A block can be made less obvious if it shares a colour with the adjacent blocks. For instance, one shuttle could carry two red and one black yarns and the other shuttle carry three blacks.

2. A similar effect is obtained if one shuttle carries a tie-dyed weft. If it is space-dyed red and black and the other shuttle is all black, then the block will appear or disappear depending on whether or not the red part of the weft happens to coincide with the position of a block.

3. Two wefts of quite different texture but the same colour, e.g. white brushed mohair and white carpet wool, will give blocks differing only in their surface texture; see Plate 41 (p. 83). The more similar the two textures, the larger the blocks must be in order to register visually.

4. Very subtle blocks can be obtained by using two wefts of the same colour, but one in an S-plied the other in a Z-plied form.

Clasped Wefts

The methods described so far introduce variety into the blocks, but all the blocks across the rug which are threaded similarly of necessity look the same. This sameness can be overcome by introducing the Clasped Weft principle.

Fig. 60 shows the set-up at its simplest with a warp threaded for five blocks. At the right selvage is a shuttle carrying weft C of normal thickness; this will form the background blocks, threaded on (2,3,1). Also at the right selvage there is another shuttle with weft A which is wound on at half the normal thickness. At the left selvage is a ball (or cone or spool) of weft B, also of half normal thickness. The work proceeds as follows:

Lift 13, throw shuttle with weft A to the left selvage, catch it round weft B and throw it back to the right, pulling a loop of B into the shed. Adjust the clasping point so it lies behind a raised warp end, as shown in the detailed *Fig. 61*.

Lift 14, throw weft C to the left.

Lift 23, throw A as before picking up a loop of B. Again locate the clasping point behind a raised end.

Lift 24, throw C back to the right.

Repeating these four picks, shown in *Fig. 61*, will make the right-hand block threaded (2,4,1) colour A, and the left-hand one colour B. This effect will be obtained as long as the clasping points are *somewhere* in the central block; their exact position being immaterial as wefts A and B are here hidden by weft C. In *Fig. 60* and subsequently, the clasping points are marked by circles, sometimes numbered to clarify their sequence. Naturally the clasping points will be visible on the back of the rug, so this is really a one-sided technique.

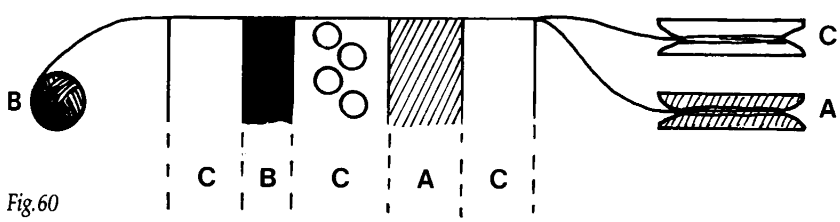


Fig.60

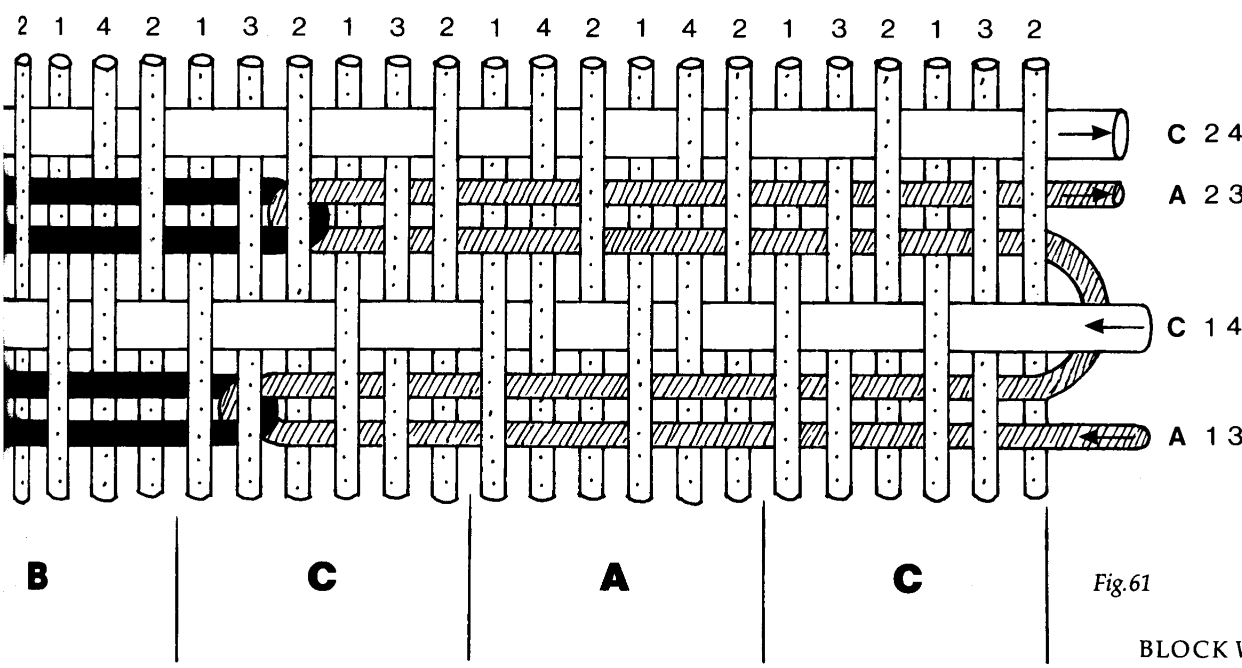


Fig.61

Plate 40 (see p. 80)

Plate 41 (see p. 81)

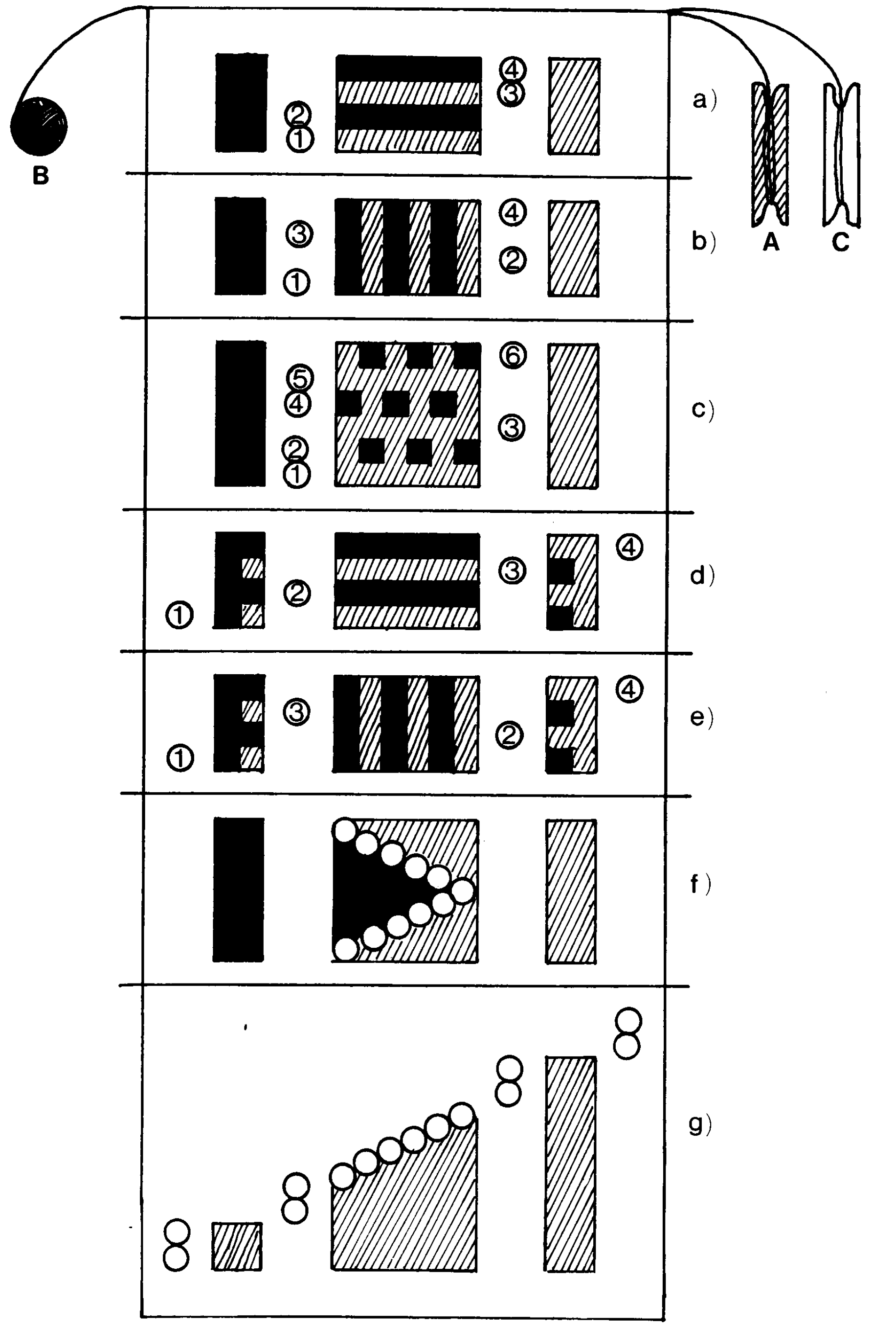


Fig.62

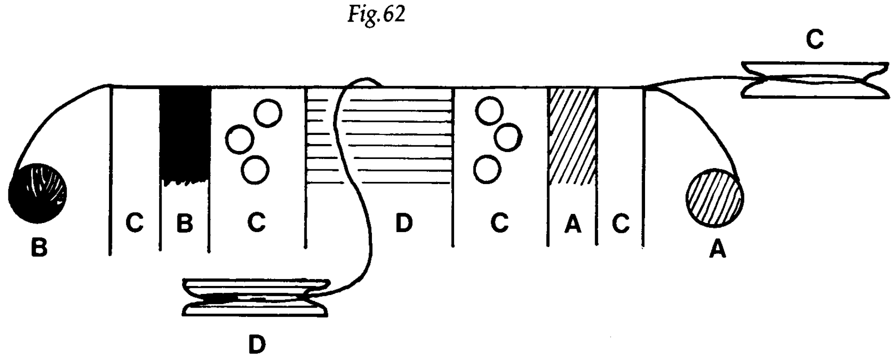


Fig.63

Fig. 62(a), (b) and *(c)* show in a diagrammatic way how moving the clasping points makes it possible to produce blocks with horizontal and vertical stripes and spots. So in *(a)*, the clasping point is twice on the left side, twice on the right of the central block giving it the narrowest possible cross-stripes. In *(b)*, the clasping points alternate from side to side of the central block giving it vertical stripes. In *(c)*, the clasping point is twice (it could be three times) to the left, once to the right of the central block, giving it staggered spots. These stripes and spots are seen in the central block in Plate 42 (p. 86).

In these three examples the two outer blocks remain a solid colour, but by moving the clasping points about more freely the outer blocks can, for instance, be spotted. This will happen if they are placed as in *(d)* or *(e)*; see bottom of Plate 42 (p. 86).

In all the above examples the clasping point has been carefully hidden between blocks threaded on (2,4,1); but if it is placed within such a block, the latter will be partly colour A, partly B. The idea works well if the clasping point is made to move diagonally. So it is placed under the next raised end - to the right, if the diagonal is moving up to the right - and a convincing oblique colour junction is produced; see *Fig. 62(f)*, and Plate 43 (p. 86). In this case the clasping points are not seen on the front or back. A colour junction with a steeper angle results from moving the clasping point over one warp end (whether raised or lowered in the shed), and allowing it to be visible.

There are other possibilities:

(a) Two balls of different colour at the left selvage

Weft A can catch either of these colours as desired. The selvage works best if one is caught for two picks, then the other for two picks.

(b) Weft at left selvage the same colour as weft C

Blocks can be made to disappear if the ball of half-thickness yarn at the left selvage is the same colour as the full thickness weft C. *Fig. 62(g)* shows where the clasping points must be for a block to disappear suddenly (outer two blocks) or gradually (central block). See Plate 44 (p. 87), where the clasped wefts changed sides at the midpoint of the sample.

(c) Ball at either selvage, shuttle in the centre

This is very like the plain weave application (see *Fig. 23* on p. 32), except that, due to the weave structure, the central 'jump' forward is handled differently. It gives the possibility of three blocks all of different colours; see *Fig. 63*. A shuttle of half-thickness D operates from the middle of the central block, and balls of half-thickness A and B are at the right and left selvages respectively. Weft C is of normal thickness.

Lift 13, pass D to right selvage, catch it around A, throw it all the way to left selvage (dragging a loop of A into the shed), catch it around B and throw it back to the middle of the warp. There it leaves the shed under the same end it passes under on entering; see detailed *Fig. 64*.

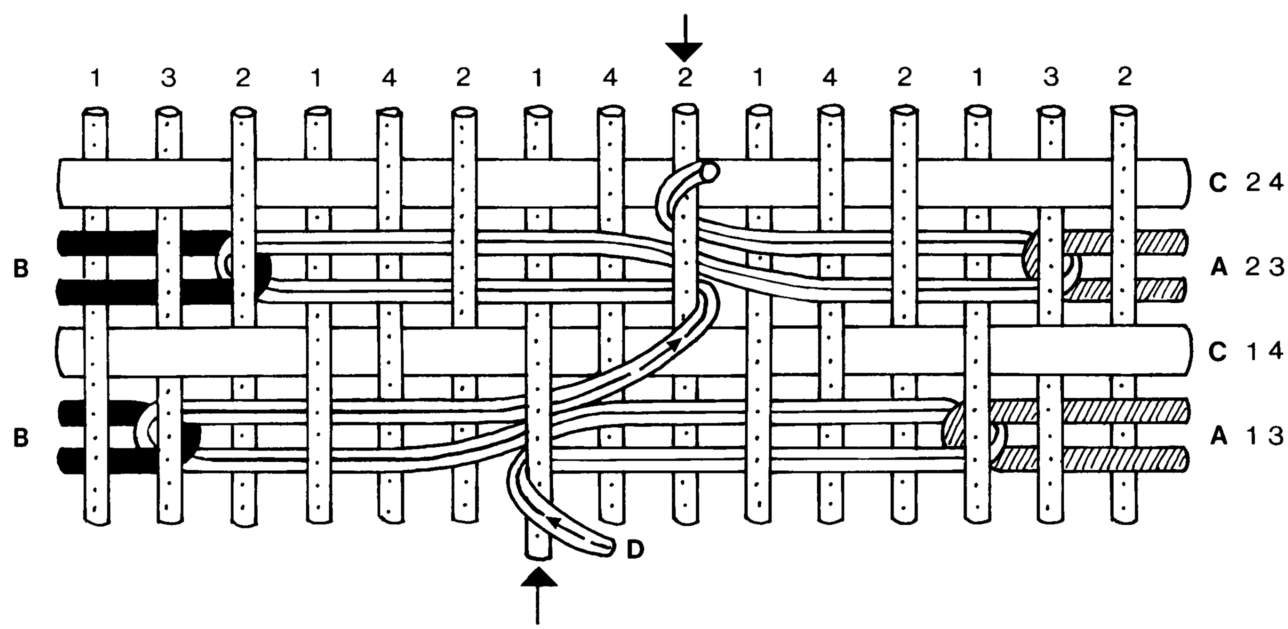


Fig. 64

Plate 42 (see p. 85)

Plate 43 (see p. 85)

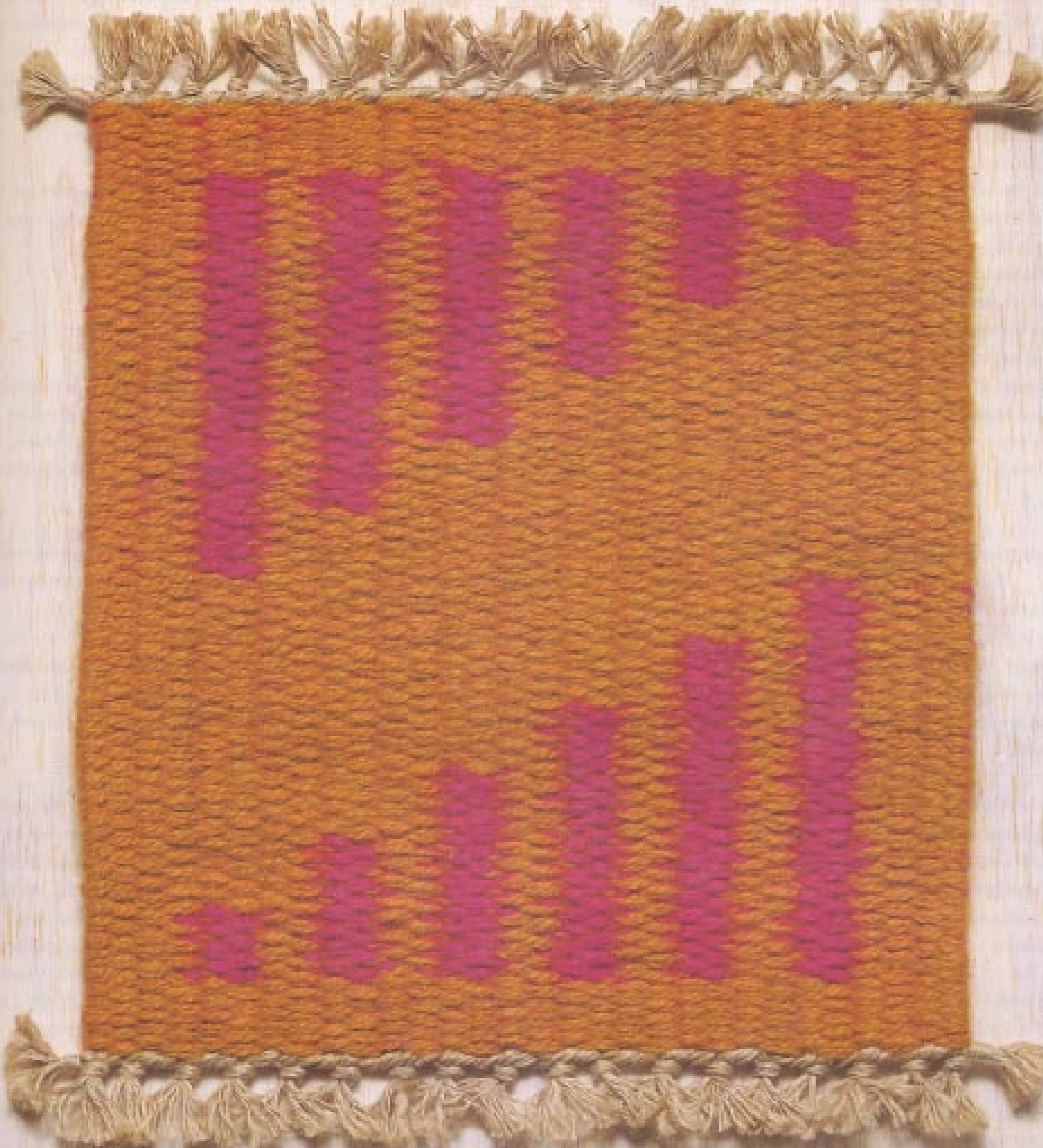


Plate 44 (see p. 85)

Lift 14, throw C to the left.

Lift 23. The last pick of D started by going to the right. This one goes first to the left, entering the shed around a raised end to the right (see arrow at top of diagram). After catching weft B then A, it returns to the centre and emerges under the same arrowed end.

Lift 24, throw C to the right.

Fig. 64 shows these four picks in detail, but for simplicity it includes only the central block and a portion of the two flanking blocks.

This is the whole repeat; D starting alternately to right and to left in order to make a neat central 'jump' forwards. So the next repeat begins on 13 with D going first to the right around the nearest raised warp end to the left (lower arrow), and so on. Plate 45 (p. 90) shows this technique with the half-thickness wefts A,B and D changing places regularly to give a diagonal movement to these colours.

By placing the clasping points within the blocks as well as between them, a design such as the one shown in *Fig. 65* can be woven in which it is assumed that the two balls at the selvages are of the same colour.

(d) Using four half-thickness wefts

For this interesting variation, there is a shuttle at each selvage, one carrying colour A, the other B; and there is also a ball at each selvage, both of the same colour C. All are half normal thickness; no normal weft is used, because all picks consist of clasped wefts. *Fig. 66* shows this set-up. The work proceeds as follows:

Lift 13, throw A to the left, catch it around C, throw it back, drawing a loop of C into the shed.

