Design of SHM Cam

Example 3: Design a shedding cam for plain weave using the following particulars.

Minimum distance between cam and follower centres (d) : 3 units
Lift (l): 6 units
Diameter of follower (f): 2 units
Dwell period: 1/3 of a pick
Movement pattern during rise and fall: Simple harmonic motion (SHM)

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Design of SHM Cam

The follower will rise (or fall) following simple harmonic motion which implies that the movement of the follower per unit time (per degree of cam rotation) will not be constant as it happens in case of linear movement pattern.

As it is plain weave, the 360° rotation of the bottom shaft or shedding cam will correspond to two picks. Therefore, one pick is equivalent to 180° rotation of the cam. Each of the two dwells will be spanning over 1/3 ×180° = 60°.

Therefore, the span for rise (and fall) will be 120° each.

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Design of SHM Cam

The rise and fall of the follower in SHM has been shown with bold line.

The broken line represents the linear movement pattern

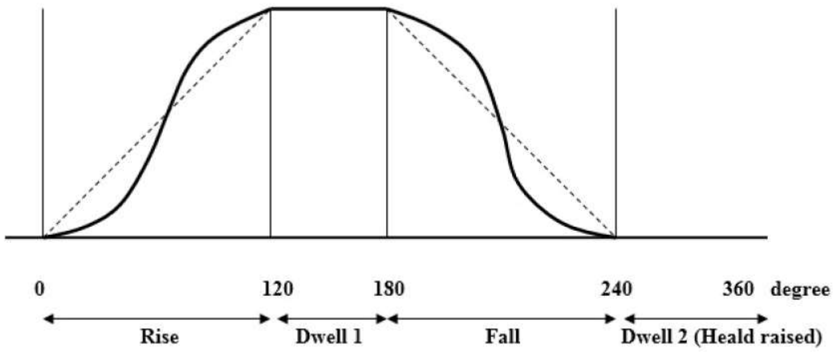

Figure 6.29: SHM movement pattern for plain weave

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Steps for Drawing SHM Cam Profile

Step 1

Draw a circle having its centre at O and radius (OA) of 3 units (cm or inch)

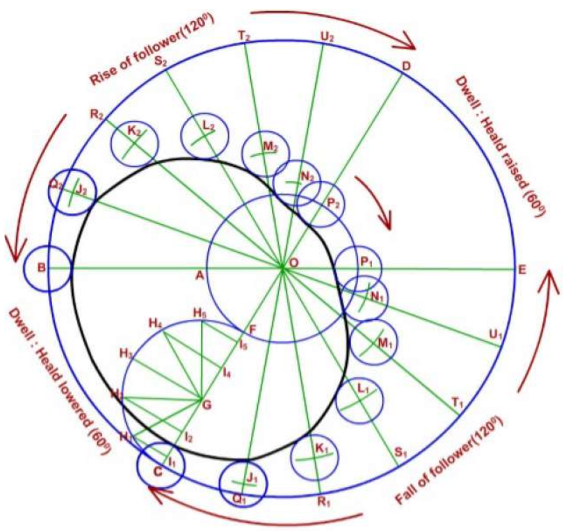

Figure 6.30: SHM cam for plain weave

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Steps for Drawing SHM Cam Profile

Step 2

Add d and l (3 + 6 = 9). Then draw another concentric circle having radius (OB) of 9 units.

