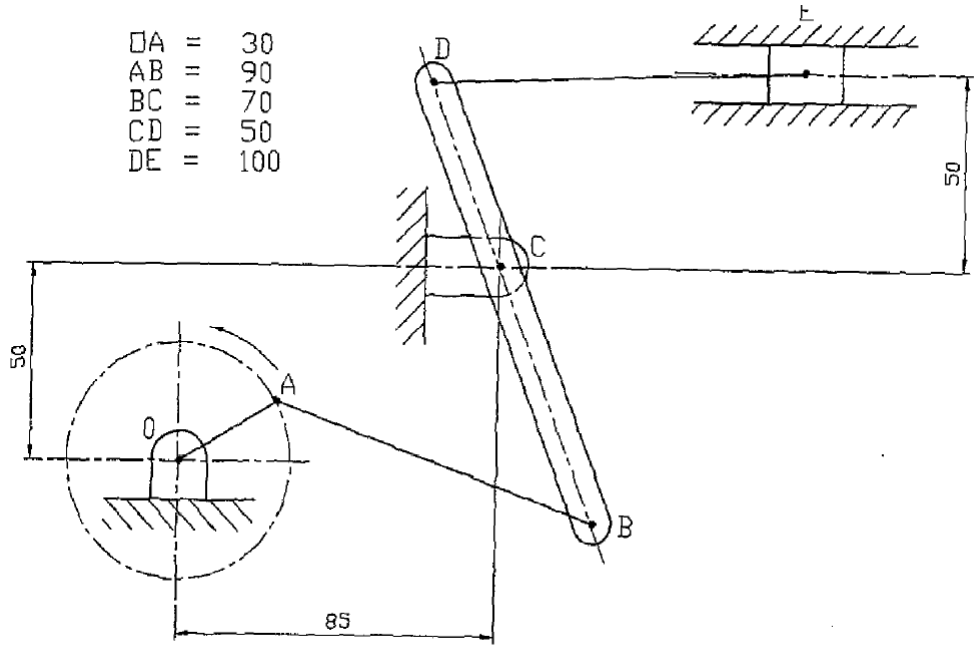


(b) In the mechanism shown in Fig. 3 the crank OA rotates at constant speed, in an anti-clockwise direction, about O. The arm BD oscillates about a fixed pivot C and is connected to the crank OA by the link AB. The connecting rod DE links the arm BD with the piston at E.

1998 HL

(i) Draw a displacement diagram and plot the displacement of E for one revolution of OA.

(ii) Measure and dimension on the drawing the length of stroke of the piston E.



(b) Fig. 3 shows a link mechanism. A and C are fixed points. Crank AB rotates in an anti-clockwise direction. Link BDEF is pin jointed at B and D. Link CD oscillates about point C.

2006 OL

(i) Using a line diagram to represent the mechanism, plot the locus of point F for one revolution of the crank AB.

(ii) Draw the profile of a simple machine guard about the mechanism with a minimum clearance of 15mm.

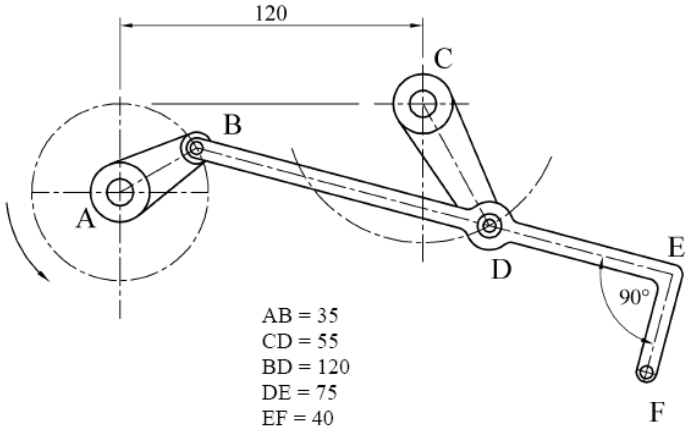
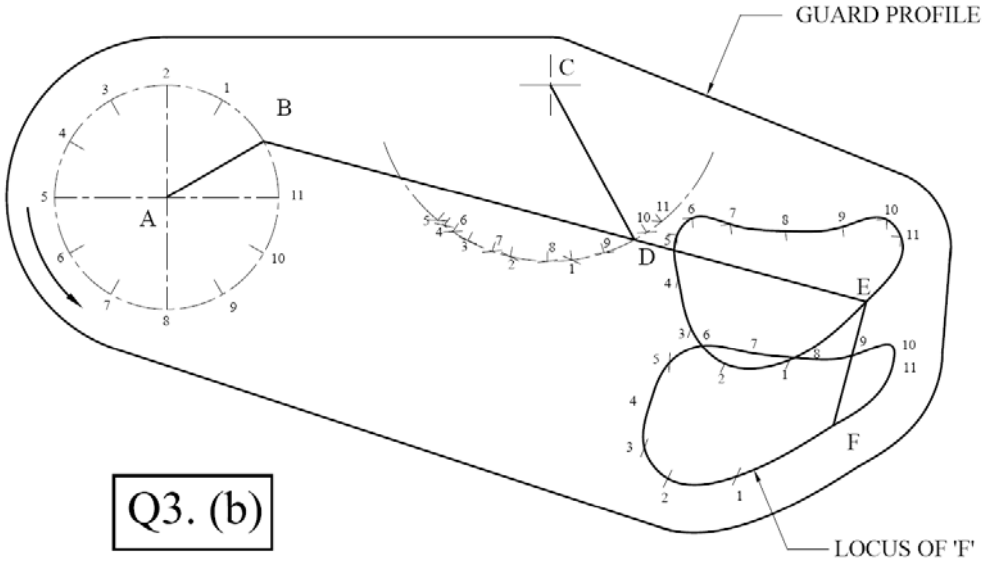


Fig. 3



Q3. (b)