Lift 14, throw B to the right, catch it around C, throw it back to the left, drawing a loop of C into the shed.

Lift 23, as for 13.

Lift 24, as for 14.

All the wefts catch perfectly at the selvages.

This is a confusing technique to design for; the appearance of *any* colour both in a block threaded (2,3,1) and in a block threaded (2,4,1) is partly controlled by the weave structure and partly by the placing of the clasping point. To take a very simple example, assume the right half of the warp in *Fig. 66* is threaded (2,3,1) and the left half (2,4,1). Then when 13 or 23 are lifted, colour A can show only in the area threaded (2,4,1), i.e. the left half of the warp. Similar restrictions apply when 14 or 24 are lifted. So the left half can show various arrangements of A and C, and the right half arrangements of B and C, as suggested in *Fig. 66,* which omits the positions of the clasping points.

(e) Two balls of different colour at left, two shuttles of different colour at right selvage

In this variation the four half-thickness wefts for the block always work in pairs. In Plate 46 (p. 91), the red-and-blue weave for two repeats always clasping at the centre of the block; then the black-and-white weave for two repeats with a clasping point which gradually moves diagonally across the block. A fifth weft of normal thickness provides the background colour.

There are probably many other ways clasped wefts can be used in conjunction with the three-end block weave, some being very slow to weave.

Dovetailing

A good way to introduce two colours into a block is to apply the dovetailing principle found in tapestry. Three shuttles are needed carrying wefts A,B and C of normal thickness; see *Fig. 67* which shows a warp with one central block. The technique is worked as follows:

Lift 13, throw A from the right selvage and B from the left. Bring them both out of the shed at the same spot, somewhere in the central block.

Lift 14, throw C to the left.

Lift 23. Now, as A and B are inserted into this shed and return to their own selvages, they must both go around the same raised warp end (arrowed at top of the detailed diagram, *Fig. 68*). This is the dovetailing; to its right the block will be colour A, to its left colour B.

Lift 24, throw C back to the right.

Obviously, if this dovetail continued in the same place, it would cause a surface ridge; so it is advisable to move it up on an angle, or stagger it from side to side. To make a clean colour junction on the diagonal going up to the right, work as described above. For a colour junction on the opposite diagonal, A and B must move inwards, towards each other, on the 23 lift (not the 13 lift as above). To get into this situation, simply weave two picks of any one of the three wefts on 13 and 14, then bring in A and B on 23. This will give small spots of whichever colour weft was used, as seen in Plate 47 (p. 94).

This method has an advantage over clasped wefts in that the dovetailing is far less of a surface imperfection than a clasping point. But it can be used with ease only at a point where the wefts are showing on the surface, i.e. in a block threaded (2,4,1) in this example. To dovetail two wefts where they are appearing on the back, i.e. in a (2,3,1) block, is a finicky operation.

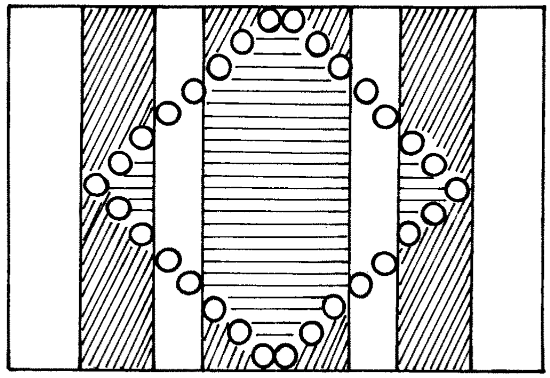


Fig.65

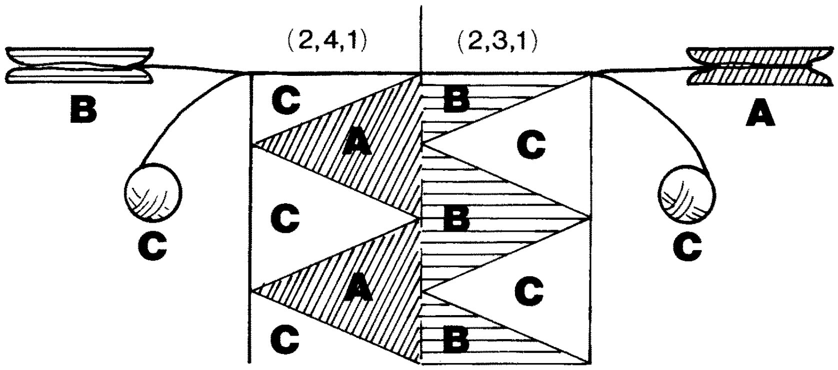


Fig.66

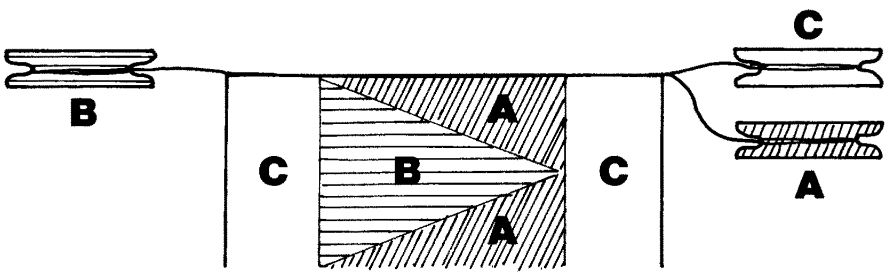


Fig.67

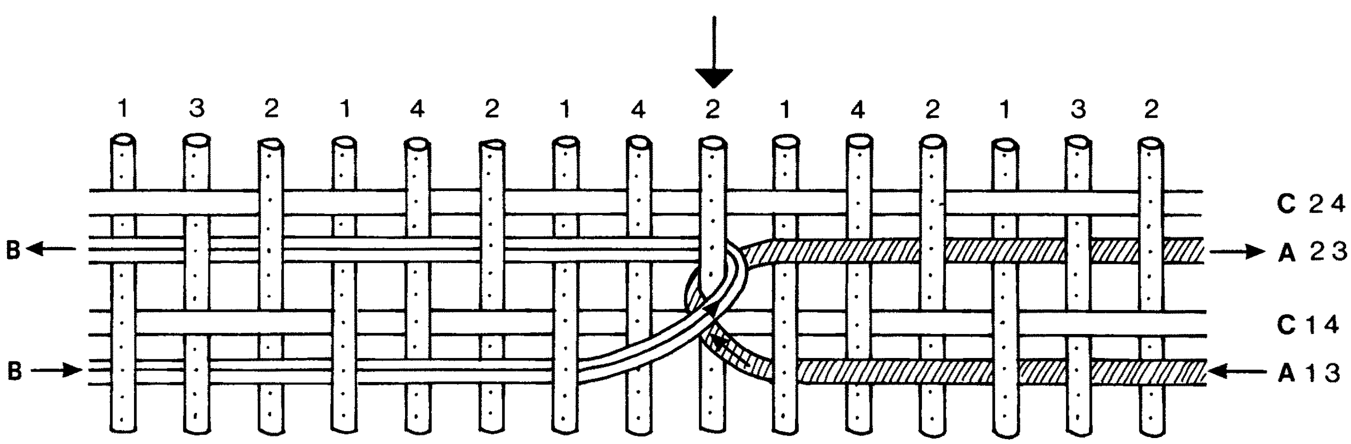


Fig.68

Plate 45 (see p. 88)

Plate 46 (see p. 88)

Pick-up Version of Three-end Block Weave

When considering how to increase the design possibilities of three-end block weave, it might be thought that the use of pick-up was superseded by the far quicker shaft-switching. But pick-up does have definite advantages.

1. It can be started at any moment without any preliminary additions to the loom.
2. It can easily be introduced in just a few places in a design otherwise controlled by the shafts.
3. It can be easily extended to the use of three weft colours.
4. There are certain effects which add no extra time to this already slow technique, but which would be tedious with shaft-switching.
5. Perhaps most importantly, it serves as a very good theoretical introduction to shaft-switching, because the pick-up stick performs so visibly operations which are a little difficult to see and grasp when done by shaft-switching.

In essence, both techniques are doing the same thing – they are forcing shafts 3 and 4 to relinquish their job of deciding where the blocks are to be and handing over that decision to the weaver. Till now the positioning of blocks has been totally decided by where the threading units of (2,3,1) and of (2,4,1) have been disposed across the warp. Many techniques have been described which try and soften that tyranny by bringing variety into the blocks; but it is only with pick-up and shaft-switching that the weaver is set free and can control his or her own block design *while* weaving.

Of the two methods for pick-up, the Raised End technique will now be described in detail.

Raised end technique

This description assumes the technique is to be worked on a narrow warp already threaded with only nine blocks, i.e. with some areas threaded (2,3,1) and some areas threaded (2,4,1).

Lift 34. However the blocks are threaded, this will raise every third end all across the warp, one from each block; as there are nine blocks there will be nine raised ends, as in *Fig. 69(a)*. Take a rod or narrow stick and thread it through this sheet of warp ends, going over and under ends in any desired manner. See stick 1 in *Fig. 69(a)* which goes under three, over three, under three ends. Remember that wherever the pick-up sticks lies above the ends (shaded part) the following pick of weft will show on the surface of the rug; and wherever it lies below the ends the pick will show on the back. So visible stick = visible pick is the rule which governs the path chosen through the raised ends.

Lower 34, leaving the stick in place.

Lift 1. The rising shed will lift the stick and with it all the ends on shafts 3 and 4 it passed under. The shed will be smaller than usual, but is largest under the pick-up stick when it is pressed against the reed. Pass weft A in this shed.

Lower 1, leaving the stick in place, so beating is impossible.

Lift 34. Using the first pick-up stick as a guide, thread another stick through the raised ends, but taking an exact opposite course, passing over them where the first stick passed under and vice versa; see upper stick 2, in *Fig. 69(b)*. This manoeuvre for brevity will in future be called pick-down, i.e. the opposite of the pick-up. Remove the first stick leaving the second stick in position, as in *Fig. 69(c)*.

Lower 34,

Lift 1. Again the pick-up stick will be lifted by the rising shed, but this time it will carry up all the ends on shafts 3 and 4 *not* carried up before. Pass weft B in this shed.

Lower 1. Now the stick can be removed and these two picks beaten together.

The above sequence is then repeated exactly, but lifting shaft 2, instead of 1; making a complete repeat of four picks.

The repeat can therefore be abbreviated thus:

Lift 34, pick-up, lower 34, lift 1, weft A, lower 1.
Lift 34, pick-down, lower 34, lift 1, weft B, lower 1. Beat.
Lift 34, pick-up, lower 34, lift 2, weft A, lower 2.
Lift 34, pick-down, lower 34, lift 2, weft B, lower 2. Beat.

To shorten such instructions further, they can be reduced to a diagram, as *Fig. 70*, which by means of the dashes shows that the central three raised ends are the ones involved in the pick-up and pick-down, both when weaving with shaft 1 raised and with 2 raised.

If the above was continued with the stick always taking the same route through the raised ends, a block design would result exactly like a threaded design; see *Fig. 69(d)*. But the beauty of the technique is that at every pick-up stage the first stick can take a different route through the ends (followed of course by an exactly opposite pick-down), thus making the design possibilities unlimited. In fact, if desired, the design could be changed every two picks. But however often it is changed, the first stick is always the leader, the decider of the pattern, the second stick blindly following, taking the opposite course.

Notes

— *The most common mistake is to lift shafts 1 and 2 alternately, instead of 1 twice and then 2 twice; see above. If in any doubt which is the correct shaft to raise, it is always the one which makes the weft catch at the selvage.*

— *The theory behind this is that the stick, as it selects a path through the raised ends, is deciding which of them are to be up, which down for the following weft. So it is, as it were, deciding which part of the warp should behave* as if *threaded (2,3,1), and which* as if *threaded (2,4,1).*

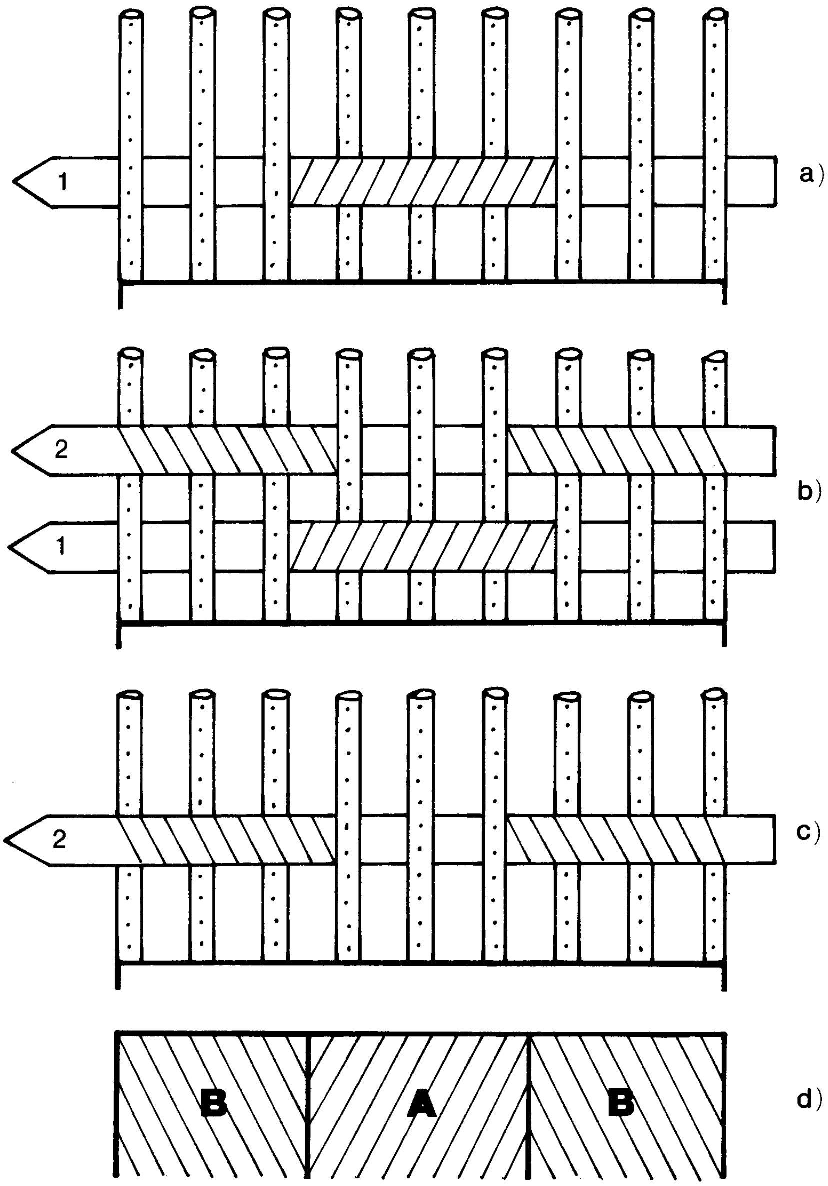


Fig.69

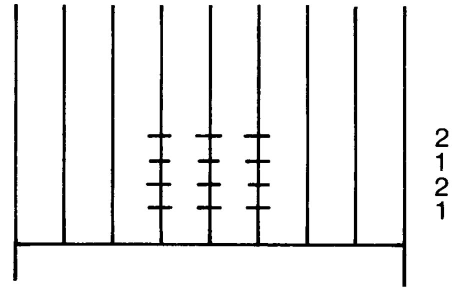


Fig.70

An alternative quicker sequence

It is naturally the picking up and down which slows up the process. By using a slightly different sequence, these manoeuvres can be halved in number.

Lift 34, pick-up, lower 34.

Lift 1, pass weft A, lower 1.

Lift 2, pass weft A, lower 2, so the pick-up stick stays in position for these two picks.

Lift 34, pick-down, lower 34.

Lift 2, pass weft B, lower 2.

Lift 1, pass weft B, so again the stick stays in position for two picks. Lower 1.

With this sequence, all four picks can be beaten together, giving a better chance for the wefts to slide in front of or behind each other. The design can be changed after the first pick of A or of B; so the stick will have to be altered to a new pick-up or pick-down position and not left in place as described above.

Plate 47 (see p. 88)

Plate 48 (see p. 96)

Producing striped and spotted areas

If the pick-up position is changed markedly after every two picks (one of weft A, one of B), areas of vertical stripes as well as of solid colour can be woven. In *Fig. 71(a)*, the position for the pick-up (and of course the pick-down) involves the central five raised ends when weaving on 1, but extends three ends either side (involving the central 11) when weaving on 2. Repeating this alternation of two pick-up positions gives a central area of solid colour with vertical stripes on either side, as shown immediately below. So areas of vertical stripes become a third design element and can be placed at will; see *Fig. 71(b)* and *(c)*. see central diamond in plate 51 (p. 99).

In a similar way, areas of cross-stripes and of spots can be woven, as shown in *Fig. 72(a)* and *(b)*. See Plate 48 (p. 95).

These techniques greatly increase the design possibilities.

Producing oblique stripes

If a piece of this woven block weave is folded obliquely, a natural twill line is seen because the structure is almost a 2/1 twill. By following this natural diagonal line exactly, a very convincing oblique join between two colours can be made. But the junction will look straight and clean only on one side of the rug, the upper as woven; on the back it has an irregular stepped character. It is impossible to make a clean junction on both sides, as it would be with tapestry technique.

The rules involved can be illustrated in the weaving of an oblique stripe three pick-up threads wide; see *Fig. 73*. The problem is knowing when in the cycle to change the pick-up position. Now, if, as in *Fig. 73(a)*, the stripe is to incline up to the right, then the pick-up position must be shifted over one thread to the right after the two picks (with A and B) with shaft 1 raised. Four picks are then woven in the new position and the position again changed. The arrows at the side mark these change-over positions, and the dashes in the centre are seen to move to the right accordingly.

Though from the pick-up positions in the diagram it looks as if the stripe will move up in definite steps, it will in fact have perfectly straight edges because of the way the threads lie in the woven structure. See Plate 49 (p. 98).

There is thus seen to be a change of pick-up position after every four picks. The same is true for a stripe inclined up to the left, as in *Fig. 73(b)*, except that here the pick-up position is changed after weaving with shaft 2 raised; see the arrows.

Following these rules gives clean edges to the stripe on the front of the rug, stepped edges on the back; compare Plates 49 and 50 (p. 98) showing the front and back of a sample respectively. Disobeying the rules means the stepped edge will be on the front, the clean at the back. Of course, both types can be combined on one side of a rug.

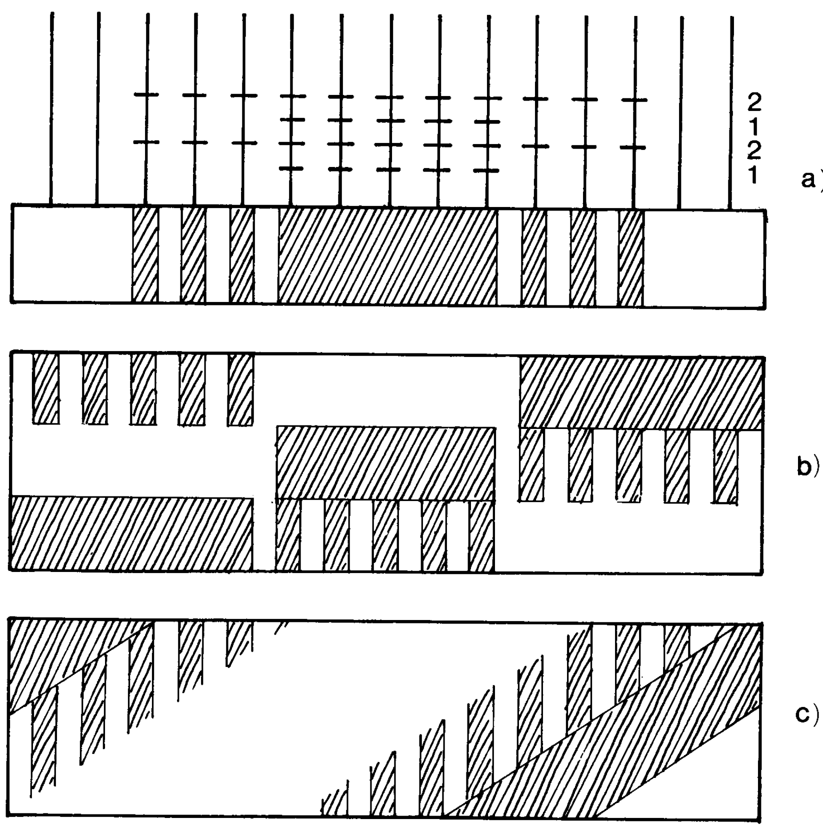


Fig. 71

Notes

— This clean edge can only lie at one angle, because the pick-up position has to change every four picks. The angle can be altered only by varying the warp setting or the weft thickness, in other words, the epi or the ppi. If the pick-up position were changed after 6, 8 or 10 picks, the stripe would be much steeper but would have a definitely stepped outline, on both the back and the front of the rug.