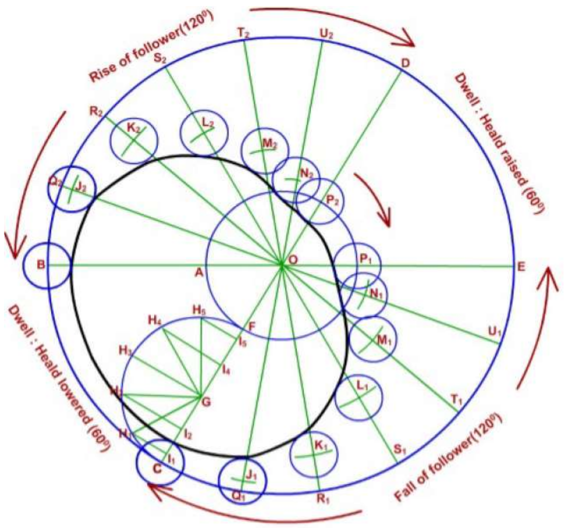

Figure 6.30: SHM cam for plain weave

Steps for Drawing SHM Cam Profile

Step 3

Divide the circle in four segments of 120°, 60°, 120° and 60° for rise, dwell 1, fall and dwell 2 respectively.

Here ∠COE = ∠BOD = 120° (for the rise and fall of follower).

Segments BOC and DOE correspond to the dwells at lowered and raised position of heald

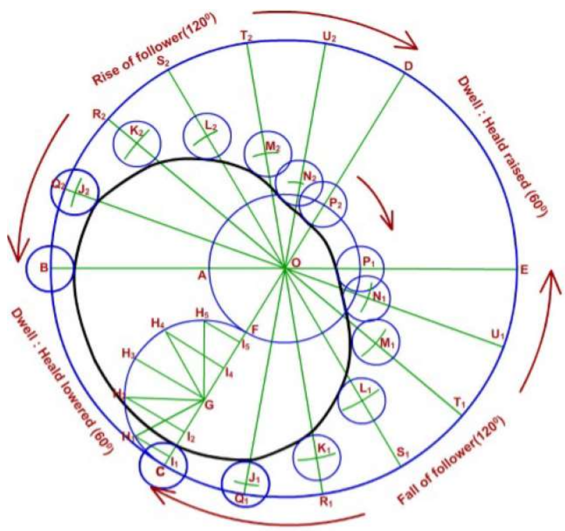

Figure 6.30: SHM cam for plain weave

Steps for Drawing SHM Cam Profile

Step 4

Divide ∠COE into six equal parts by the radii OQ1, OR1, OS1, OT1 and OU1.

Similarly, divide ∠BOD is divided into six equal parts by radii OQ2, OR2, OS2, OT2 and OU2.

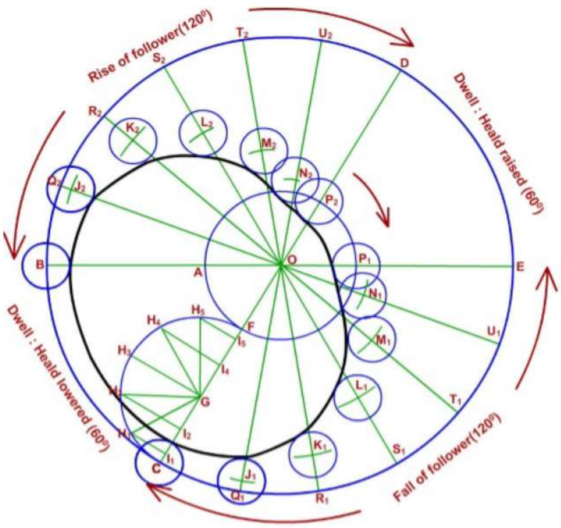

Figure 6.30: SHM cam for plain weave

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Steps for Drawing SHM Cam Profile

Total lift of the follower is 6 units. This is indicated by the distance FC.

This implies that when the cam rotates by 120°, the follower will descend (or rise) by 6 unit following SHM.

In case of SHM, a generating point is having a circular motion with constant angular velocity on the circle of reference.

If perpendicular lines are drawn from the generating point on the diameter of the circle of reference, then the locus of that point follows SHM.

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Steps for Drawing SHM Cam Profile

Step 5

Hence, draw one semicircle considering CF as the diameter.

Divide this semicircle in six equal segments. Therefore, angles CGH1, H1GH2, H2GH3, H3GH4, H4GH5 and H5GF are all equal to 30° each.

