LOOM ATTACHMENTS

UNDERCAMS FOR OTHER THAN TWO-HARNESS WORK

INTRODUCTION

1. Cams in General.—As shedding by cams is the most perfect form of shedding ever devised, it will be found that cams are employed in every case where the expense attached to them does not prohibit their use, or where their number does not render them impracticable on account of the great amount of space occupied. In the United States, cams are generally employed on three-, four-, five-, or six-harness work; in England, even a larger number of harnesses are frequently operated in this manner. The classes of fabrics principally woven in cam-looms are *plains*, *twills*, and *sateens*.

2. In considering the possibilities of cams, there are always certain limitations to be dealt with. If a cam is constructed for two-harness work, it is impossible to use it in weaving any cloth that requires a larger number of harnesses; consequently, when a cam-loom is changed from one kind of weave to another, it is always necessary to change the cams to suit the requirements. This necessitates the loss of time, especially in a mill that is constantly changing from one class of work to another. In many cases special cams must be constructed for special work, thus adding greatly to the expense of operation. Moreover, as undercams act directly on the treadles only, when depressing the harnesses, some arrangement must be adopted by means of which they

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may indirectly raise the harnesses. This is accomplished by the use of a strap-and-roller connection placed at the top of the loom. This arrangement, however, places certain limitations on the movement of the harnesses. It will be remembered that the action of the cam in pressing down one harness serves to raise another harness by means of the straps and rollers just referred to. Consequently, one harness cannot be raised unless another is lowered; the opposite is equally true—that is, it is impossible to lower a harness without raising another one. This will be found to be true in every case where cams are used in combination with strap-and-roller connections, the number of cams employed not changing the conditions.

3. Suppose, for example, that a cam-loom is on three-harness work, two harnesses being up on each pick and one down, producing what is known as a $\frac{2}{1}$ weave (read two up, one down); then the ratio of harnesses raised to those lowered must always be the same, that is, on every pick that is placed in the cloth there must be two harnesses up and one down. The same would be true if more harnesses were used. Take for example a cam-loom operating four harnesses, the cams being so constructed that two harnesses will be up and two down, producing a $\frac{2}{2}$ weave; then on every pick of the weave there must be the same ratio of harnesses raised to those lowered.

The order in which the cams change the harnesses, however, may be altered. Suppose that a cam-loom is running on four-harness work, the cams being so constructed that three harnesses will be up on each pick and one down. These cams may be placed on the shaft of the loom in such a manner that the first harness will be lowered on the first pick, the second harness on the second pick, the third harness on the third pick, and the fourth harness on the fourth pick. This produces a regular *four-harness twill*. Again, the cams may be so placed on the shaft that the first harness will be lowered on the first pick, the second harness on the second pick, the fourth harness on the third pick, and the

third harness on the fourth pick; this will produce what is termed a *broken crow weave*. Cams for more than three harnesses are usually made separate in order that they may permit this interchanging of their order of operation.

After one harness has been lowered or raised, it cannot again be lowered or raised until all the other harnesses employed in the weave have been moved in the same manner. Thus, in the case of the weave just referred to, where one harness is down and three up, if the first harness is lowered on the first pick, all the other harnesses must be lowered before that harness can again be dropped.

4. The order in which the harnesses are changed, where only one harness is raised or lowered on each pick, is generally shown by means of numbers, which designate the number of the harness and also on which pick each harness is to be moved. Thus, in the case of the four-harness twill just referred to, where one harness is down and three up on each pick, the harnesses could be said to be lowered in 1–2–3–4 order; that is, the first harness is lowered on the first pick, the second harness on the second pick, the third harness on the third pick, and the fourth harness on the fourth pick, the figures representing which harness is moved, while the order in which the figures stand show on which pick each harness is moved.

The different orders of moving four harnesses when operated by cams constructed so as to give one harness down and three up on each pick are as follows:

1. 1–2–3–4
2. 1–2–4–3
3. 1–3–2–4
4. 1–3–4–2
5. 1–4–2–3
6. 1–4–3–2

CONSTRUCTION OF DIFFERENT CAMS

5. In constructing cams for different kinds of work there are certain points that should always be borne in mind in order to fully comprehend the different steps necessary. The outer circle of construction, *h d*, Fig. 1, should first be divided into a certain number of equal parts that will be the

same as the number of picks to the round; that is, the number of picks that are inserted in the cloth while the cam is making one complete revolution. The term number of picks to the round also generally indicates the number of harnesses that are employed in the weave. Thus, in speaking of a three-harness twill, a twill would be understood that would be woven on three harnesses employing three cams and, consequently, three picks would be inserted while one cam was making a complete revolution. It is not necessary, however, that the number of picks to the round should limit the number of harnesses on which the weave could be woven. However, it will generally be found to be the case on cam-looms that the number of harnesses employed in the weave will indicate the number of picks to the round, and vice versa.