— A stripe only one pick-up thread wide gives disconnected spots on the back of the rug.

Fig. 74 shows how to change the pick-up positions when weaving a zigzag.

Fig. 72

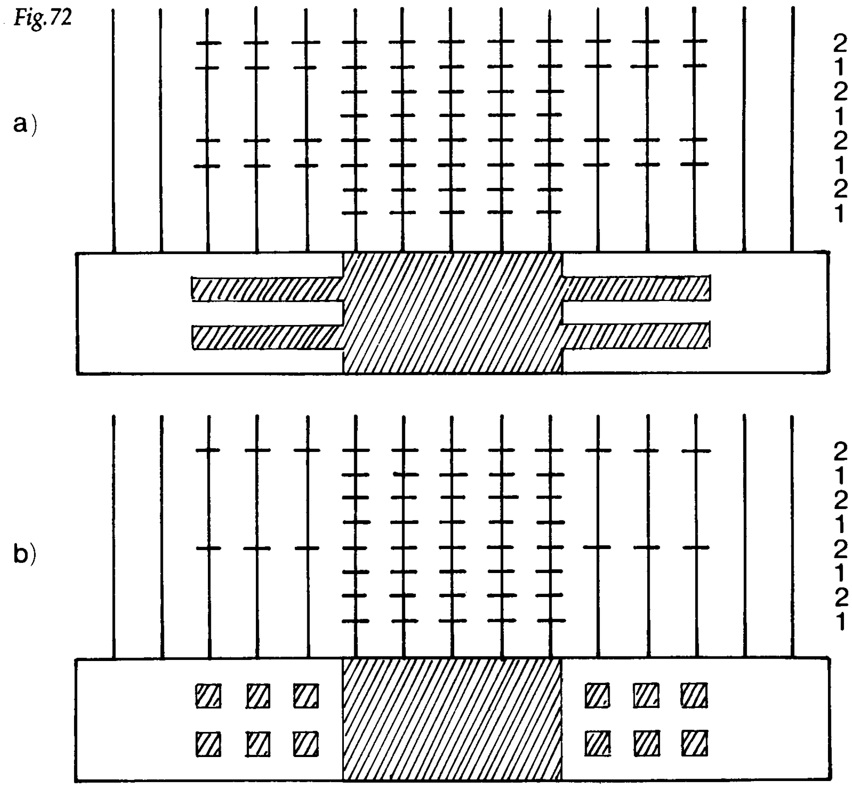


Fig. 73

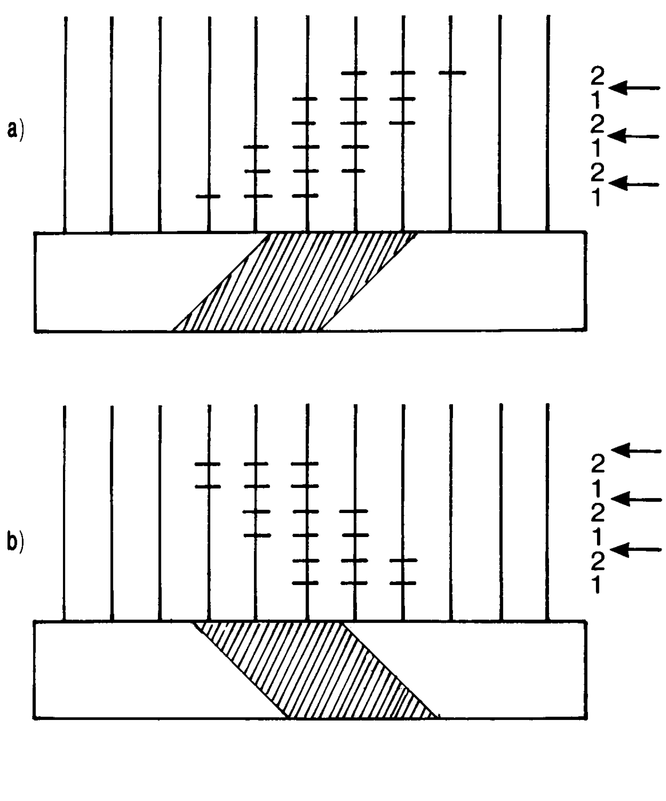
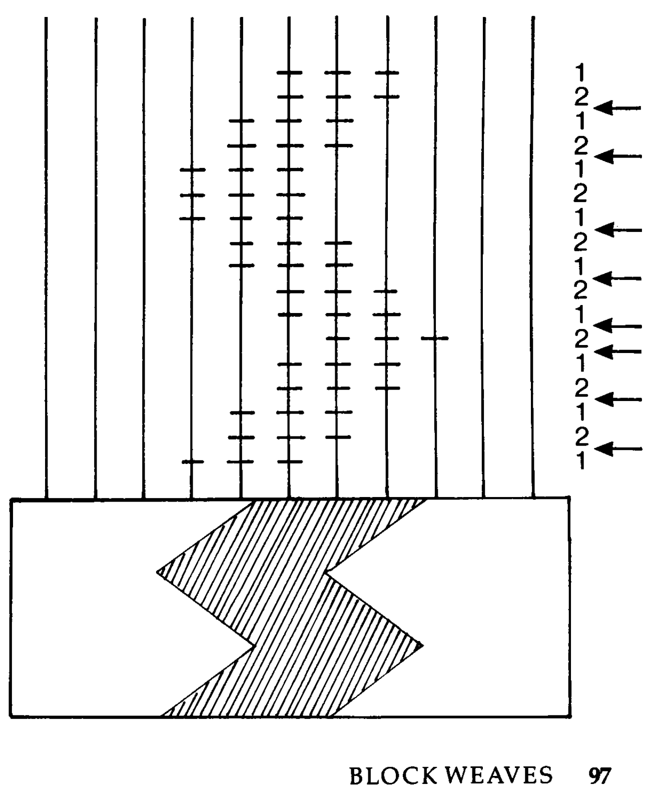


Fig. 74



FRONT

Plate 49 (see p. 96)

Plate 50 (see p. 96)

BACK

Plate 51 (see p. 100)

Weaving a diamond

As might be expected a diamond with its two oblique edges needs a change of pick-up position every two picks.

Start by picking up a single raised end, but make sure you do so when the following two wefts will weave with shaft 1 raised; see *Fig. 75*. These picks establish the point of the diamond. The next stage is to pick up the first end plus the one to its *right* (see diagram) and weave with shaft 2 raised. Then add one end to the *left* (making three being picked up in all) and weave with shaft 1 raised.

Continue in this way, adding one end to the pick-up position, alternately to right and to left, after every two picks. To help keep track, notice that when weaving with shaft 2 raised (an even number), an even number of ends are picked up; when weaving with shaft 1 (an odd number), an odd number are picked up.

When a diamond has reached its full width, decrease its size by reversing the procedure exactly, i.e. the last end added to the pick-up position is the first one to be dropped.

When weaving a shape like this, it is always best to insert the motif's weft first, then the background weft. Mistakes are more quickly seen and rectified. Plate 51 (p. 99) shows a sample based on diamond shapes.

Note

— No arrows are drawn in Fig. 75 *because there is a change of pick-up position after* every *two picks.*

Partial pick-up

This variation allows the blocks produced by the threading to be altered as much as desired by means of pick-up. Let *Fig. 76(a)* represent the blocks resulting from the threading and *(b)* how they are to be altered. The work is done as follows:

Weave the blocks normally, lifting (13,14,23,24) until the point in the design where the openings begin.

Then lift 4. These ends will be raised in three groups corresponding to the three blocks; see *Fig. 76(c)*. Pick-up, passing the stick *under* the ends where the openings are wanted; see stick 1 in diagram.

Lower 4.

Lift 13, pass weft A, the colour forming the blocks. Lower 13.

Lift 4, pick-down; see stick 2 in diagram. Remove first stick. Lower 4.

Lift 1, pass weft B, the background colour. Remove stick and beat.

The second half of the sequence can be abbreviated thus:

Lift 4, pick-up as before. Lower 4.

Lift 23, weft A. Lower 23.

Lift 4, pick-down as before. Lower 4.

Lift 2, weft B. Remove stick, beat.

Note

— The ends of a block which is not being altered, e.g. the narrow central block in Fig. 76, *are passed over by the first stick and passed under by the second.*

The single block at the centre of Plate 52 (p. 102) has been treated in this way.

In a similar way, the blocks threaded on (2,3,1), i.e. the background areas in *Fig. 76*, can be selectively altered; *Fig. 76(d)* shows a possible result. The sequence in summarized form is as follows:

Lift 3, pick-up, passing the stick over the ends which are to be altered. Lower 3.

Lift 1, weft A. Lower 1.

Lift 3, pick-down. Lower 3.

Lift 14, weft B. Lower 14.

Lift 3, pick-up. Lower 3.

Lift 2, weft A. Lower 2.

Lift 3, pick-down. Lower 3.

Lift 24, weft B. Lower 24. Beat.

Three-colour pick-up

In the normal structure of this block weave, a weft which shows on the front of the rug slides down and almost completely obscures the corresponding weft on the back. Using three colours, the one visible on the front endeavours to hide the other two which lie together in the same shed at the back. So it has an unbalanced structure, and though the front can with care give the appearance of a solid colour, the back will always show a mixture of two colours. The method is worked as follows:

Lift 34, insert a pick-up stick in some fashion; see the lower stick, 1, in *Fig. 77*. Lower 34.

Lift 1, pass weft A which will show where the stick went over the raised ends. Lower 1.

Lift 34, insert second stick. This is *not* a pick-down, i.e. the opposite of the previous pick-up. It is just another pick-up passing over more of the raised ends. It could be inserted as stick 2 in the diagram. Lower 34. Remove stick 1.

Lift 1, pass weft B. Lower 1.

Lift 34, insert the third stick so that the ends not passed over previously are now covered; see stick 3 in *Fig. 77*. Lower 34. Remove stick 2.

Lift 1, pass weft C. Remove stick 3 and beat all three wefts together.

Repeat the above procedure exactly but lifting shaft 2, instead of 1, for the next three insertions of A, B, and C. Continue in this way, three picks with 1 raised, followed by three picks with 2 raised. The bottom of *Fig. 77* shows how the resulting blocks relate exactly to the three pick-ups made.

Note
– Despite what Fig. 77 *shows, there is never any moment when all three pick-up sticks are together in the warp.*

It will be understood that the picking-up is more difficult than with only two colours. The only rule is that the three pick-ups *considered together* must cover all the raised ends. The three-colour blocks produced can naturally be moved, have angled junctions and so on, just as in the two-colour version. See Plate 53 (p. 103) where the three colours have been arranged differently in each repeat of the diamond.

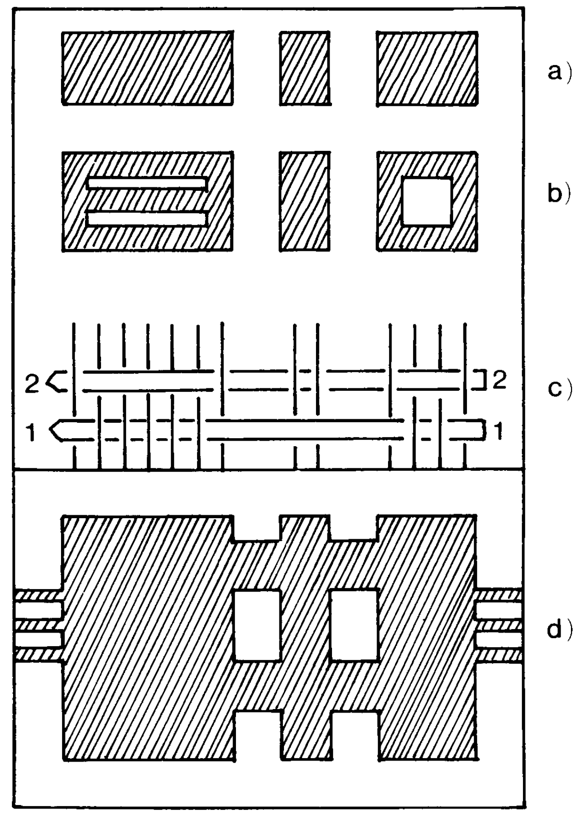


Fig. 76

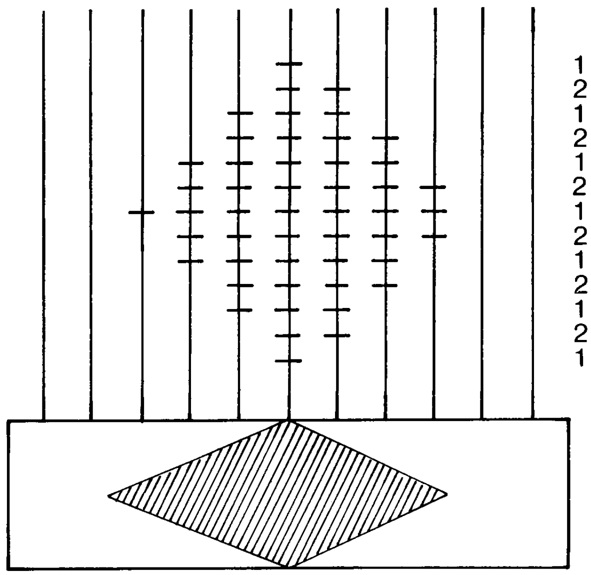


Fig. 75

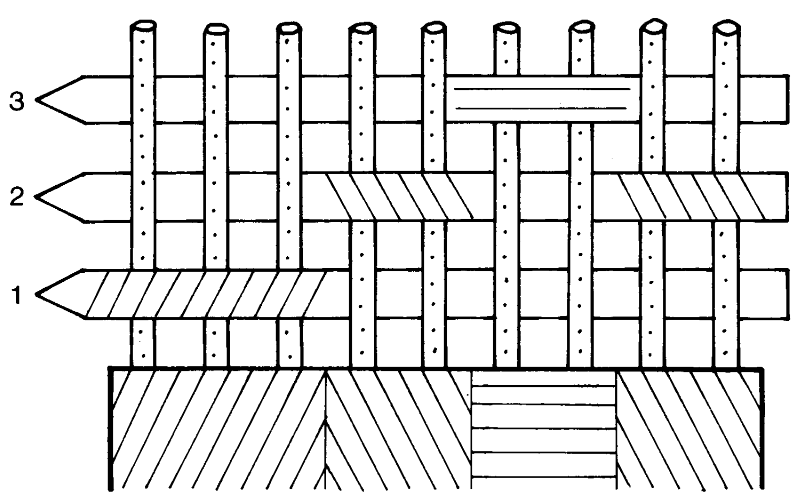


Fig. 77

Plate 52 (see p. 100)

Plate 53 (see p. 101)

Shaft-switching Applied to Three-end Block Weave

In the search for greater freedom in the placing and movement of blocks, a weaver naturally thinks of using more shafts. Indeed, the three-end block weave can be extended in this way – each new shaft added giving one more controllable block. *Fig. 78 (a)* shows one possibility using six shafts and, below, the sort of design which could be woven. At the right are the sixteen different lifts. It is just possible, using both feet with the pedal tie-up shown at *(b)*, to produce all the lifts required by this six-shaft version. But this is about the limit; if a design demands more than six shafts, then a mechanism like a dobby or Jacquard is needed to control them.

It was this realization that led me to another approach. If the four-shaft version is examined – *Fig. 79(a)* – it can be seen that the only difference between the two threading units used is the warp ends on shafts 3 and 4. The ends on shafts 1 and 2 occur regularly right across the warp; they are just the tie-down ends and cannot be involved in controlling the blocks. But it is *because* there is a warp end on shaft 3 in the (2,3,1) blocks that colour B appears on the surface; and *because* there is a warp end on shaft 4 in the (2,4,1) blocks that colour A appears on the surface. The ends on shafts 3 and 4 are, in other words, the *pattern-controlling* ends.

So if it were possible to switch ends from shaft 3 to 4, and back again, *while weaving*, the boundaries between blocks could be moved at will. The blocks would no longer need to be rectangles whose placing is rigidly controlled by the initial threading of the warp, and any two-colour design could be woven with ease. For example, if a warp end on shaft 3 was somehow moved on to shaft 4 (see right-hand arrow), that block changes from a (2,3,1) to a (2,4,1) block, making the design alter from that at *(b)* to that at *(c)*. If then an end on shaft 4 was moved to shaft 3 (see left-hand arrow), that block is changed to (2,3,1) and the design now becomes that shown at *(d)*.

This is the theory behind shaft-switching, a method which combines the speed of normal block weaving with the freedom of design formerly possible only with pick-up. Taken to its logical conclusion, it can be applied to every threading unit in the width of a rug, say, fifty in all. The loom, though possessing only four shafts and using only four pedals, would have the designing potential of a fifty-two-shaft loom.

Practical ways of switching ends between two shafts have brought out the inherent ingenuity in weavers. They all assume that ends on shafts 1 and 2 are threaded normally; they concentrate on the manipulation of the pattern-controlling ends, the ones usually threaded on shafts 3 and 4.

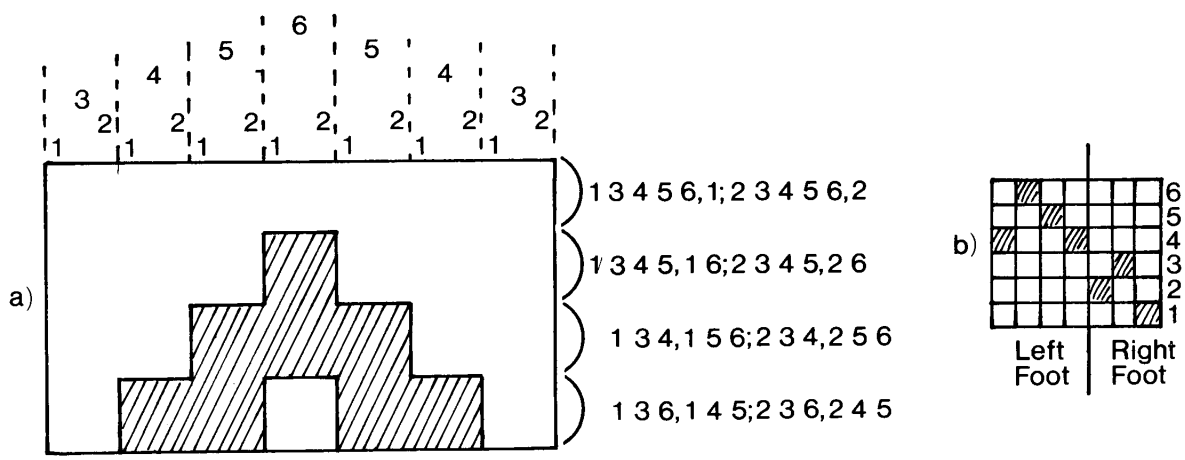


Fig. 78

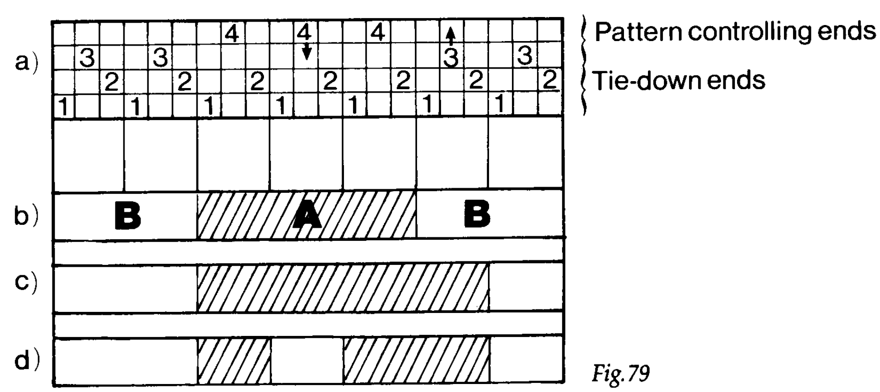


Fig. 79

Methods of shaft-switching with pattern-controlling end threaded

(a) REPAIR HEDDLE

A simple solution is to thread the relevant end on a metal repair heddle which is clipped to either shaft 3 or 4 as required; see *Fig. 80(a)*.