Draw perpendicular on diameter CF from points H1, H2, H3, H4 and H5.

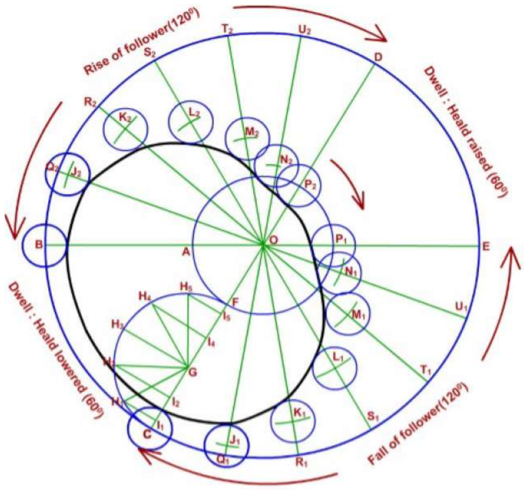

Figure 6.30: SHM cam for plain weave

Steps for Drawing SHM Cam Profile

Step 6

Take OI1 as radius and draw arcs which cut the radii OQ1 and OQ2 at J1 and J2 respectively.

Then take OI2 as radius and draw arcs which cut the radii OR1 and OR2 at K1 and K2 respectively.

Repeat this step till OI5 as the radius and draw arcs which cut the radii OU1 and OU2 at N1 and N2 respectively.

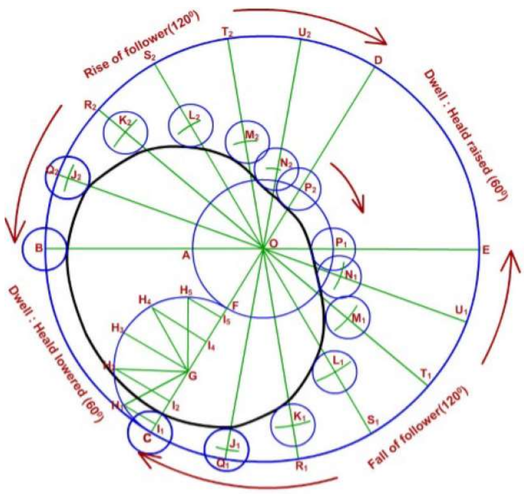

Figure 6.30: SHM cam for plain weave

Steps for Drawing SHM Cam Profile

Step 7

Draw small circles having diameter of 2 units of the follower, considering 14 centres C, J1, K1, L1, M1, N1 and P1 while the follower is having a fall and B, J2, K2, L2, M2, N2, and P2 while the follower is rising.

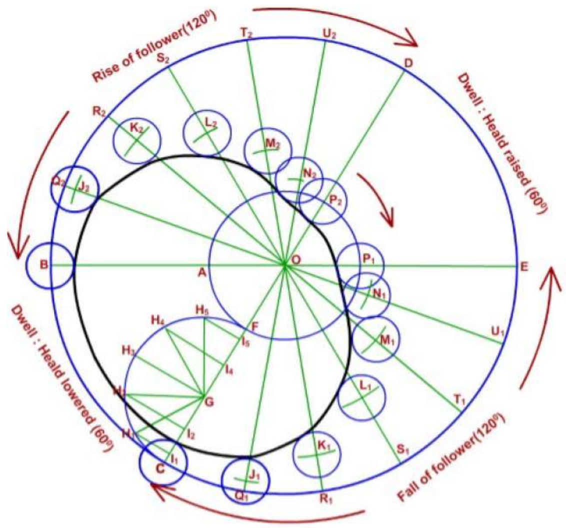

Figure 6.30: SHM cam for plain weave

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Steps for Drawing SHM Cam Profile

Step 8

Join the inner surfaces of these 14 circles with smooth curved line to get the profile of the cam.

Segment BOD is giving rise to the follower (heald is lowering)

Segment BOC (60°) causes dwell 1 of the heald at lower position.