Each one of these equal parts into which the cam is divided will represent one pick of the weave, but since one harness is being lowered while another is being raised, *one-half the change part of one cam will always overlap one-half of the change part of another cam.* The length of dwell of the cam should always be decided on first and marked off on the outer circumference of construction. A dwell equal to the time that it takes the loom to make one-half a pick, or, as it is known, one-half a pick dwell, will be allowed in all cams illustrated here.

FOUR-HARNESS CAMS

6. Cams for $\frac{3}{1}$ Twill.—Fig. 1 shows the construction of a cam that would be suitable for a four-harness twill weave, three harnesses being up and one down on each pick. Two repeats of the weave, in both ends and picks, produced by cams of this construction are also shown in this illustration. In the complete set of cams for this weave, there would be four cams similar to the one shown in Fig. 1. Each cam, however, is constructed in exactly the same manner, with the exception of a slightly greater throw being given to each succeeding cam moving toward the back of the loom, the object of this being to produce an even shed in front of the reed.

In constructing cams for any class of weaves, there are certain instructions that will be found common to all. The inner circle representing the cam-shaft should always be drawn first. This circle is shown at *b*, Fig. 1. To the radius used in drawing the circle of the cam-shaft, add the thickness of the hub of the cam; and with this new radius

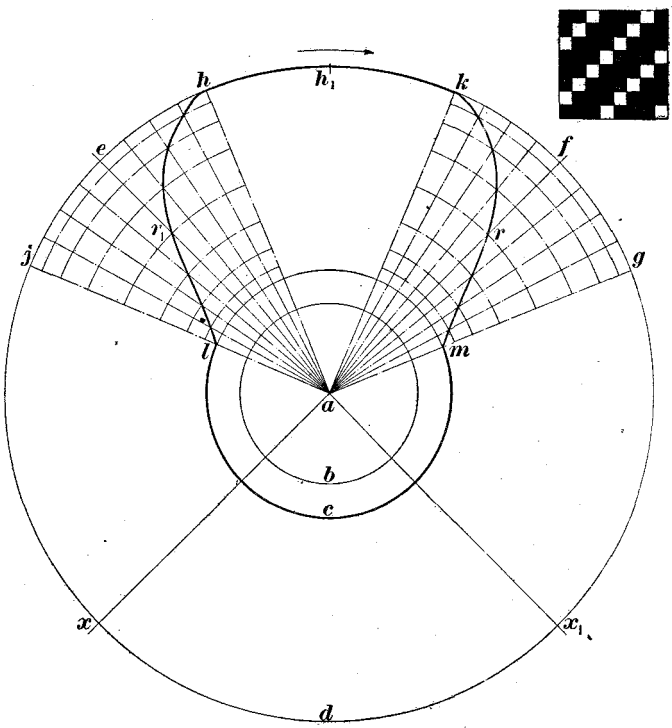

FIG. 1

describe another circle having the same center as the circle previously drawn. This second circle represents the inner throw of the cam and is shown at *c*, Fig. 1. To the radius last used, add the entire throw of the cam; and with the same center describe a third circle, which will represent the outer throw of the cam. This circle is shown at *d*, Fig. 1. After describing these different circles, divide the outer

circle into the same number of equal parts as there are picks to the round.

As previously stated, these instructions apply to the construction of any cam. The number of cams employed, the time the harnesses are to remain up or down, or, in short, any circumstances whatever do not interfere in the slightest with this method of construction.

7. As the cam shown in Fig. 1 is for four-harness work, the circle d must be divided into four equal parts, as shown by the arcs fe, ex, xx_1, and x_1f. The cam will move the distance of one arc during one pick and will therefore make one complete revolution in the time that it takes to place four picks in the cloth. The time occupied by the dwell of the cam is to be equal to one-half of the time occupied by one pick, and since the cam moves through one of the four equal arcs during one pick, half of the space occupied by any one of these arcs may be taken to represent that part of the cam during which the harness is stationary. Therefore, divide the arc ef into four equal parts eh, hh_1, h_1k, and kf, and select the two central ones hh_1 and h_1k as the dwell, equal to one-half of ef.