(b) FREE HEDDLE

In a similar method the end is threaded on a string heddle which has a small weight at the bottom and a loop at the top. Pins are driven either directly into the tops of shafts 3 and 4, or into removable wood strips which can be fixed to these shafts. The loop on the heddle is then hooked over a pin on shaft 3 or 4; see *Fig. 80(b)*.

(c) METAL HOOK

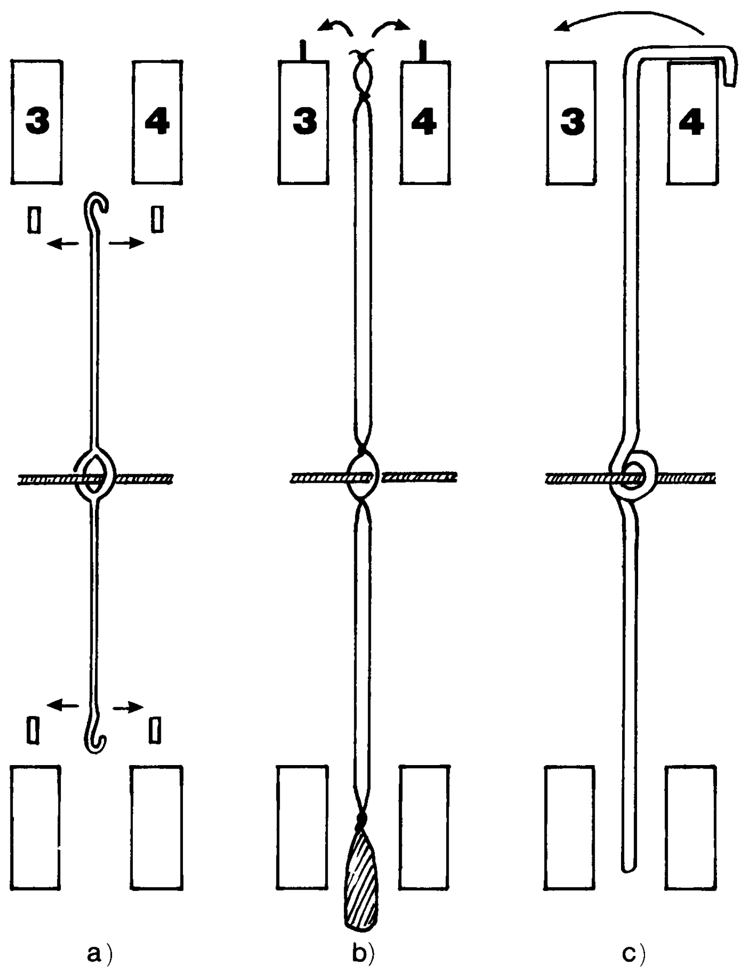
A stiff wire is bent so there is an eye in the middle and a hook at its upper end; see *Fig. 80(c)*. The warp end is passed through the eye and the wire can be twisted so the hook engages with either shaft 3 or 4.

Methods (b) and (c) work only with a rising-shed loom, as there is nothing to draw the end down positively if the shaft to which it is attached is lowered.

Methods of shaft-switching with pattern-controlling end unthreaded

All these methods depend on having an empty heddle on shafts 3 and 4 between which, or beside which, the warp end passes; see *Fig. 81*. They differ in the way the end is attached to either one or other of the empty heddles.

Fig. 80



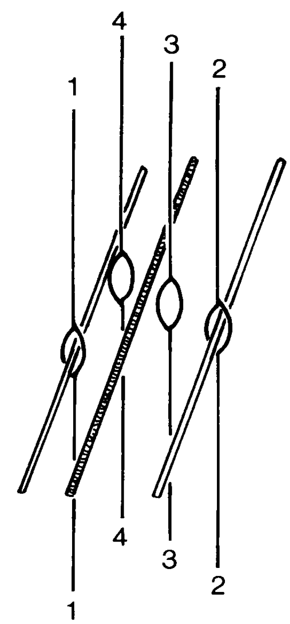


Fig. 81

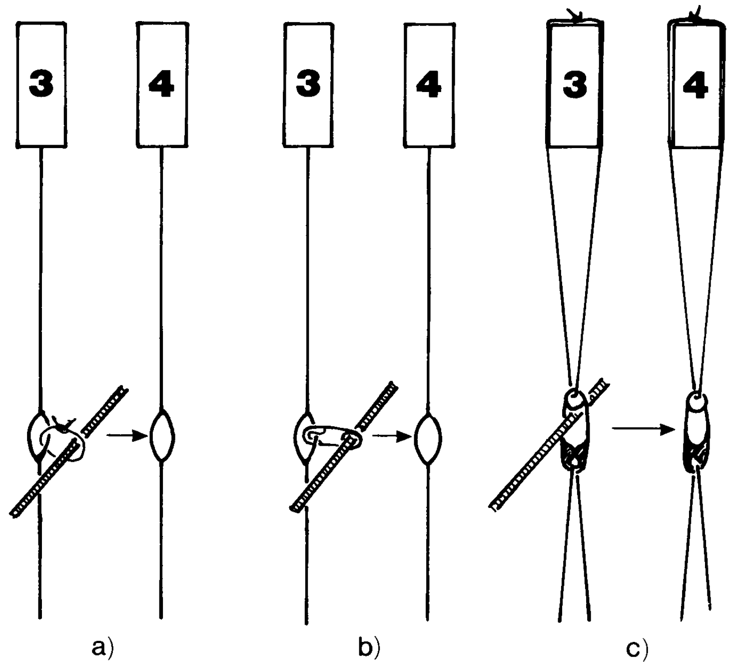


Fig.82

(a) PATTERN-CONTROLLING END
ATTACHED DIRECTLY TO THE HEDDLE EYE

1. Probably the simplest method of all (and the one I first tried) is to tie the warp end to the eye of one of the empty heddles with a short length of strong yarn, perhaps the same as the warp material; see *Fig. 82(a)*. To switch shafts this loop is either untied or cut and the end tied to the eye of the other heddle. This is a useful way of setting up a block weave on a sample warp when teaching. The ties can remain unaltered while the normal block weaves are explored; then cut and perhaps replaced with method (b)(1), below, when shaft-switching is reached.
2. A little more sophisticated than the above is the use of some sort of snap hook; see *Fig. 82(b)*. This is threaded on the warp end and can be clipped into the empty eye of either heddle. A size 12 or 14 snap swivel (used by fishermen), with the swivel end cut off, is said to work well, though it is very stiff to open. A small safety pin is another possibility. The larger the hook or pin, the more the depth of the shed will be reduced.
3. Another approach is to make special heddles of which the eyes are actually snap hooks or safety pins, the rest being heddle twine; see *Fig. 82(c)*.

These methods all work with a rising and falling shed, but shaft-switching at warp level is not easy; and with a complex design there can be no numbering system to help the weaver.

(b) PATTERN-CONTROLLING END
ATTACHED INDIRECTLY TO HEDDLE EYE

All these methods depend on the introduction of two loops or doups; see *Fig. 83(a)*. One loop goes around the warp end, through the empty eye of the heddle on shaft 3 and then upwards; the other loop takes a similar course in relation to the heddle on shaft 4. Now if some way is found of tightening the loop on 3, the warp end will be pulled over to the empty heddle eye. It will lie close beside it, not through it; but whenever shaft 3 is moved, that warp end will behave *as if* it were threaded on shaft 3. Similarly, if this loop were now loosened and the loop on 4 tightened, the same warp end will be pulled over to the empty heddle eye on shaft 4 and will behave *as if* threaded on 4.

The methods now described differ only in the ways the two loops are loosened and tightened; they share the great advantage that the shaft-switching is controlled, not at warp level, but at the top of the shafts which is far more convenient for the weaver.

1. Two Loops and Two Constrictor Knots

The two loops are arranged exactly as in *Fig. 83(a)*, with their knots at the top and with half of each loop passing in front, half behind, the relevant shaft. A constrictor knot is tied around each loop above the shaft; labelled A and B in diagram. If the loop on shaft 3 is pulled upwards to tighten it, and its constrictor knot (A) is then slid down until it will go no further, the warp end will rise and fall with shaft 3; see *Fig. 84(a)*.

Note
— The other constrictor knot, B, must be slid to the end of its loop to give enough slack for this to happen.

If knot A is now slid up out of the way and knot B slid down,

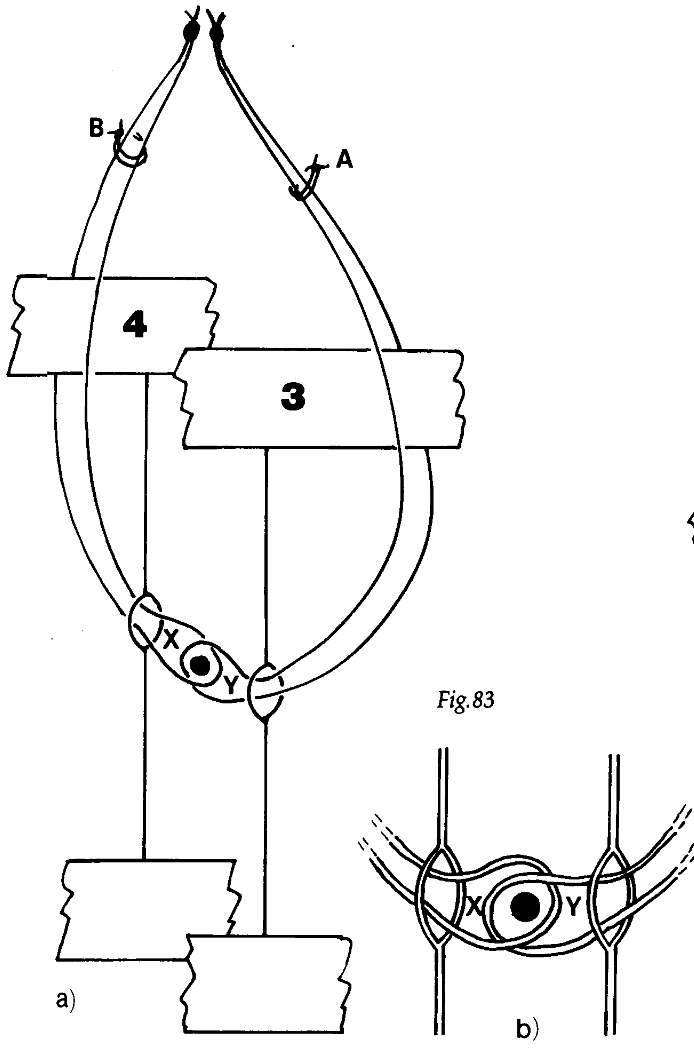


Fig.83

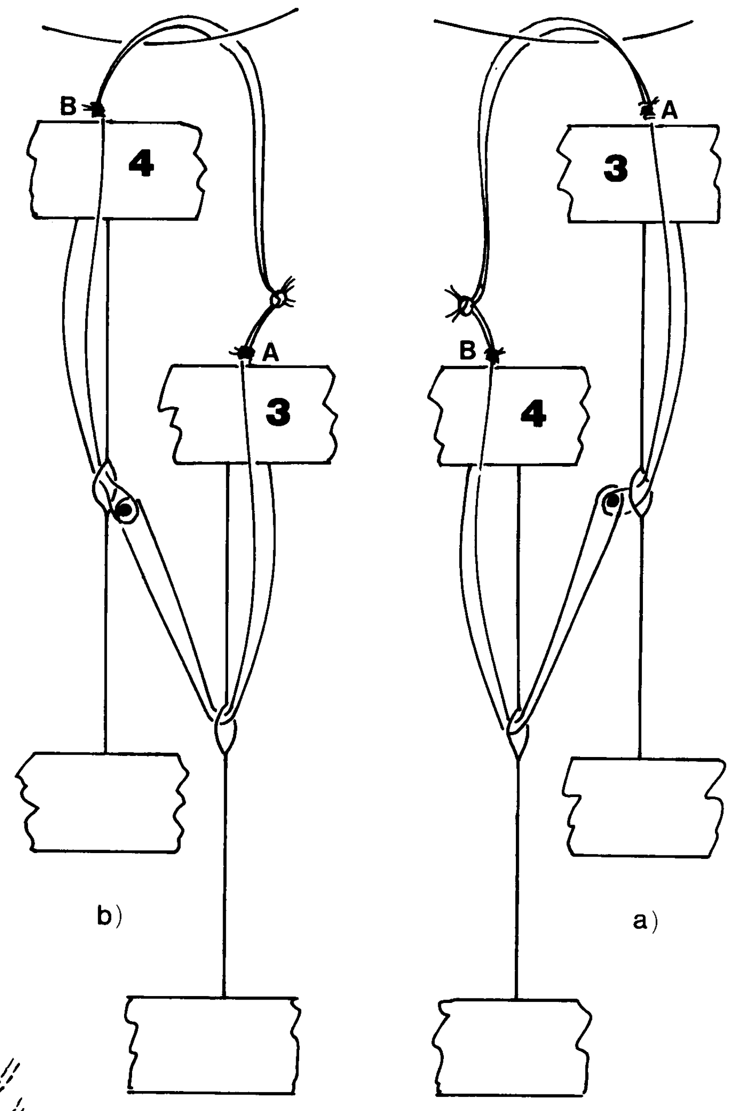


Fig.84

the warp end will rise and fall with shaft 4; see *Fig. 84(b).*

This method is now described in detail as it is the one most frequently used in workshops and so is the one that introduces many weavers to the idea of shaft-switching.

Practical Details

(a) The Loops

The loops should be made from tightly twisted or cabled yarn, like cotton heddle twine. The yarn has to be strong but not slippery or the constrictor knots will fail to grip.

In length it should be about twice the distance from heddle eye to top of the shaft. A too short loop will impede the shed; a too long loop will work perfectly but look untidy and get in the way.

At warp level the two loops can be linked together as shown in detail in *Fig. 83(b)*. This is not essential but it means that, when a warp is finished, the loops will be fixed in place ready for the next warp; they cannot slip out of the heddle eyes. When threading such linked loops be sure the warp end goes through both loops and not through the spaces labelled X and Y in *Fig. 83(a)* and *(b)*.

To keep the loops in identifiable pairs, join their upper ends in one knot, as in *Fig. 84(a)* and *(b)*.

To stop the loops tangling or falling down between the shafts, pass them over a cord or rod or some part of the loom above the shafts; see the cord at top of *Fig. 84(a)* and *(b)*. A raddle hung in this position works well and keeps the loops in perfect order. Adjust the height of whatever is used so that the loops can easily slide over it when a shed is opened.

(b) Heddle eyes

There is naturally much friction between the loops and the heddle eyes, so the latter should be as smooth as possible. Twisted wire heddles work well, especially if the eyes are painted with resin or thick enamel to increase their smoothness. The punched-out flat metal heddles will soon fray the loops. If string heddles are used it is important that the shaft is a four-sided rigid frame, not just a top and bottom bar. The latter type can easily be made rigid with vertical wooden strips joining the ends of the two bars.

(c) Constrictor knot

The character of this knot is vital. As *Fig. 84(a)* shows, it is only the fact that knot A is gripping the loop securely that ensures the warp end is lifted with shaft 3. Any slippage here would lead to a progressively smaller shed. The knot must also be loose enough to slide up and down the loop to make the shaft-switching possible.

A good material to use is a harsh wool, like carpet wool, perhaps two- or three-fold; the best knot is a constrictor knot, tied as follows:

Holding the two ends, make a loop between the hands, the part from the left hand crossing over the part from the right, as shown in *Fig. 85(a)*. Put the left index *up* into the loop and the right index *down* into the loop. Twist the right hand away from you, until the two index fingers can touch. Slip the loop from the left index on to the right index. The finished knot is now on the right index and can be transferred on to the shaft-switching loop. Tighten by pulling on the two free ends until it is difficult to slide the knot up and down the loop, see arrows in *Fig. 85(b)*.

Before even making the shaft-switching loops, ensure by experiment that the materials available for them and the knots will work together satisfactorily. The whole system will fail or need constant adjustment if the knots slip when they should be holding.

It is helpful to colour-code the knots. If the colours are, say, red for the shaft 3 loops and blue for the shaft 4 loops, then on every pair of loops either the red or blue must be *down*, tight against the top of the shaft, and the other *up*. If both red and blue are *up*, the relevant warp thread will not move when a shed is opened; if both red and blue are *down*, something will break or shafts 3 and 4 will act as if stuck together.

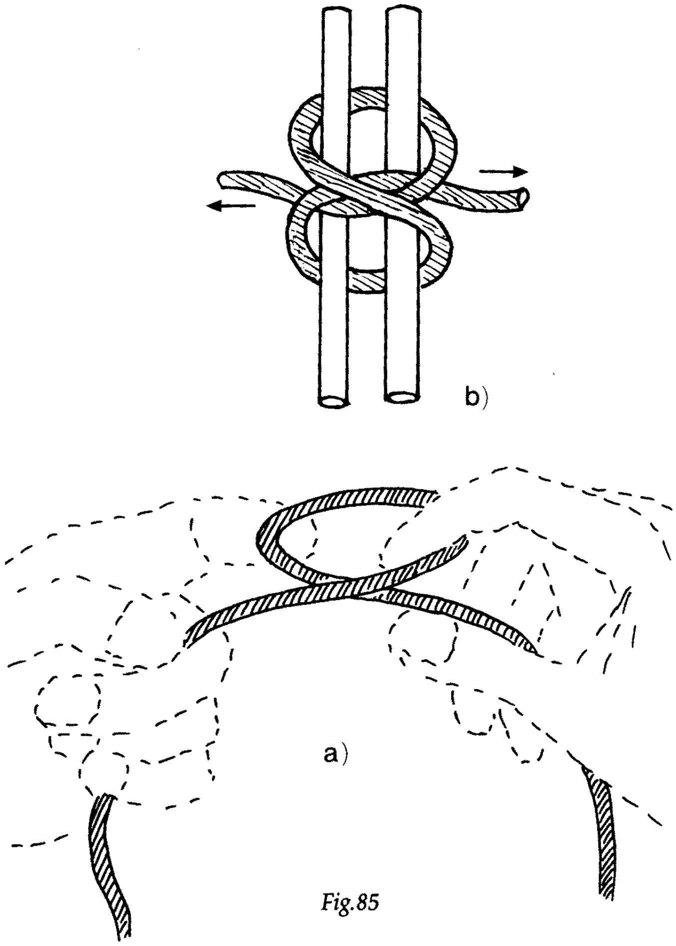


Fig.85

(d) Inverting the threading

It is of course logical to invert the threading so that the tie-down shafts are the two back ones, and the pattern shafts the two front ones, thus making the shaft-switching manipulations conveniently close to the weaver. To avoid having to transpose all the lifts, number the shafts from back to front while threading and tying pedals.

This applies to almost all shaft-switching methods; but the old form of the threading has been maintained here both to avoid confusion and because the two nearest shafts are traditionally used for the tie-down ends.

(e) Recording threadings

Some convention is needed for recording a threading involving shaft-switching. It is here suggested that the two shafts between which the switching is to take place are written one above the other in the same vertical column. The threading now becomes that shown in *Fig. 86(a)*. This can be emphasized by arrows, as in *(b)*, or a circle as in *(c)*. Perhaps the best way is an oblique line, as in *(d)*, as it shows the actual path taken by the warp end between the empty heddles on shafts 3 and 4. This can be written in text as (2,4/3,1).

2. One Loop and One Constrictor Knot.

A natural development from the above method is to make the two loops from one continuous cord. This is a little more difficult to install, but it means that only one constrictor knot is needed; A in *Fig. 87*.

Start with a length four times the height of a heddle.

If the two ends of the loop are to be linked, as in the diagram, begin with the cord at X and follow the course indicated by arrows, ending at Y, where the two ends are tied together.