Segment COE (120°) is causing fall of the follower (heald is raised)

Segment DOE (60°) causes the dwell 2 of the heald at the raised position.

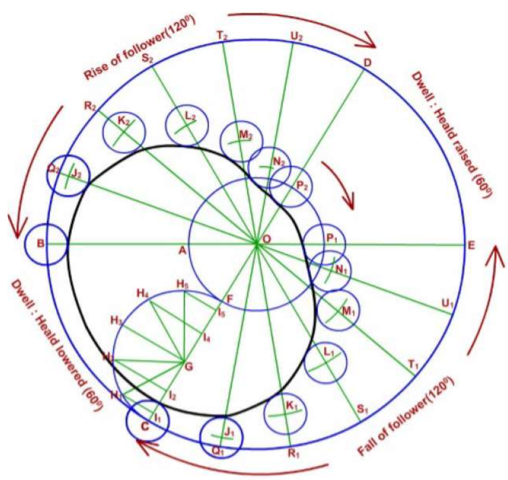

Figure 6.30: SHM cam for plain weave

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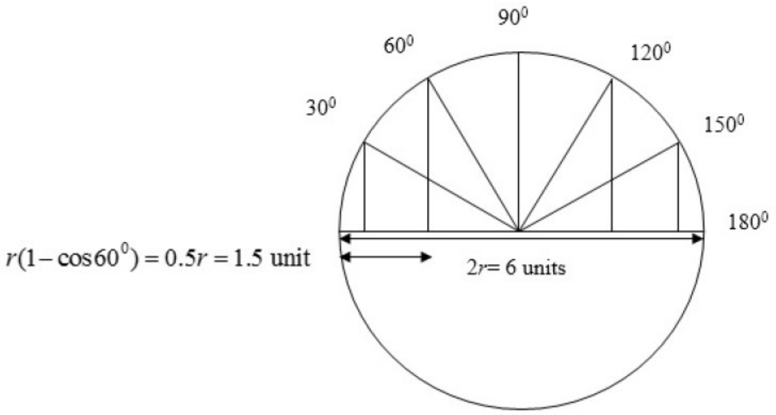
Displacement of follower in SHM

As the diameter of the semicircle having centre at G is 6 units

From Figure, If *r is the* radius of the semicircle, then 2*r* = *6 or r = 3 unit.*



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Displacement of follower in SHM

Starting at point C where one of the dwells is finishing, after 20° rotation of the cam (or 30° in semicircle), the displacement of the follower will be equal to the distance of CI1.

Similarly, the total displacement of the follower after 40, 60, 80, 100 and 120° rotation of the cam will be given by the distances CI2, CG, CI4, CI5 and CF respectively.

$$CI_1 = r(1-\cos 30^0) = 0.134r = 0.4 \text{ unit}$$
$$CI_2 = r(1-\cos 60^0) = 0.5r = 1.5 \text{ unit}$$
$$CG = r(1-\cos 90^0) = r = 3 \text{ unit}$$
$$CI_4 = r(1-\cos 120^0) = 1.5r = 4.5 \text{ unit}$$
$$CI_5 = r(1-\cos 150^0) = 1.866r = 5.6 \text{ unit}$$
$$CF = r(1-\cos 180^0) = 2r = 6 \text{ unit}$$

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Displacement of follower in SHM

Therefore, the displacement of the follower between 30° and 60° (with respect to semicircle) is = CI2-CI1= 1.5-0.4= 1.1 units.

Table summarizes the displacements according to linear and SHM movement pattern.

Span of cam movement (Total span of rise or fall is equal to 180° of segment semicircle)	**Displacement according to linear profile** (unit)	**Displacement according to SHM profile** (unit)
0-30°	1	0.4
30-60°	1	1.1
60-90°	1	1.5
90-120°	1	1.5
120-150°	1	1.1
150-180°	1	0.4
Total	6	6

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Displacement of follower in SHM

From Table, it is observed that the displacement made after each 30° is equal (1 unit) in case of linear profile.