Since the dwell of the cam is to occupy one-half of a pick, one-half the pick, $eh + kf$, will remain in which to construct change parts of the cam. Further, since one-half of each period of change is to be taken from each of the adjoining picks, lay off arcs fg and ej on arcs fx_1 and ex, respectively, each of the former arcs being equal to kf or eh. The first change will now take place during the arc gk, the dwell during the arc hk, while the arc hj marks the change during which the harness will return to its initial position.

8. It should be noted that the arc fg occupies one-quarter of the arc x_1f, which represents the distance through which the cam moves during one pick. The same is equally true of the arc ej with reference to the arc ex. This is in accordance with what has previously been stated in regard to one-half of the change part of one cam overlapping one-half of the change part of another cam. This may be more readily

understood if it is remembered that as one harness is being depressed by one cam another harness is being raised, the two harnesses becoming level at a point that marks half the distance of their rise and fall.

It may further be stated that if the time occupied in changing is one-half of a pick, as in Fig. 1, then the harnesses pass at a point reached after the loom has moved one-quarter of a pick; but if the time occupied in changing is one-third of a pick, the harnesses will pass each other at a point reached after the loom has moved one-sixth of a pick. Therefore, a cam constructed after the manner of the one shown in Fig. 1 must move through the distance represented on the outer circle by the arc hj when allowing the harness to rise, while in depressing the harness it must move through the distance represented on the outer circle by the arc kg. Therefore, the arc hk, which represents half a pick, is taken for the dwell of the cam, while the arcs hj, kg, each of which represents half a pick, are utilized for the construction of the change parts of the cam.

9. Next divide the arcs jh, kg into any number of equal parts; eight are used here, but it will readily be seen that the more parts into which these spaces are divided, the more accurately will the lines of the cam be derived from them. Draw lines from these points of division to the center of the circle. Proceed in the same manner as was adopted in laying out the lines of the cam for two-harness work; that is, divide the lines jl and mg into the same number of unequal parts, commencing at the circle c with a small space and gradually increasing this until the center of the line is reached, when it is reduced again proportionately. With the center a and radii equal to the distances from the center to the points of division, draw arcs cutting the lines previously drawn. The points formed by the intersection of these arcs and radial lines are then connected by the symmetrical curves hl and km. This will give the necessary lines, and as a result the cam $hlcmk$ will be obtained.

It will be noticed that at the points r and r_1, which mark half

the drop and lift of the cam, the harness operated by this cam will be level with the harness that is passing it; consequently, the central part of the lift of one cam is passing the central part of the drop of another cam.

10. Cams for $\frac{2}{2}$ Twill.—In the case of the cam previously illustrated, each harness must be held down during the time that it takes the loom to make but a single pick. In a large number of weaves, however, the harnesses must be kept down for a longer time than this. An illustration of a cam of this type is found in one constructed for a four-harness twill having two harnesses up and two down on each pick. A cam suitable for this weave will cause the harness that it operates to be depressed during two picks of the loom and will also allow the harness to be raised during two picks. However, in a weave of this character there will be two harnesses changing on each pick, one being lowered and another raised.

Fig. 2 represents the construction of a cam suitable for such a weave. The circles b, c, and d are drawn in a manner similar to the construction of all cams. The outer circle is then divided into four equal parts, since there must be four cams to operate the harnesses for this weave. These parts are represented by the arcs $x\,x_1$, $x_1\,x_2$, $x_2\,x_3$, and $x_3\,x$.

As previously stated, this cam holds the harness down while two picks are being made by the loom, but it should be noted that during half a pick the cam must be changing the harness; therefore, that part of the outer circle d that is to form the line of the cam must represent one and one-half picks. Any part of the circle d that represents one and one-half picks may be taken as this part of the cam. In Fig. 2, it is represented by the arc $h\,d\,k$. This arc is obtained by adding to each side of the arc $x\,d\,x_3$ a space equal to one-quarter of a pick. Since the arc $x\,d\,x_3$ is equal to one pick, and the arcs $x\,k$ and $x_3\,h$ are each equal to one-quarter of a pick, the arc $h\,d\,k$ must be equal to one and one-half picks.

From the points k and h, measure off on the outer circumference arcs that will represent the space moved through by