If the two ends are not to be linked, the loop can be more simply made in another way; see *Fig. 88*. Tie the cord in a loop around the tops of shafts 3 and 4; see *(a)*. Pull the bottom of the loop upwards; see *(b)*. Pull down the two loops thus made and thread them through the empty heddles, securing them immediately by passing the warp end through both; see *(c)*.

Note

— In both methods, note the position of the knot joining the two ends of the cord. It must be below the level of the top of the shafts so it will not impede the movement of the single constrictor knot.

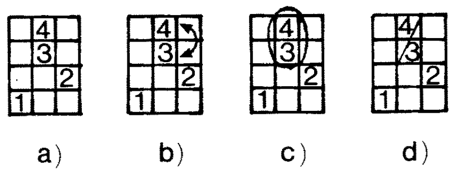
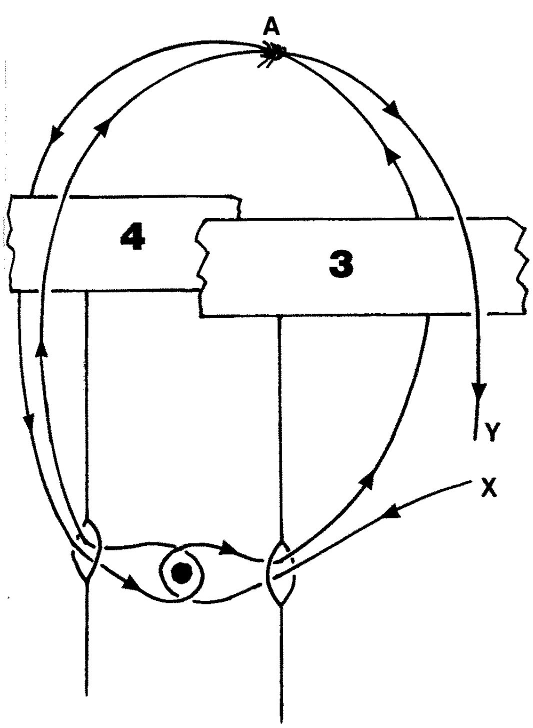


Fig.86

Fig.87



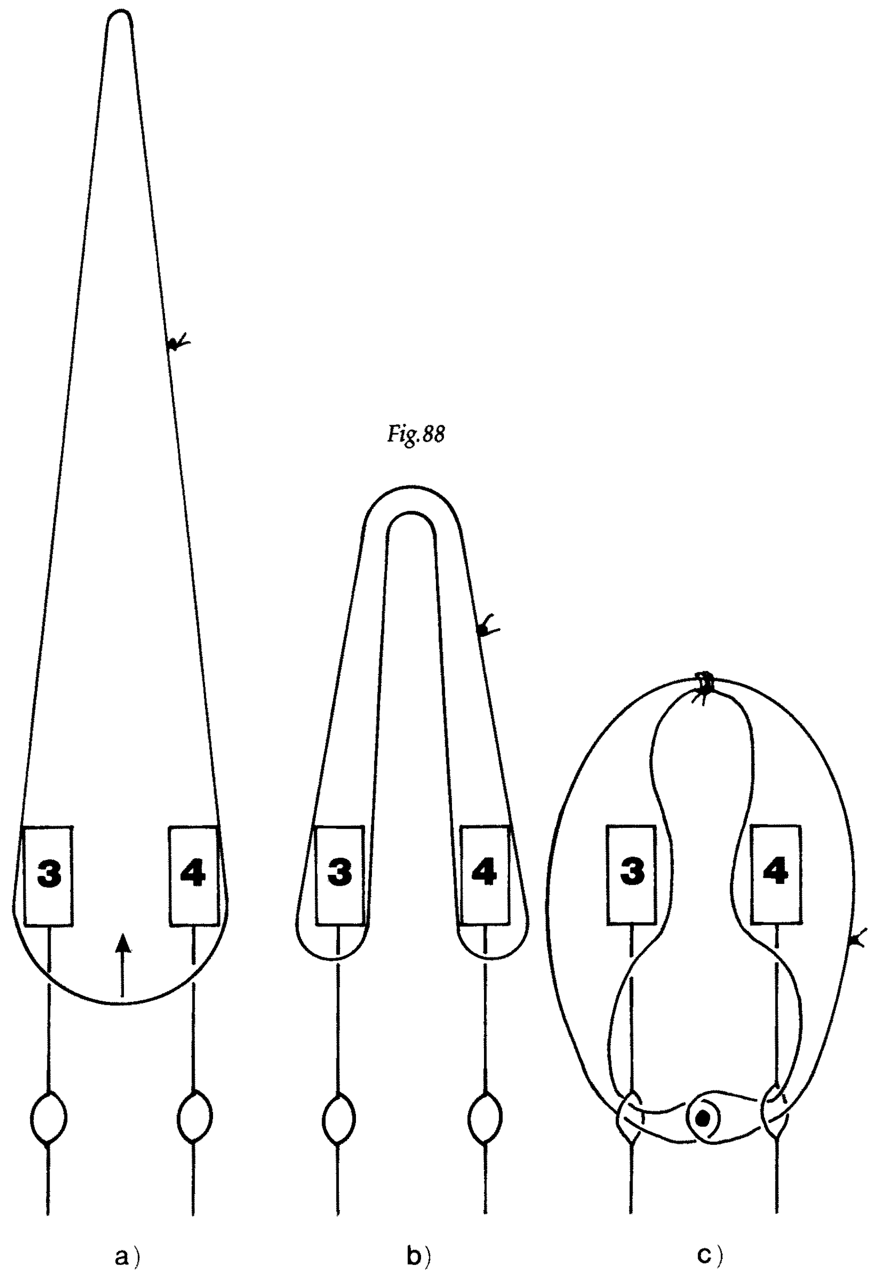


Fig.88

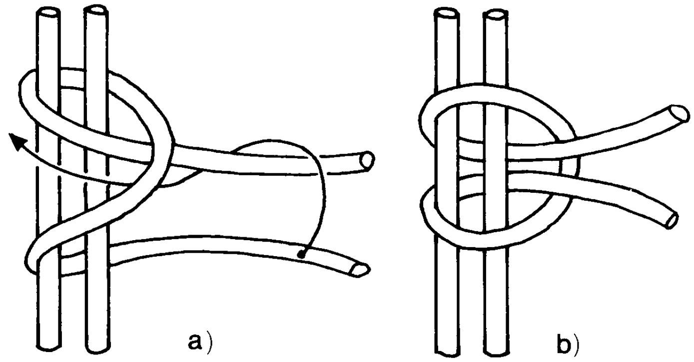


Fig. 89

The constrictor knot has to be tied differently as there is no free end to slip it over, as in method 1. *Fig. 89(a)* shows how it is tied around the two elements of the loop above the shafts; see A in *Fig. 88(c)*. *Fig. 89(b)* is an alternative knot, a lark's head, which should then be secured with a square (reef) knot.

The single constrictor knot is either slid down against the top of shaft 3 to make the warp end weave with 3, or against the top of shaft 4 to make it weave with 4. So it is a foolproof method, making it impossible to tighten on both shafts at the same time, as can happen with method 1.

3. Two Loops and Two Boards with Pins

The two-loop method can be refined by replacing the constrictor knots by boards with pins on to which the loops can be hooked to tighten them; see *Figs. 90* and *91*.

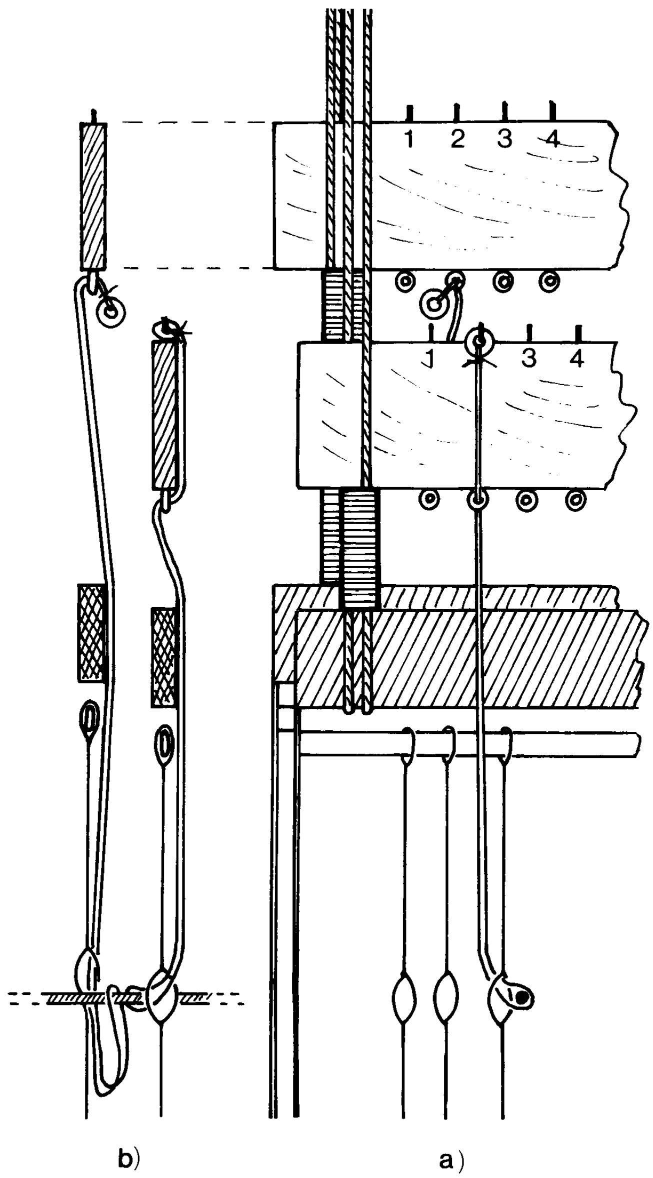


Fig. 90

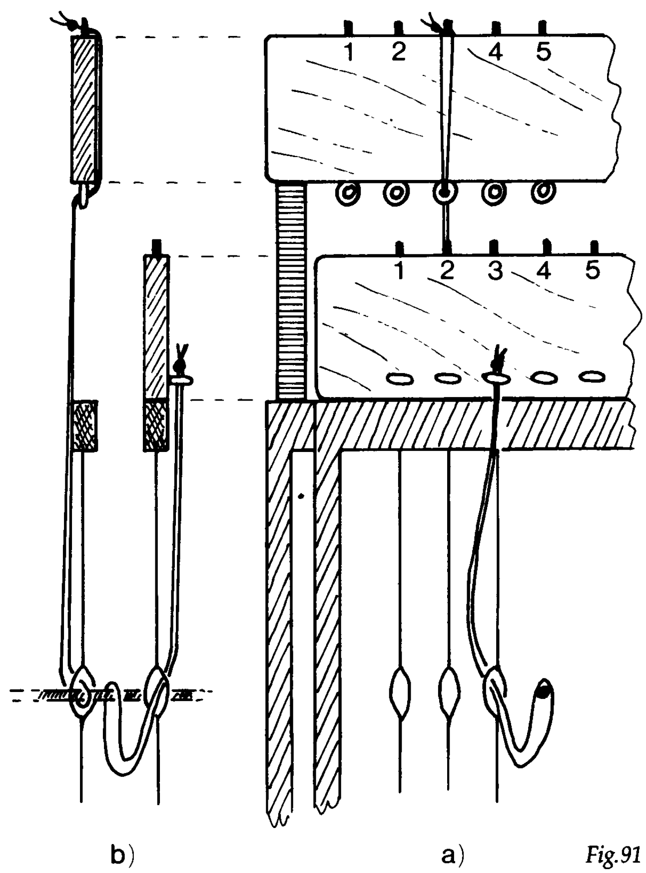


Fig. 91

Above each of the shafts concerned, fit a thin board about 4 inches (10 cm) wide and as long as the shafts. For convenience the one further from the weaver should be at least 4 inches (10 cm) higher than the nearer one. With a countermarch or counterbalanced loom this is easy, as the boards can be attached to the cords suspending the shafts using cardboard tubes of appropriate length as distance pieces; see horizontal hatching in *Fig. 90(a)*. On a jack loom, the front board can be fixed directly to the top of the shaft; the rear board needs some intervening piece, see horizontal hatching in *Fig. 91(a)*.

Along the top edge of each board fix small pins or nails (one every ¾ inch (19 mm) if a warp setting of 4 epi is being used), and along the underside small screw-eyes, similarly spaced. The front board on a jack loom has no available underside, so fix the screw-eyes near its lower edge; see *Fig. 91(a)*.

Tie a loop. Pass it down through a screw-eye and then through an empty eye of a heddle. Pass a warp end through to secure it. The upper knotted end of the loop can, for easy handling, have a small ring, paperclip or washer on it. Place this over the nail directly above the screw-eye to tighten the loop. To loosen, just take it off; the ring will prevent it falling further than the screw-eye. If linked loops are wanted, they can be made in pairs then threaded upwards from warp level.

This mode of action implies that the loops must be very accurately made in two sizes, measured from heddle eye to top of appropriate board. Unlike the constrictor knot method, there is no easy adjustment once the loops are tied. The absence of these knots and their need to grip the loop means the latter can be made from smooth, strong, synthetic material, like braided nylon fishing line.

For convenience, number the nails on both boards. This will help to avoid mistakes; if the loop is on nail 5 on the front board, then the corresponding loop *must* be off nail 5 on the back board. Numbers are also useful when weaving from a design worked on a squared grid, as each pair of nails controls the design in one threading unit (= one square).

4. One Length of Texsolv and Nails

Texsolv with its smoothness, strength and regular holes seems made for shaft-switching; its great advantage being that *one* length of Texsolv replaces the *two* loops previously needed. It could for instance be used to simplify the last method. Even simpler is the following method:

Measure lengths of Texsolv about twice the height of a heddle.

Mark the central hole. Pass each length through the empty heddle eyes on the two relevant shafts and bring the ends up above the shafts and tie them together, as in *Fig. 92(a)*.

Insert small screw eyes every ¾ inch (19 mm) along the top of both shafts, assuming these are made of wood. Thread the warp end through the marked central hole.

To make this end weave on shaft A, pull the Texsolv up in front of A as far as possible, then fix it by pushing its nearest hole over the screw-eye; see *Fig. 92(b)*. Mark this hole for future use. To switch shafts, take the Texsolv off this screw-eye, pull up the part behind shaft B and fix it over the screw-eye on B, again marking the hole used. A screw-eye is suggested, rather than a nail, because the Texsolv needs to fit firmly.

This is all that is needed; but the system could be refined with screw-eyes on the front of A and back of B through which the Texsolv passes, by numbering the screw-eyes and so on.

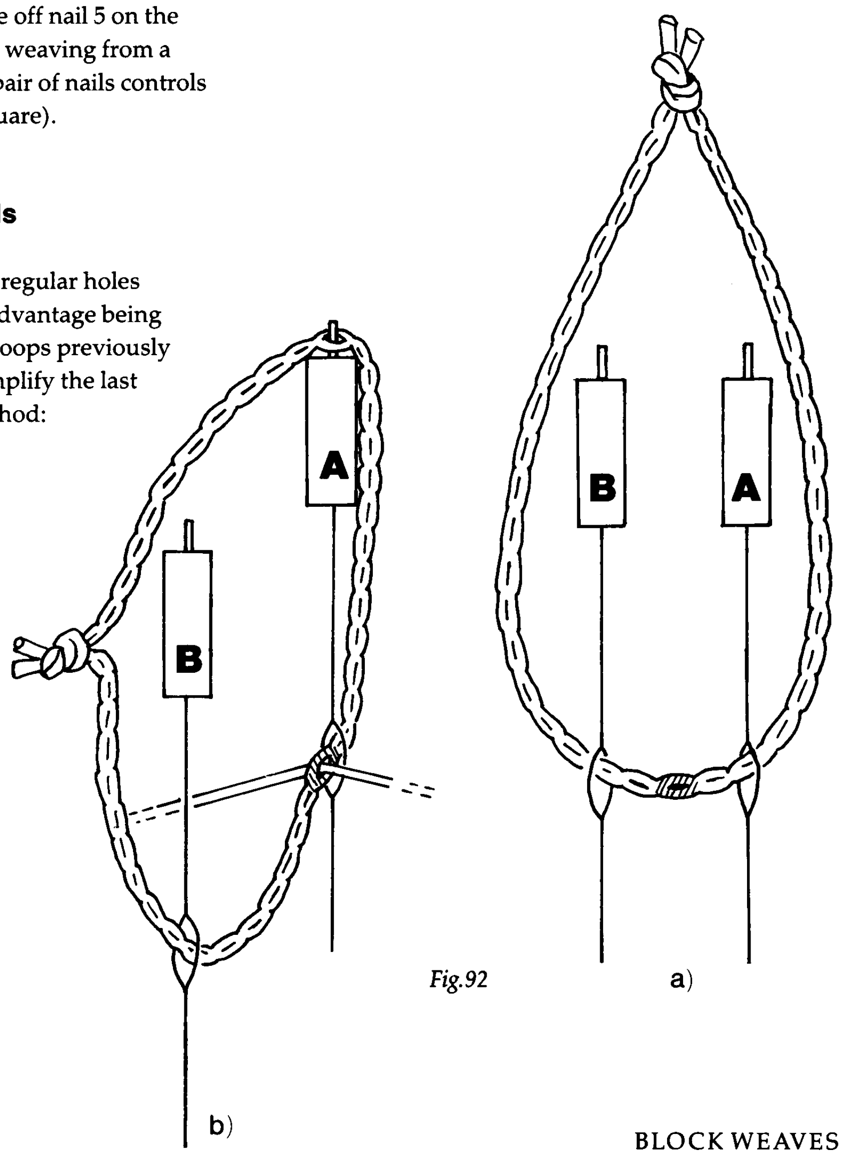
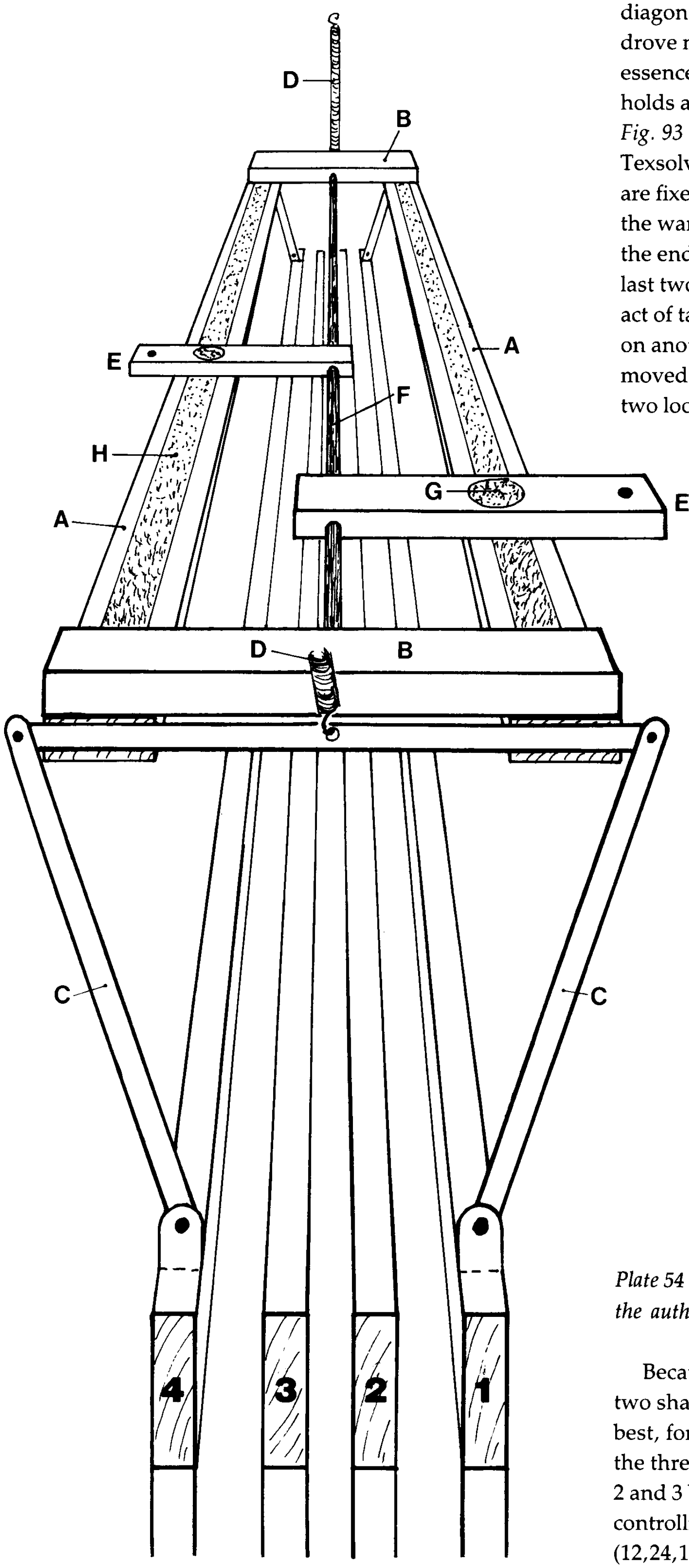


Fig.92 a) b)

Fig. 93



5. Lever System

I used method 3 for several years until the desire to weave diagonal stripes, which involves frequent shaft-switching, drove me to work out a quicker system. It can be described in essence as follows. A platform, supported above the shafts, holds a set of levers, one for each shaft-switching unit; see *Fig. 93* and Plate 54 (left). The two ends of each length of Texsolv (threaded through the heddles as in the last method) are fixed to each lever. So when the lever is in one position, the warp end weaves with one shaft, flip the lever over and the end weaves with the other shaft. Comparing it with the last two methods, this one movement of a lever replaces the act of taking the Texsolv (or loop) off one nail and placing it on another. It is far quicker, especially as many levers can be moved at once. Also it makes impossible the mistake when two loops controlling one warp end are both tightened.