In contrast, for SHM, the displacement is very small (0.4 units) near the start and end of the motion.

However, the displacement made in each 30° duration increases gradually from the starting point and reaches maximum (1.5 unit) between 60-90°.

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Advantages of SHM Cam over Linear Cam

For linear cam, the displacement, velocity and acceleration profile of the follower are shown in Figure.

Between 0° and 60° and between 180° and 240°, the velocity of the follower is constant.

The constant velocity arises as the slope of the displacement profile is constant (linear line) in these two zones.

The follower will experience very high acceleration at 0° and 240° and very high deceleration at 60° and 180°.

This can create jerky movement as well as wear and tear of the machine components.

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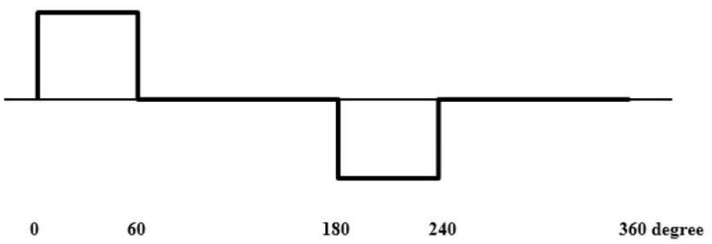

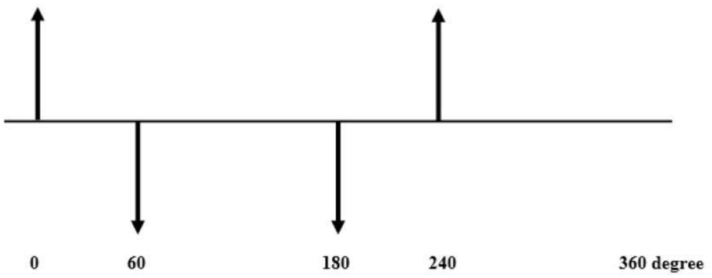

Figure 6.32: Velocity and acceleration profile in linear movement pattern of follower

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Advantages of SHM Cam over Linear Cam

Figure depicts the velocity and acceleration profile of the follower in case of SHM.

Change is velocity after the dwell is not sudden but smooth (as the displacement pattern is following SHM).

Thus the acceleration and deceleration of the follower is much lower as compared to that of linear movement pattern.

Thus the motion of the follower is smoother and wear and tear of the machine components is lower.

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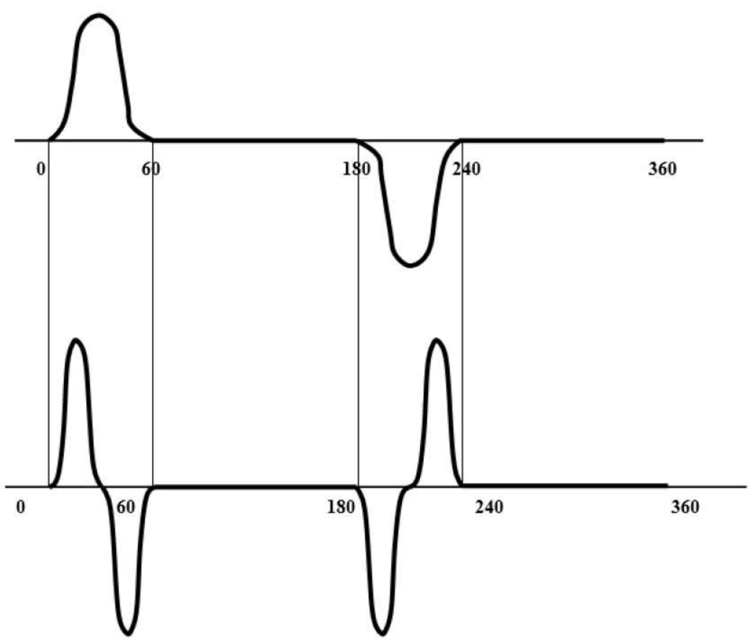

Figure 6.33: Velocity and acceleration profile in SHM movement pattern of follower

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Dobby Shedding Systems

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Limitation of Cam Shedding

The cam shedding system has limitation in terms of number of healds that can be effectively controlled during shedding

The problem arises when the number of picks in the repeat of the design is very high.