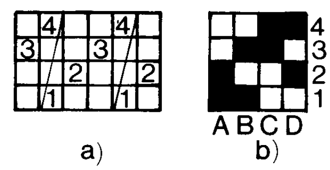


Fig. 94

Plate 54 (left): shaft-switching platform on the rug loom designed by the author and Harrisville Designs (Harrisville, NH, 03450, USA).

Because the platform has to be flexibly attached to the two shafts between which switching is to take place, it is best, for the sake of stability, that these shafts be 1 and 4. So the threading is transposed to (2,4/1,3); see *Fig. 94(a)*. Shafts 2 and 3 become the tie-down shafts, 1 and 4 the pattern-controlling ones. Similarly, the lifts have to be altered to (12,24,13,34).

The basic structure of the rectangular platform is two lengths of wood, A (slightly shorter than the shafts), joined at their ends by two short cross pieces, B; see perspective view *Fig. 93* and cross-sectional views *Figs. 95* and *96*. The platform is held in position by pivotted metal struts, C, running from the corners of the platform down to the ends of shafts 1 and 4; the pivots allow it to tilt as different shafts are operated. Two springs, D, stretching from the cross pieces at each end to the loom super-structure, help keep the platform in place.

The wooden levers, E, each about ¾ inch (19 mm) wide, are all threaded side by side on one long central rod, F, whose ends are fixed into the cross pieces. At intervals this rod is supported by small metal brackets (not shown) which also give stability to the long pieces of the platform. Each lever has a hole about 3¼ inches (8.25 cm) from the rod, for the two ends of the Texsolv to pass through and be knotted; see *Fig. 95*. These knots provide a way of fine adjusting the Texsolv length. Each lever has a patch of Velcro, G, on either side, placed so that it engages with the long strips of Velcro, H, running the full length of the top of the platform. This simple way of holding the levers in either position replaces the complicated metal springs in my first lever system.

Narrow rods, J, attached to the front and back edge of the platform reduce friction on the Texsolv as it runs down to the heddles, first passing through screw-eyes, K, on the front of shaft 1 or the back of shaft 4; see *Fig. 95*.

The rods, L, going right across the loom keep the shafts from bunching together and rubbing each other, due to the tension in the Texsolv lengths.

Fig.95

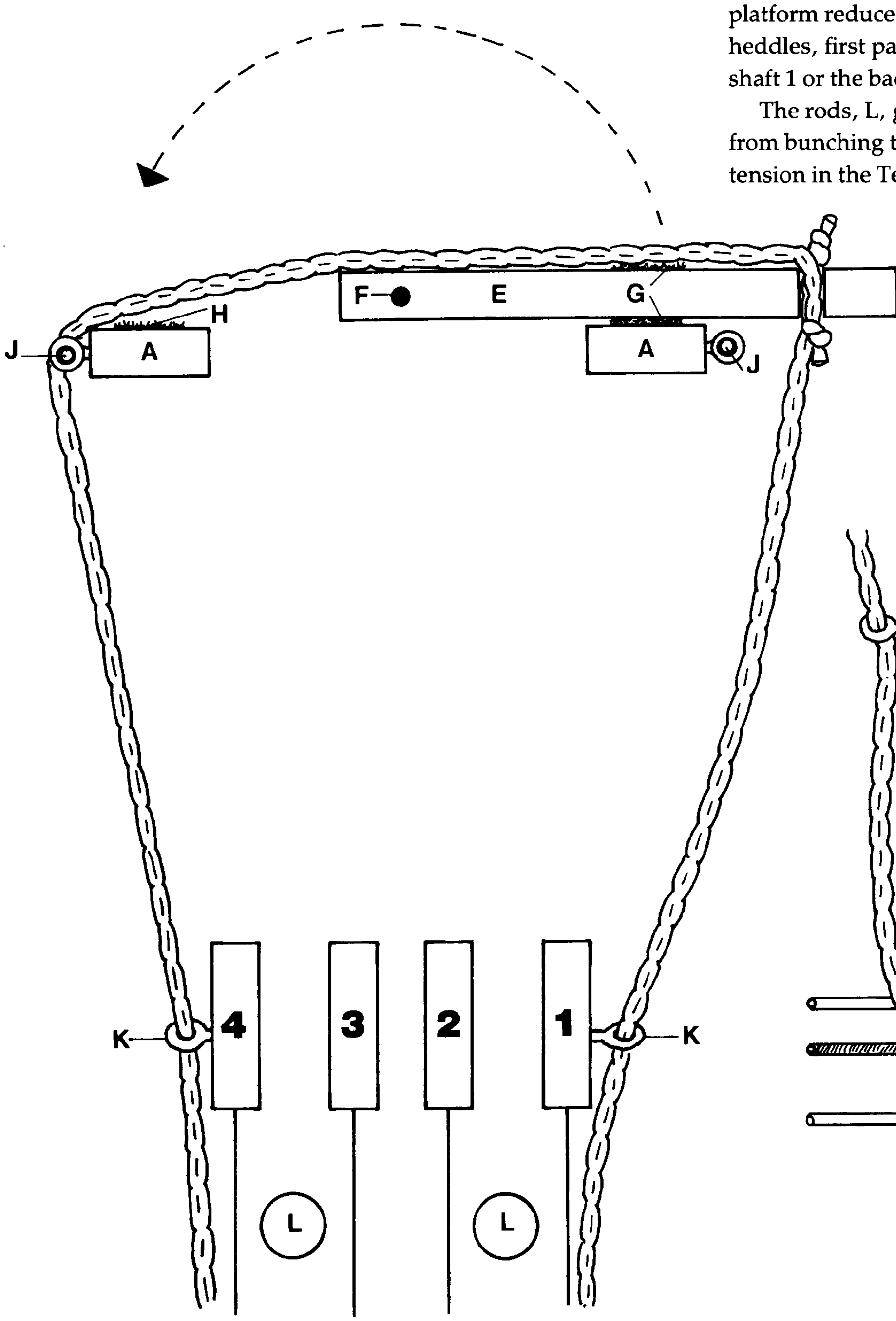


Fig.96

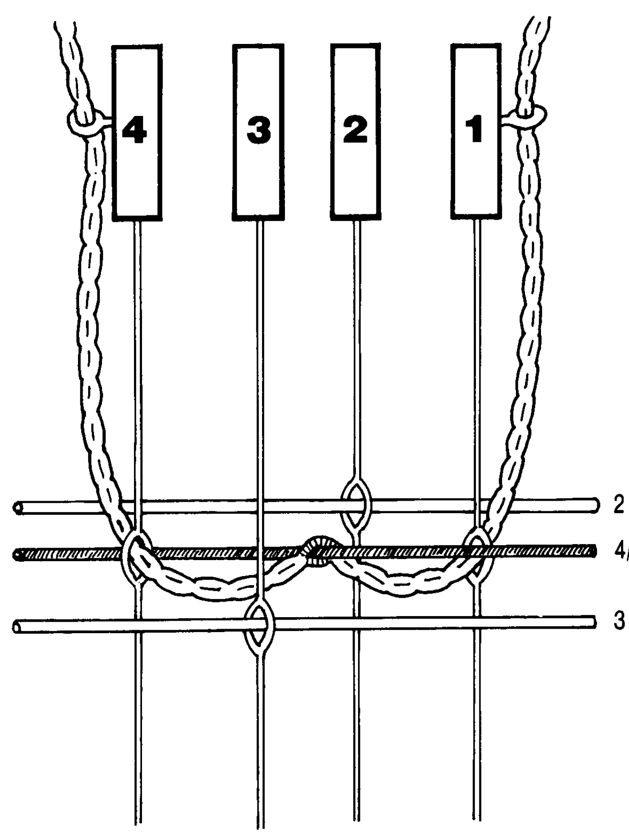
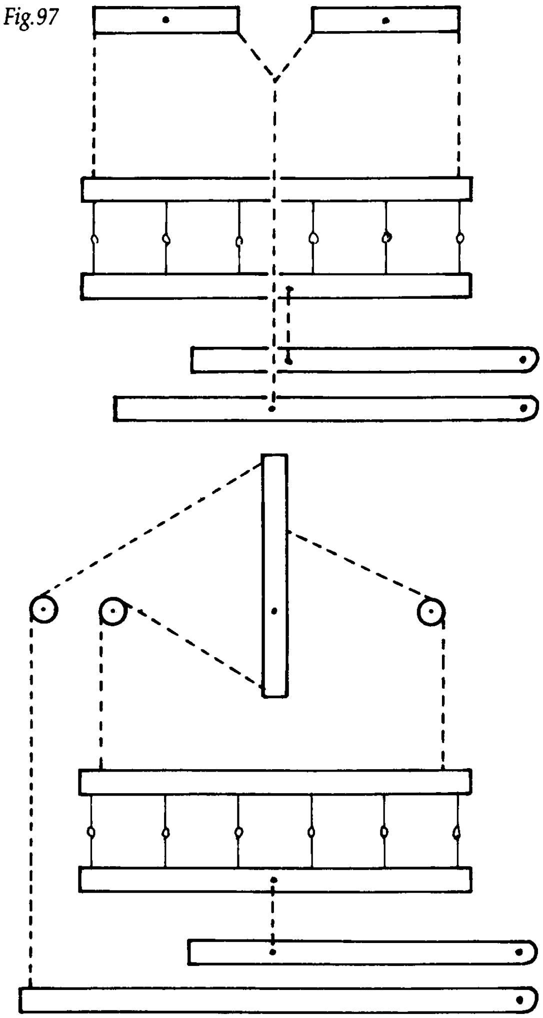


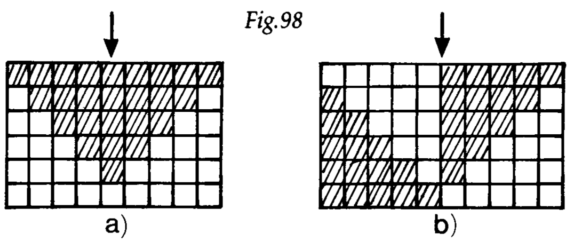
Fig. 97



a)

b)

Fig. 98



The ends of the levers can be numbered either outwards from the centre or straight across, making it easy to follow a similarly numbered paper design.

The system as described is intended for a countermarch loom. The cords lifting the shafts must be attached just outside the struts supporting the platform. Such a loom with two sets of horizontal jacks has cords passing centrally down between the shafts; see *Fig. 97(a)*. A lever must be omitted at the centre of the platform to allow these cords to pass through. Alternatively, the action can be altered to the type with one set of vertical jacks which has no such central cords; see *Fig. 97(b)*.

An adaptation of the lever system for a jack loom has been developed and described (see article by Sadye Wilson in *Shuttle, Spindle and Dyepot*, Winter 1978).

Practical Details

(a) Threading

When threading a warp, keep the levers upright so that the marked hole in the Texsolv is halfway between shafts 1 and 4 and easy to locate. The threading unit of three ends is repeated all across the warp, each unit being exactly as shown in *Fig. 96*, where the switchable end is shaded. If the relevant lever were positioned towards the weaver, as in *Fig. 95*, the left side of the Texsolv would be tightened and the warp end would weave as if on shaft 4. If the lever were then flipped away from the weaver (dotted arrow), the right side of the Texsolv would tighten and the end would weave as if on shaft 1.

(b) Tie-up

Fig. 94(b) gives the tie-up. The pedals are used in the sequence A,C,D,B for weaving the heading, and in the sequence A,D,B,C (using alternate feet) for the rug proper. No other lifts are needed. If for instance a solid colour all across the rug is wanted, the levers are flipped so they all face in one direction and the above sequence used; there is no need to use four special lifts as was done in *Fig. 52(b)* on p. 69.

Once this device is installed, a long warp can be beamed and, without any change of threading or tie-up, a succession of completely different rugs can be woven, their design depending entirely on how the levers are manipulated.

Designing with shaft-switching

Designing with shaft-switching can be daunting because so few limitations are placed on the designer. If the rug is to be 36 inches (91 cm) wide, then it will use 36 ÷ ¾ = 48 (91 ÷ 1.9 = 48) threading units, because the threading units are ¾ inch (19 mm) wide. This could be increased to 50 or 51 to allow for the draw-in. So the design can be represented on squared paper by an area fifty squares wide by, say, eighty to a hundred squares long, depending on the proportion wanted. Any design made by filling in squares in this area can be woven.

It is a good idea to start with some very rough thumbnail sketches and then, when one of these has been selected, to transfer it to squared paper. One basic decision is whether the design will need an odd or even number of units. A design with a central diamond will need an odd number; see *Fig. 98(a)*; but if the diamond is two-coloured, as in *Fig. 98(b)*, it will need an even number. In the first case, the design is centred on a unit (arrowed), in the second case on the junction between two units (also arrowed).

Once the design is on squared paper, find out how many picks of weft, *when beaten*, build up into ¾ inch (19 mm). This is vital information. The woven squares are by nature ¾ wide (19 mm), so if the design is to be reproduced exactly, the squares when woven must also be ¾ inch (19 mm) high, i.e. measured in the warp direction. If this is not done, the design will appear either compressed or expanded. Depending on the yarn and strength of beating, this ¾ inch (19 mm) woven length may need between sixteen and twenty-two picks. Remember that the shafts can be switched after a full repeat of the four lifts (= four picks), or after a half repeat (= two picks). Sometimes for complete accuracy one square is woven with sixteen picks (= four repeats of the lifts) and the next is woven with eighteen picks (= four and a half repeats), and this alternation maintained. Sometimes four repeats for one square is almost correct; but occasional checking against the total length shows a slight adjustment is necessary, so the next square is woven with three and a half or four and a half repeats.

The total length is marked up the side of the design, every four squares conveniently measuring 3 inches (7.5 cm), every sixteen a foot (30 cm). See *Fig. 99(a)*. The design can be numbered along its lower edge to tally with the numbering of the levers.

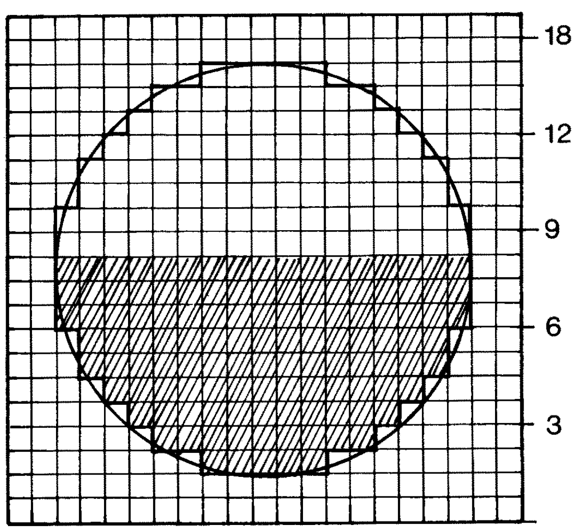
To weave a circle, draw one with compasses on squared paper, making sure its circumference coincides with horizontal and vertical lines where possible; see *Fig. 99(a)*. Then fill in squares as near as possible to the drawn line, as shown in lower half of the diagram. Make it absolutely symmetrical; if the circle starts five squares wide, as in the diagram, then the sides must be five squares high. A snag is encountered here because a weft-face rug contracts more in its width than its length. So the threading unit (i.e. the square) will in reality be a fraction less than ¾ inch (19 mm) wide in the finished rug, and a circle woven as described can begin to look oval. Counteract this by putting in the 6-inch (15-cm) markers at about 5¾-inch (14.6-cm) intervals, or by 'losing', say, ¾ inch when weaving the vertical sides of the circle.

All the above designs were squared off, but though every unit has to be ¾ inch (19 mm) wide, there is no need for it to be woven ¾ inch (19 mm) high. For example, to weave a design based on the smooth diagonal stripes described for the pick-up technique, the shafts *have* to be switched after every four picks. The design can be notated on squared paper, as in *Fig. 99(b)*, but here a square = four picks, not sixteen or so as previously. So it is only a working drawing and bears little resemblance to the woven result.

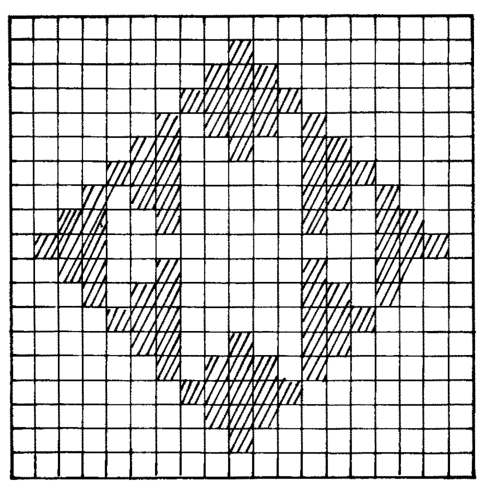
Very complex-seeming designs can be woven using areas of narrow warp- and weftway stripes, instead of areas of solid colour. These all depend on abandoning the normal colour sequence and using, for instance, (A,B,A,A) × 2, (B,B,B,A) × 2. With careful shaft-switching, the vertical and horizontal lines can be made to meet diagonally; see Plate 55 (pp. 118–19). Naturally, all the variations shown in *Figs. 55* and *62* can be coupled with shaft-switching.

Note

— There is no way of distinguishing between a two-coloured three-end block weave rug woven using the pick-up method and one woven using the shaft-switching method. The structure is identical in the two cases, only the method of achieving it differs. The woven illustrations for these two techniques are, therefore, more or less



a)



b)

Fig.99

interchangeable. It is when the speed of production is taken into account that the two methods are found to be so different, shaft-switching being incomparably the quicker of the two.

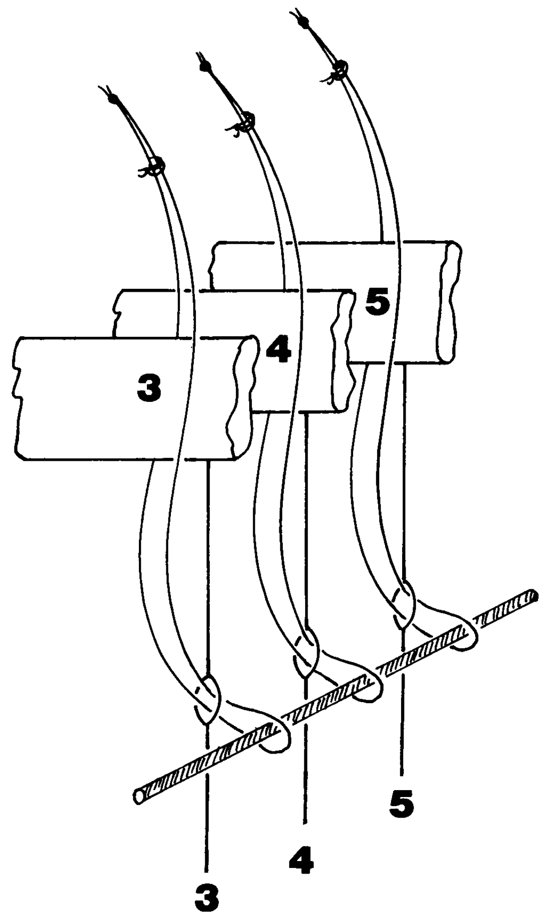


Fig.101

Three-colour version

By using one more shaft, a three-colour block weave controlled by shaft-switching can be woven. *Fig. 100(a)* shows the weave in its threaded form giving three blocks each with one colour on the surface but two at the back. The structure is identical to that obtained with three-colour pick-up.