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Keighley Dobby

Keighley dobby is known to be a double acting dobby as most of the operations is done at half speed as compared to the loom speed (picks per minute).

The basic components of Keighley dobby are as follows:

- ✓Stop bars
- ✓Baulk
- ✓Hooks (two per heald)
- ✓Knives (two for the entire dobby)
- ✓Pegs on pattern chain

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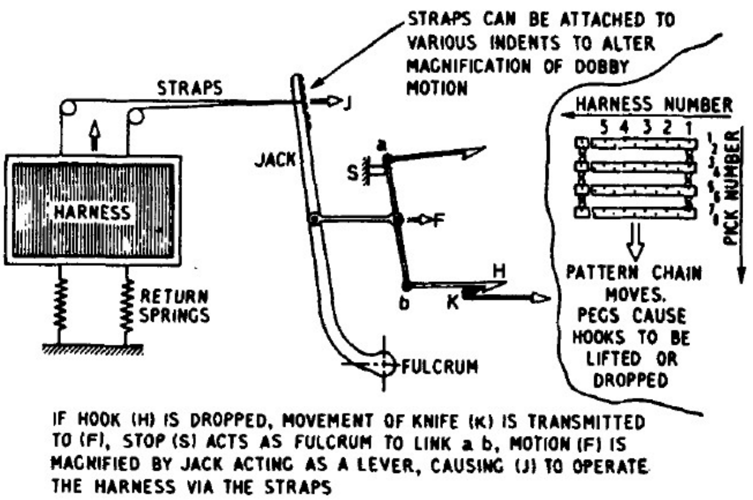

Fig. 11.8. Basic dobby motion. Not to scale. Certain parts omitted for clarity

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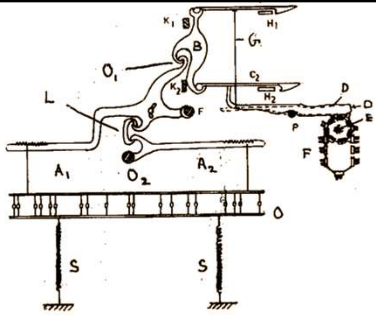
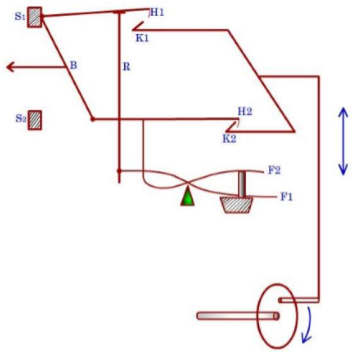
Keighley Dobby



The motion to reciprocating knives (K1 and K2) originates from bottom shaft of loom.

As one revolution of bottom shaft ensures two picks, each of two knives completes cycle of inward (towards the left) and outward (towards the right) movements

The two reciprocating knives are in complete phase difference.



Keighley Dobby

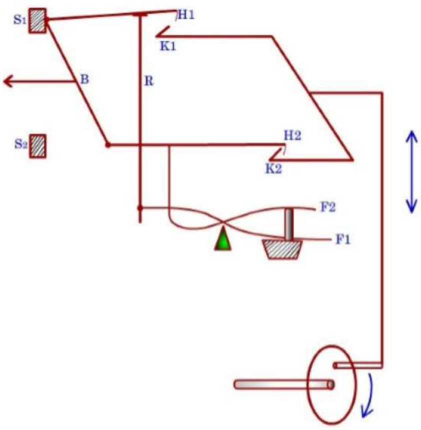
The peg pushed right end of feeler 2 in upward direction.