The shaft-switching version preserves the tie-down ends on shafts 1 and 2, but the pattern ends are arranged so they can be switched between shafts 3, 4 and 5; this gives the threading diagram in *Fig. 100(b)*. Such switching is not possible with the lever system, so one of the simpler methods must be used, such as loops and knots. There has to be a loop passing through an empty heddle on shafts 3, 4 and 5, and the pattern end goes through all three loops; see *Fig. 101*. The constrictor knots must be adjusted so each end weaves with only one of these three shafts at any point in the design. The shafts are lifted as in *Fig. 100* and three wefts, A, B, and C, passed in succession. When shafts 135 are lifted, weft A will appear wherever the ends are weaving with shaft 4, i.e. the pattern shaft *not* lifted. This relationship exists between the other lifts and where the wefts will appear.

If three fairly close colours are chosen, this is a satisfactory weave, but it is not reversible; two colours always lie together in one shed on the back of the rug.

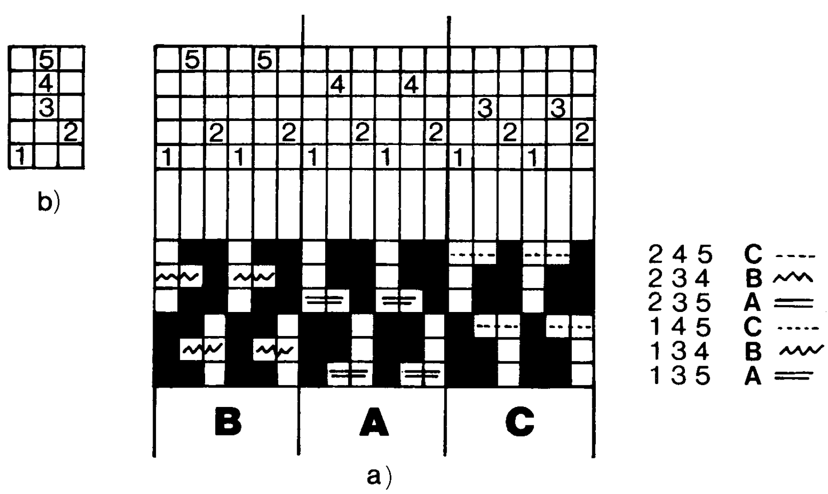


Fig.100

Plate 55 (see p. 116)

Applying Shaft-switching to Other Four-shaft Block Weaves

(a) Four-end Block Weave

This block weave, with its threading units of (1,3,2,3) and (1,4,2,4), is often chosen by weavers because it gives areas of solid colour without the colour at the back showing through on the front. By lifting (13,14,23,24) and throwing two colours alternately, blocks are produced in which the weft weaves over 3, under 1 end on both the front and back of the rug; see *Fig. 102(a)*. This long float is often reduced by weaving at a relatively high warp setting. With rag wefts and a high warp setting, the warp is not covered, but the blocks still appear as the back weft slides so well behind the front weft in each pair of picks.

Shaft-switching can be applied to this block weave in two ways.

1. Switching the two pattern ends in a unit together. If both the ends on shaft 3 were switched to 4, as shown by arrows in *Fig. 102(a)*, the weave plan becomes the one in *Fig. 102(b)*. The colour A block will move four threads over to the right, as shown; at 6 epi this means a shift of ⅔ inch (1.7 cm). These two ends can be economically switched if their controlling loops are treated *in pairs*. So depending on the method being used, they could share the same constrictor knot, be placed over the same nail on a board or be connected to the same lever. As details differ in each case, *Fig. 103(a)* gives a general diagram; it shows how two loops going through shaft 3 heddles are joined together and are moved as a unit, and how the same happens to the two loops going through shaft 4 heddles. This threading can be written as in *Fig. 103(b)*; or, if using the lever system, in its transposed form as in *Fig. 103(c)*.
2. Switching pattern ends individually. *Fig. 102(c)* shows what happens when only the left hand of the arrowed ends on shaft 3 is switched to 4. The A block moves only two ends (= ⅓ inch [8.5 mm] at 6 epi) to the right, giving much finer adjustment in a design. But of course every pattern end has to be controlled separately, which means twice as many constrictor knots, or levers or nails on a board. The sample in Plate 56 (right) was woven in this way.

However, once these are installed, the possibilities are greatly increased, because not only can the four-end block weave be woven with much finer detail, but the threading also gives everything obtainable from the Double Two-Tie Unit draft.

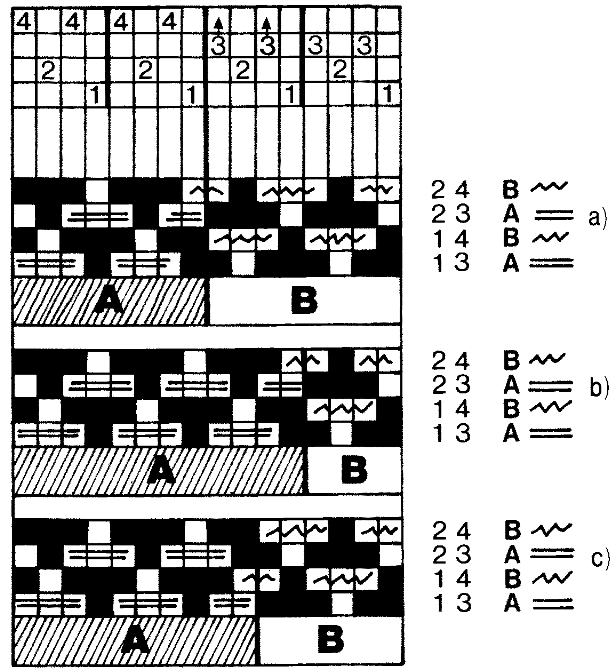


Fig.102

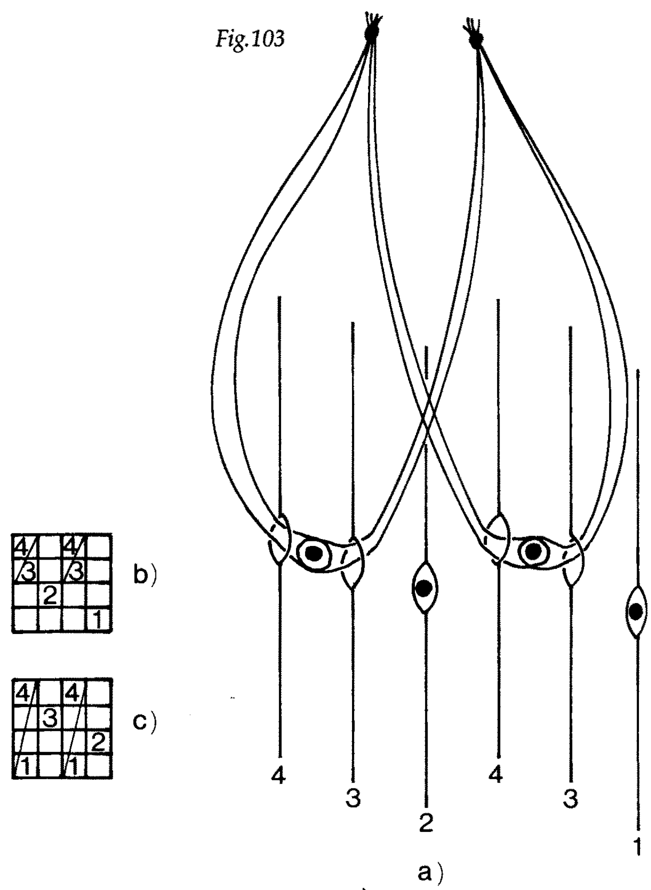


Fig.103

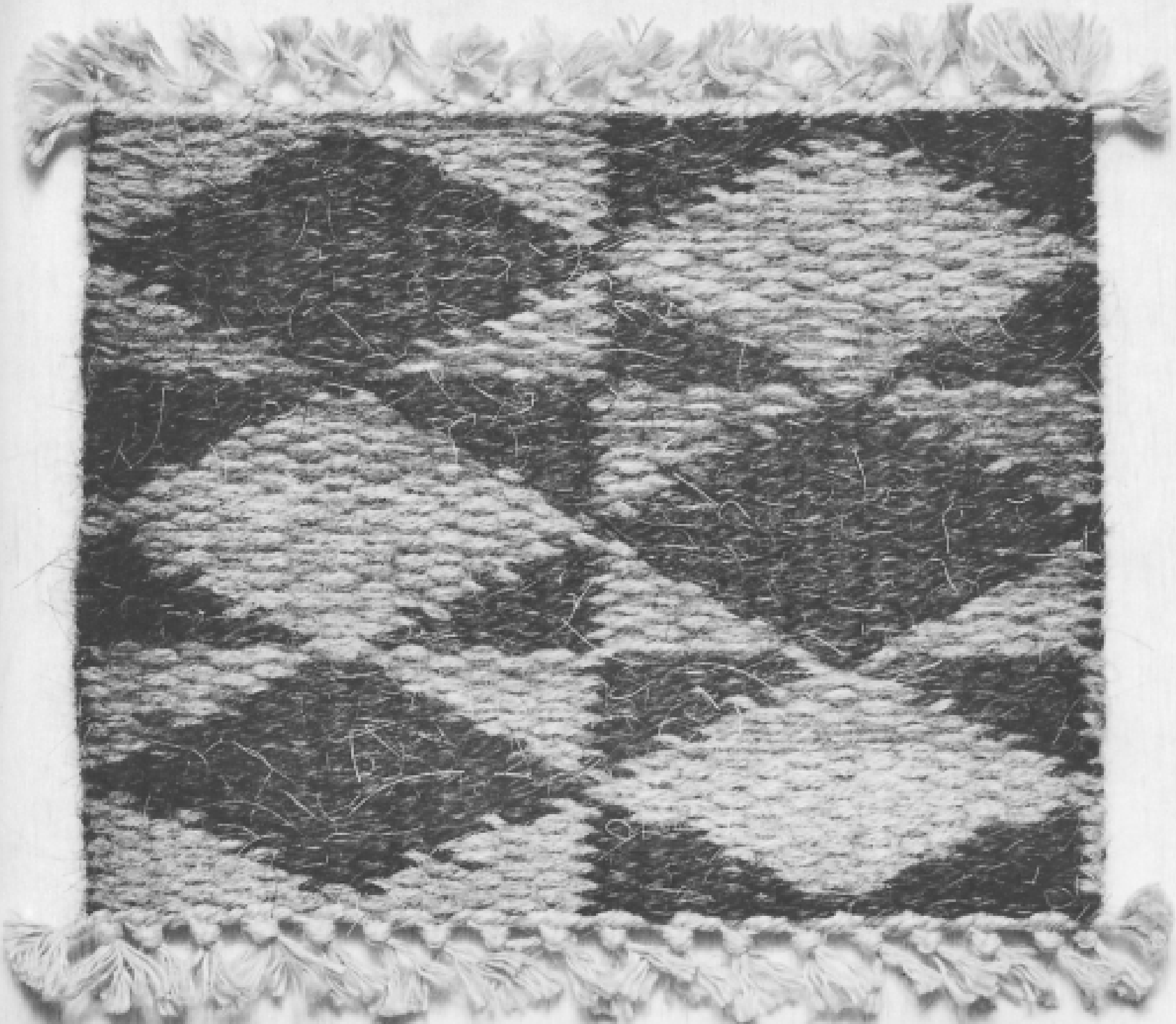


Plate 56 (see left)

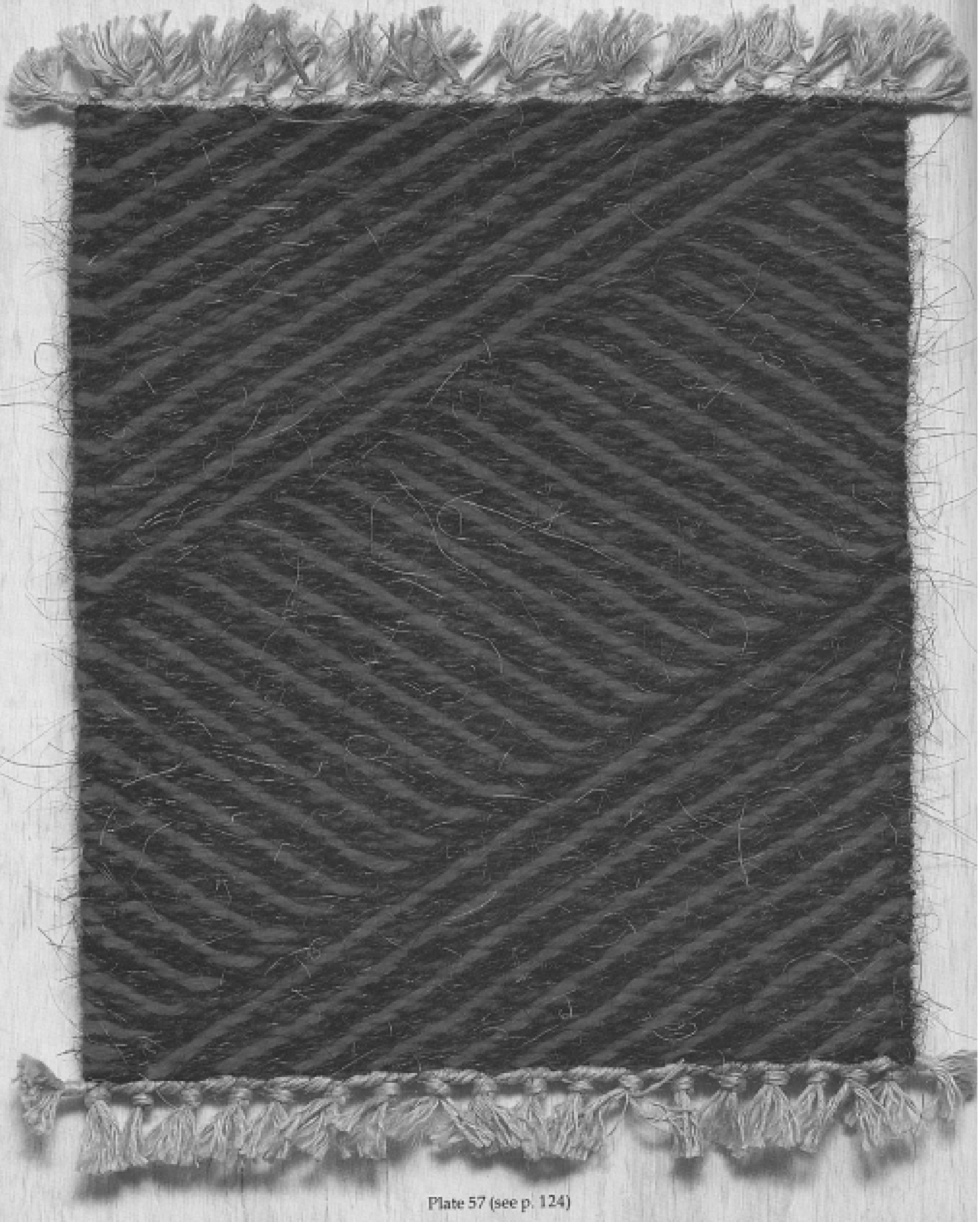


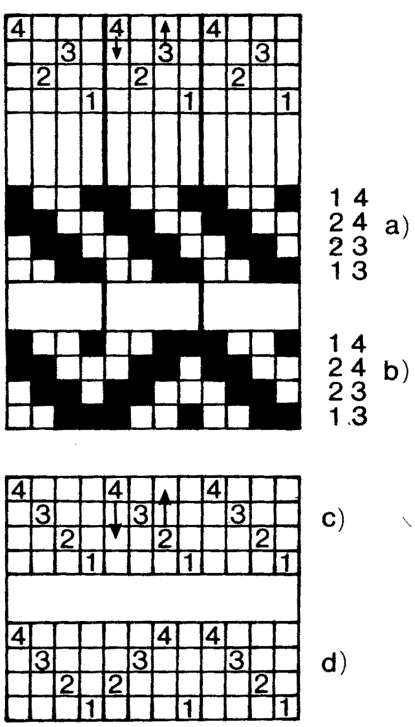
Plate 57 (see p. 124)

Plate 58 (see p. 124)

For example, consider this threading if the pattern ends are alternately on shafts 3 and 4, as in *Fig. 104(a)*. Lifting this as shown (the lifts used in the block weave in a different order), gives a 2/2 twill moving up to the left. If now the two central pattern ends are switched (arrows), the twill alters direction below the switched ends; see *Fig. 104(b)*.

This is easier to understand if the twill results from a straight draft, as in *Fig. 104(c)*, for switching the two similarly placed ends produces an obvious reverse in the threading direction, as in *Fig. 104(d)*. This reversal of twill direction by means of shaft-switching means that designs based on the colour sequences suitable for 2/2 twill, such as (A,A,B), can be worked. The result will be controllable areas of oblique stripes in the two directions; see Plate 57 (p. 122) in which the shafts have been switched in sequence to the right after every six picks. Designs become very bold if the twill is woven on opposites with alternating wefts, so that the sequence is (12,34;23,14;34,12;14,23). Plate 58 (p. 123) shows one possibility, in which a single end is switched at each boundary of the diamonds after every four picks. The diamond is outlined in red or white depending on whether the switching starts at the beginning of the lifting sequence or halfway through it. Plate 59 (p. 126) shows that a spiral can be woven by staggering the twill reversal points in the two halves of the diamond. Because of its short floats and frequent use of opposite lifts, this weave works well with a warp of 4 epi and a weft of carpet wool used three-fold.

Fig.104



Taking this a step further, a whole new field opens up if the warp is woven partly as a block weave, i.e. with the shafts switched to give areas of either (1,3,2,3) or (1,4,2,4), and partly as a twill, i.e. with the shafts switched to give (1,3,2,4). It has been noted that the lifts for a twill are those normal for a block weave in a slightly different but usable order, so combining the two structures is feasible. If, therefore, the shafts are lifted as for a twill (straight, broken or on opposites) and an appropriate weft colour sequence used, a small-scale twill pattern will appear in the twill-threaded areas of the warp and some other quite different pattern will appear in the block-threaded areas.

Plate 60 (p. 127) shows this plainly. The weft sequence (A,A,A,B,A,A,B,B,A,B,B,B) was used, the shafts being lifted to give a straight twill (13,23,34,14); this gives the familiar small triangle design. By shaft-switching, this twill area was moved diagonally. The block weave areas show either A spotted with B, if threaded (1,3,2,3), or B spotted with A, if threaded (1,4,2,4).

There is a small technical problem in that the weft in the block weave areas, which passes over three ends, under one, packs down more closely than that in the twill areas, which passes over two, under two. To preserve a straight fell, the design must take this into consideration. One obvious solution is to counter-change areas of twill and block weave. Another is the one shown in Plate 60 (p. 127), where the twill area moves regularly across the rug, so whatever irregularities may occur on the way, the fell is straight when the design is completed. This was woven at 5 working epi and with a weft of 2-ply carpet wool, used three-fold.

(b) Six-end Block Draft

This draft has the advantage that it can be quickly derived from the much-used three-end draft. By rethreading, in reverse order, alternate pairs of ends on shafts 1 and 2, the three-end draft in *Fig. 105(a)* becomes the six-end draft, in *Fig. 105(b)*. The latter gives several block weaves all containing 3-span floats.