Thus left end of feeler 2 lowered.

So, hook 2 was also lowered on knife 2 when latter moved inward.

So, lower end of baulk (B) moves away from stop bar 2 (S2).

Thus heald shaft is raised due to connection at midpoint of baulk.



Keighley Dobby

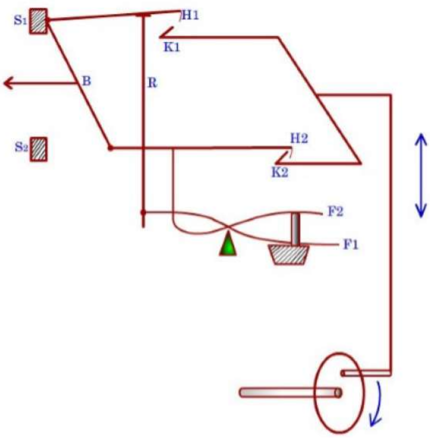
In next cycle, knife 2 will move inward and knife 1 will move outward.

Now, there is no peg corresponding to the position of feeler 1. So, right end of feeler 1 is lowered and left end of it is raised.

Connecting rod has pushed the hook 1 in the upward direction.

So, when the knife 1 will perform its outward movement, it will not be able to catch the hook 1.

The top part of baulk will be resting on stop bar 1 and thus the heald will not be lifted for the next pick.

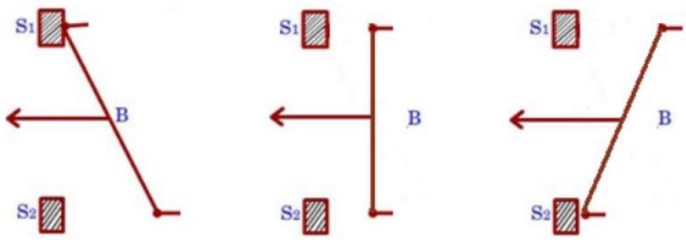


When the heald is in lower position for two consecutive picks, the top as well as the bottom end of the baulk will be resting on the respective stop bars. So, the midpoint of the baulk will not have any significant movement.

If the heald is in raised position for two consecutive picks, then one end of the baulk will move away from the stop bar and another end of the baulk will move towards the stop bar.

Thus the middle point of the baulk will not experience any significant movement.

Thus the amount of wasted movement is very nominal. Therefore, the system will produce open shed.



System of Pegging

Twill weave (3/3/1/1) which repeats on eight ends and eight picks considered for demonstrating pegging plan.

This design can be produced by using eight healds and straight draft.

Picks								
8		x				x	x	x
7	x				x	x	x	
6				x	x	x		x
5			x	x	x		x	
4		x	x	x		x		
3	x	x	x		x			
2	x	x		x				x
1	x		x				x	x
Ends	1	2	3	4	5	6	7	8

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System of Pegging

The selection for heald movement is controlled by wooden pegs which are inserted within the circular holes made on the wooden lags.

The wooden lags linked together into a lattice which is mounted on the pattern wheel (or barrel).

The pattern barrel is rotated by a certain degree once in two peaks.

For example, if the barrel is hexagonal then it must rotate by 60° after every two picks.

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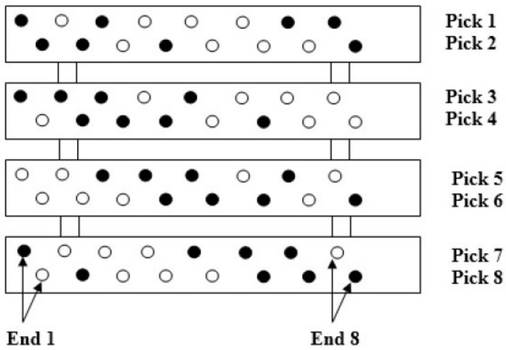
System of Pegging

The presence of a peg within the hole results raised position of the heald and vice versa.

The lateral shifting of holes is done so that two adjacent feelers can be accommodated.

Picks	1	2	3	4	5	6	7	8
8		x				x	x	x
7	x				x	x	x	
6				x	x	x		x
5			x	x	x		x	
4		x	x	x		x		
3	x	x	x		x			
2	x	x		x				x
1	x		x				x	x
Ends	1	2	3	4	5	6	7	8



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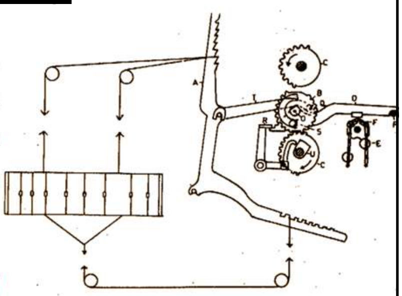
Positive Dobby

In Keighley dobby, knives and hooks cause movement in the baulk and as a result, the heald is raised. The lowering of heald is done by the reversing motion.

However, the upward and downward movements of the healds are completely controlled by the positive dobby (rotary dobby)

The systems utilises specially designed toothed gears for causing engagement or disengagement of gears and transmission of motions.



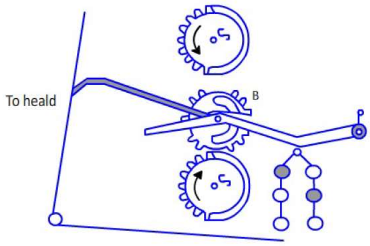


Figure 6.39: Positive dobby

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Positive Dobby

This gear can be rotated either by the top or by the bottom gear which are having teeth only over the half of their periphery.

The top and bottom gears complete one revolution in every pick.

As they rotate in different directions, they can rotate the central gear in clockwise or in anti-clockwise direction which is required to raise or lower the heald shaft through the links.

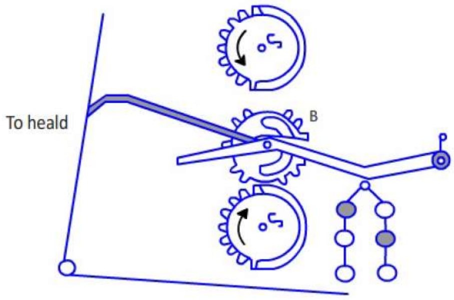

Figure 6.39: Positive dobby

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Positive Dobby

The selection mechanism presents cylinders of different diameters for different pick.

If the diameter of the cylinder is low, then the lever carrying the central gear is lowered on the bottom gear

A missing tooth on the central gear facilitates the meshing between the two gears.

The bottom gear now rotates the central gear in anti-clockwise direction by half revolution causing the heald to be lowered through links.

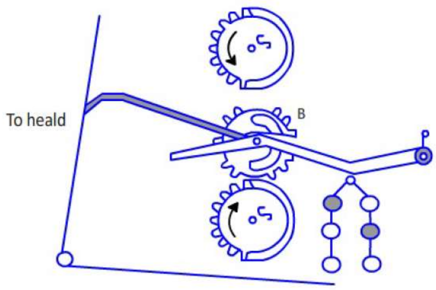

Figure 6.39: Positive dobby

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Positive Dobby

The heald will retain its lowered position as long as cylinders with lower diameter will be presented by the selection mechanism to the lever.

If a cylinder with higher diameter is fed by the selection mechanism, then the lever will be raised and thus the central gear will move in the upward direction to mesh with top gear.

The central gear will now rotate in clockwise direction causing the heald to be raised.

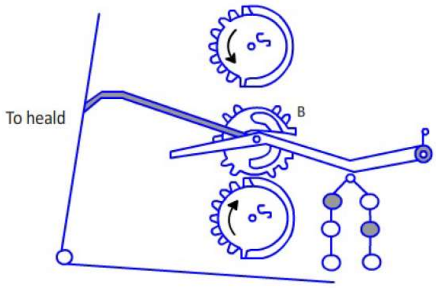

Figure 6.39: Positive dobby

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