1. Using the familiar block weave lifts (13,14,23,24) and an (A,B,A,B) colour sequence.
2. Using 2/2 twill lifts (12,23,34,14) and three wefts in an (A,B,A,C) sequence. Wefts B and C are normal thickness and form floats on back and front. Weft A should be thinner; it shows slightly all across on back and front. It can be the same colour as B or C, or a colour that works with both. When switching shafts, remember the threading unit is six ends and so has two 3s or 4s in it. Therefore two adjacent levers (or four or six) must be moved together.
3. With the pattern ends attached alternately on shafts 3 and 4 for one block, and on shafts 4 and 3 for the other block, as in *Fig. 105(c)*. When woven with the lifts

(13,23,24,14) and an (A,B,A,B) colour sequence, this gives a block weave in which the colours do not reverse on the back. Each weft weaves over three, under three in one block, and plain in the next block.

4. Repeating the first and third pick of the last weave several times, then the second and fourth several times, gives a structure like the M's and O's weave, which is not very suitable for weft-face rugs.

The most interesting use of this draft is not a block weave at all; it relies on the fact that if the pattern ends are attached alternately to shafts 3 and 4 all across the warp, the threading becomes a pointed four-shaft draft. Plain weave is then possible by lifting 13 and 24; see *Fig. 105(d)*. Now if at any moment a single end is switched from 4 to 3, or vice versa, a 3-span float will appear on the back and front of the rug. In *Fig. 105(e)*, the arrowed end, previously on shaft 4, has been switched to 3 and the weave plan below shows the floats this produces. Such floats naturally weaken the structure, so can be permitted for only a few picks, say, four or six. The relevant end is then switched back to its original shaft and perhaps the next available pattern end to right or left switched; this time it would be from shaft 3 to 4. Continuing like this in a regular way, an oblique ridge of floats can be built up. Plate 61 (pp. 130-1) shows a design based on these ridges; they are most visible if, as in this example, a light-coloured weft is used. If two colours of weft are employed, then floats of either colour can be placed on a ground of stripes; see Plate 62 (pp. 130–1).

This controlled production of floats, rather than areas of colour, is an unexpected bonus from the shaft-switching system. The warp should have 4 working epi, and the weft should be 2-ply carpet wool used two-or three-fold.

(c) Draft Based on a Straight Three-shaft Draft

This block weave (which I derived from the one called 'Crackle' by Mary Atwater) has great possibilities, as it not only gives blocks of two solid colours, but a third block of warpway stripes of these two colours as well. Moreover, these three blocks can be positioned in many different ways relative to the four threading units. It lends itself well to shaft-switching, which can be carried out between any two adjacent blocks, and was in fact the first block weave to which I applied the system.

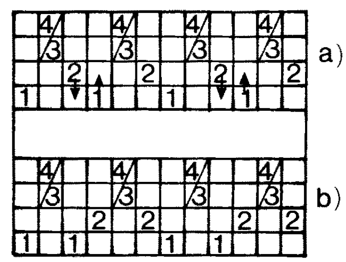


Fig.105

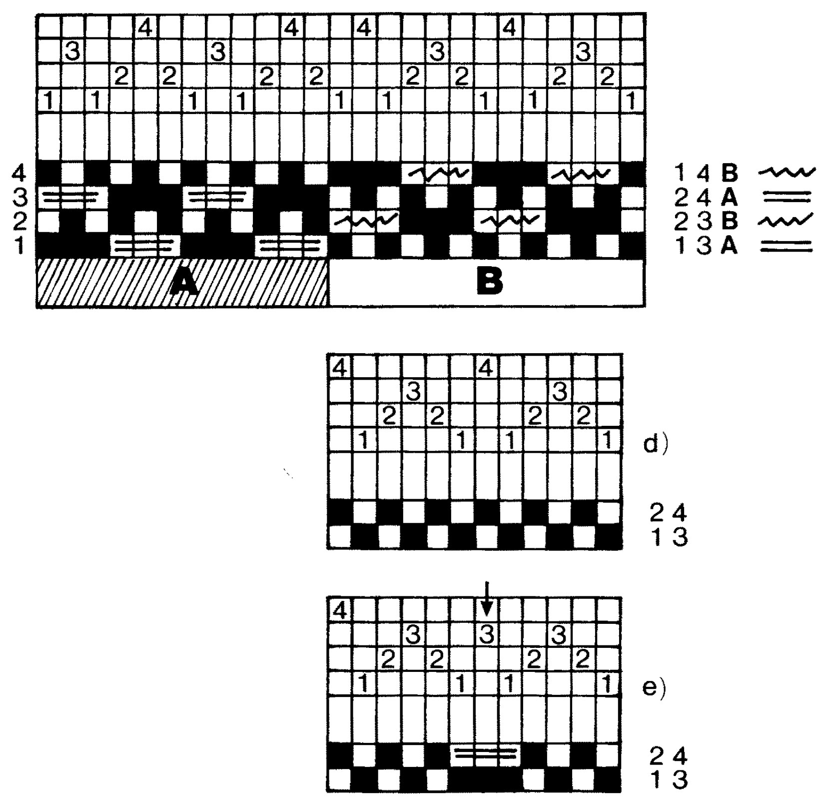


Plate 59 (see p. 124)

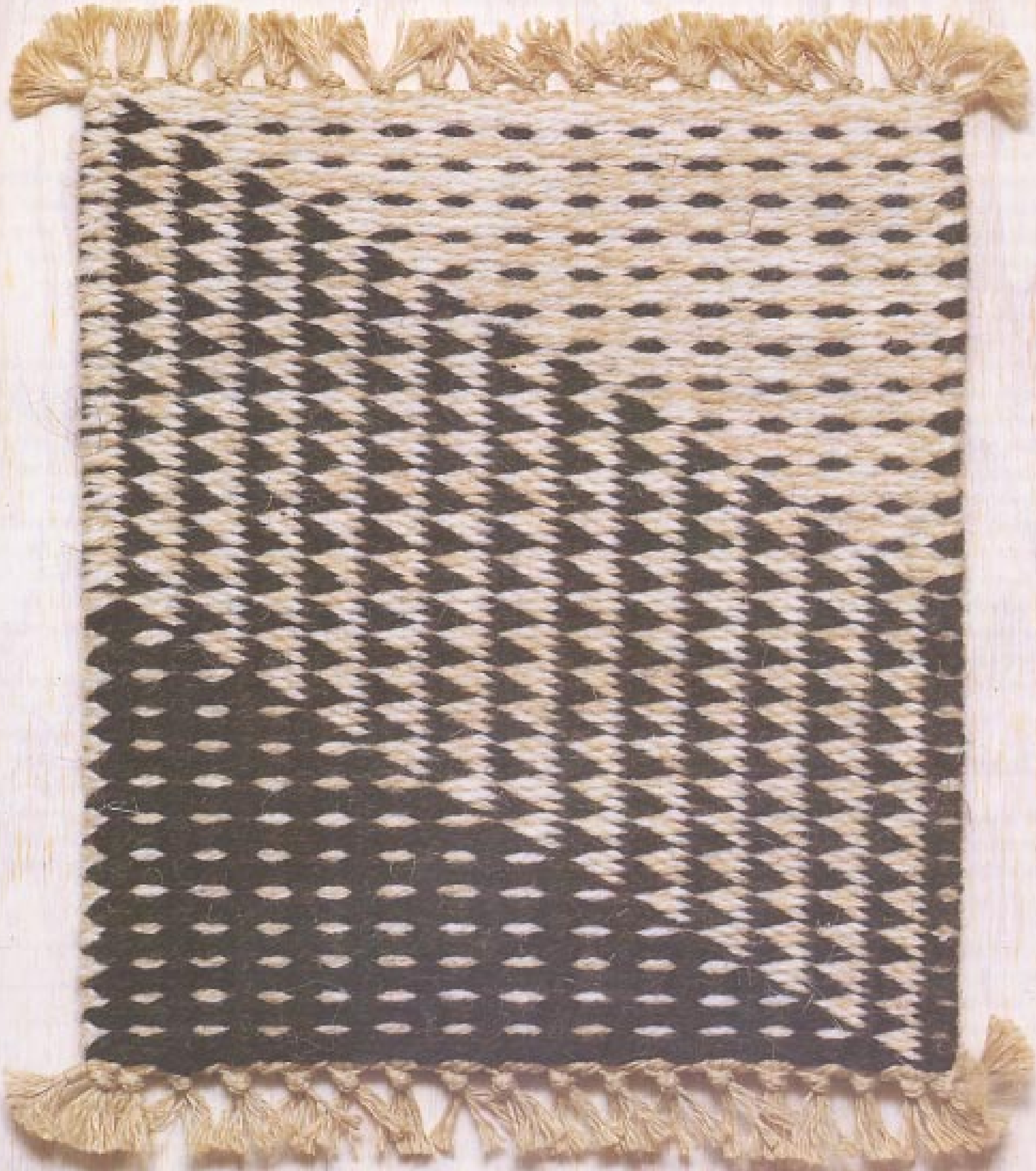


Plate 60 (see p. 124)

Fig. 106(a) shows a symmetrical arrangement of three of the available threading units. These are woven with 2/2 twill lifts and with wefts in a (A,A,B,B) colour sequence. The result is a central block of colour B, flanked by blocks striped with A and B, bordered with blocks of colour A; see bottom of diagram. Note that due to the way the colours lie, two of the threading units have to be increased in size to achieve symmetry in the woven blocks.

It will immediately be seen that threading units II and III are those of the three-end block weave. Also that threading unit I can be easily derived from the latter block weave by moving an end from shaft 2 to 3, as shown in *Fig. 107(a)* and *(b)*. So with very little rethreading a loom set up for the three-end block weave can be changed to the present weave and vice versa.

Fig. 106(b) shows the altered threading and it will be understood that, by shaft-switching in the central area, any shape of colour B can be made on a background of stripes; the outer blocks of colour A will remain unchanged; see Plate 63 (p. 132).

Using other colour sequences, areas of solid colour disappear and the design resolves into areas of different types of striping. Plate 64 (p. 133) shows a rug based on a colour sequence of (A,A,B,B) × 4, (B,B,A,A) × 4. Plate 65 (pp. 133) shows one sometimes using (A,B,B,B) × 2, (A,B,A,A) × 2, and sometimes (B,B,B,A) × 2, (A,B,A,A) × 2. All these colour sequences require a floating selvage. The warp has 4 working epi and the weft is 2-ply carpet wool used three-fold.

Three-colour Block Weave

When many two-colour block weaves can be woven on four shafts, it is surprising to realize that, in order to weave a balanced three-colour block weave, twice that number is needed. The problem is how to hide the third colour in the structure of the rug, when the other two are showing on the front and back. The two solutions now described are really developments of the three-end and four-end block weaves.

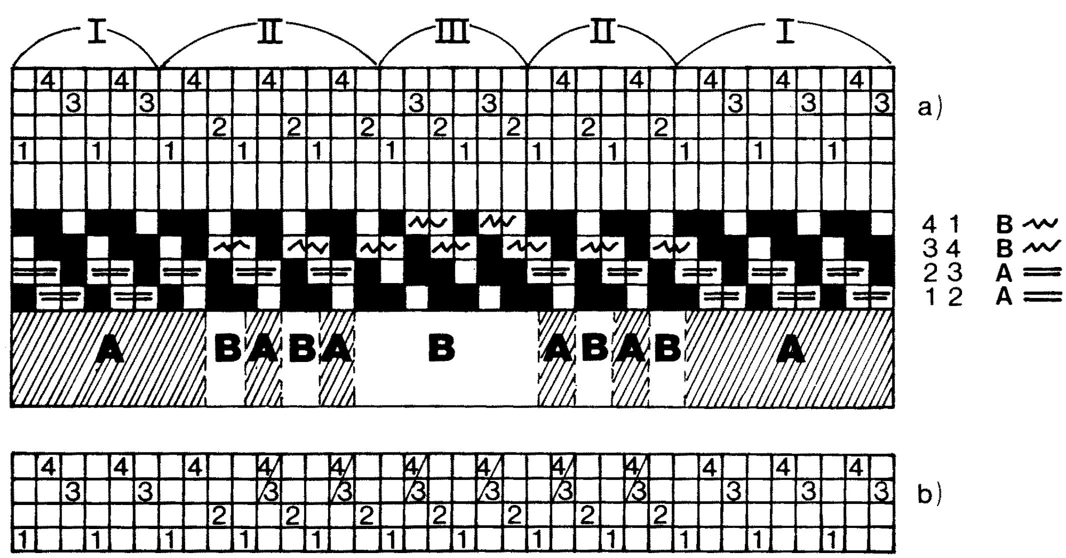
(a) Three-colour Block Weave Based on the Three-end Draft

Fig. 108(a) shows the threading and weave plan and it will be seen that, as with the three-end draft, shafts 1 and 2 occur regularly across the threading and carry the tie-down warp ends. But instead of there being single pattern ends, they are in pairs on shafts 3 and 4, 5 and 6, and 7 and 8. So in block I the threading is (2,3,4,1), in block II it is (2,5,6,1), and in block III (2,7,8,1).

The structure is best understood from the thread diagrams, *Fig. 108(b)* and *(c)*, which show the first three picks in block I. Here it is seen that the pattern ends 3 and 4 move as a *pair* when wefts A (showing on the back) and C (showing on the front) are inserted. But they *separate* to allow B (the hidden weft at this point) to pass between them. As the cross-section shows, the pair actually lie one above the other and to this end are sleyed through the same dent in the reed. In the remaining three picks of the repeat, the pattern ends move in exactly the same way, but it is shaft 2 which is raised throughout, not 1. The threading units can be arranged in any sequence.

With a three-colour block weave there are many ways the shafts can be lifted – each giving a different arrangement of the three colours (or only two of them) on the front, together with different arrangements on the back. In fact, there are more possibilities than any loom has pedals. The way to approach this problem is to pick a set of lifts which gives a different colour in each of the three blocks and ensures that each colour weaves in the front, centre and back; *Fig. 109(a)*,

Fig.106



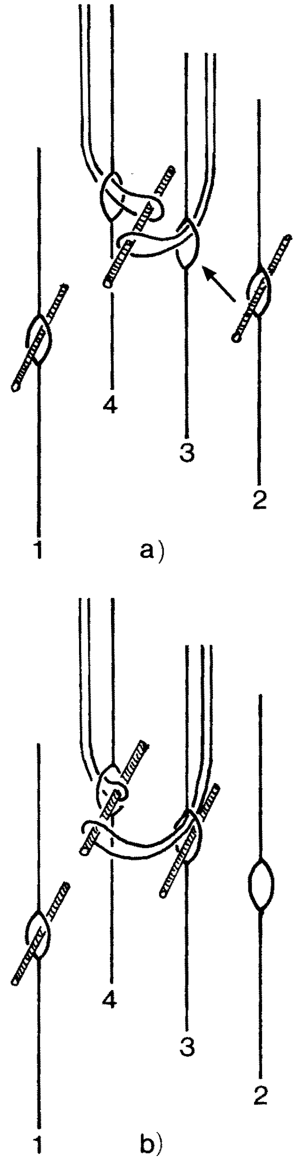


Fig.107

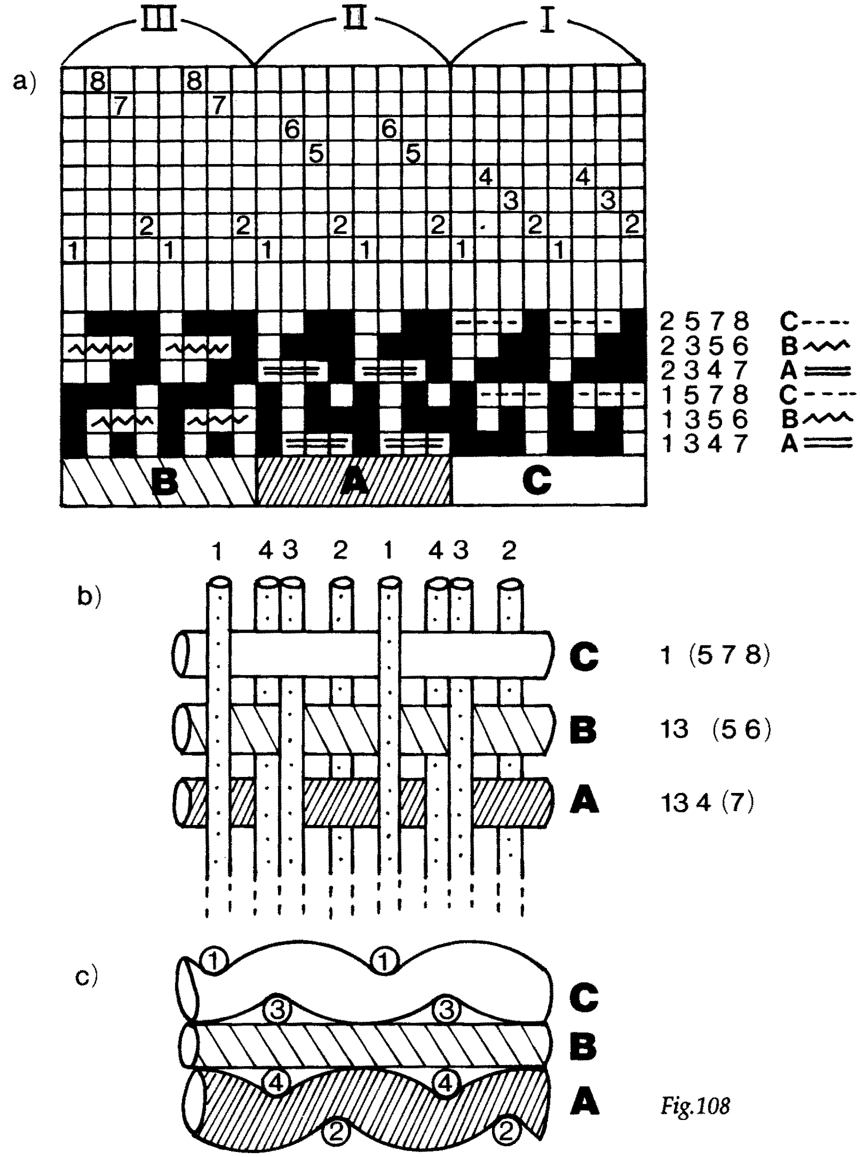


Fig.108

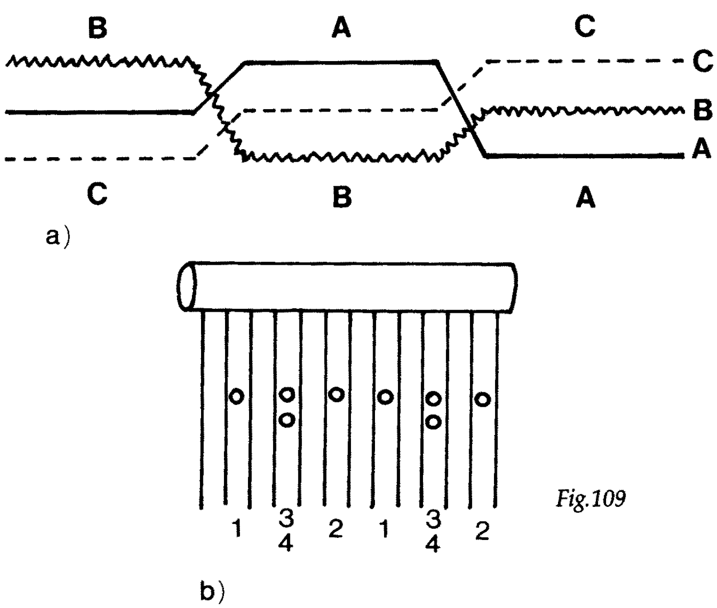


Fig.109

a diagrammatic cross-section, shows one way of achieving this. The corresponding lifts are given in *Fig. 108(a)*. If these are repeated endlessly, but the sequence of the three weft colours is varied, every possible colouring of the three blocks can be woven. This is analagous to the way a three-shaft Krokbragd is woven and means the sort of designs associated with that technique can be woven on a much larger scale.

The three wefts, A, B and C, all start at one selvage and the three picks are beaten in together to encourage good coverage. The colour sequence can then easily be changed to (A,C,B), (B,A,C), (C,B,A) or whatever is wished. If it is changed to, say, (A,A,C), so that two of the blocks show the same colour, simply stop colour B and replace it with a second shuttle of A. In this way, the selvage to selvage passage of three wefts is not interrupted and the edges stay perfect. See Plate 66 (pp. 134–5).

Plate 61 (see p. 125)

Plate 62 (see p. 125)

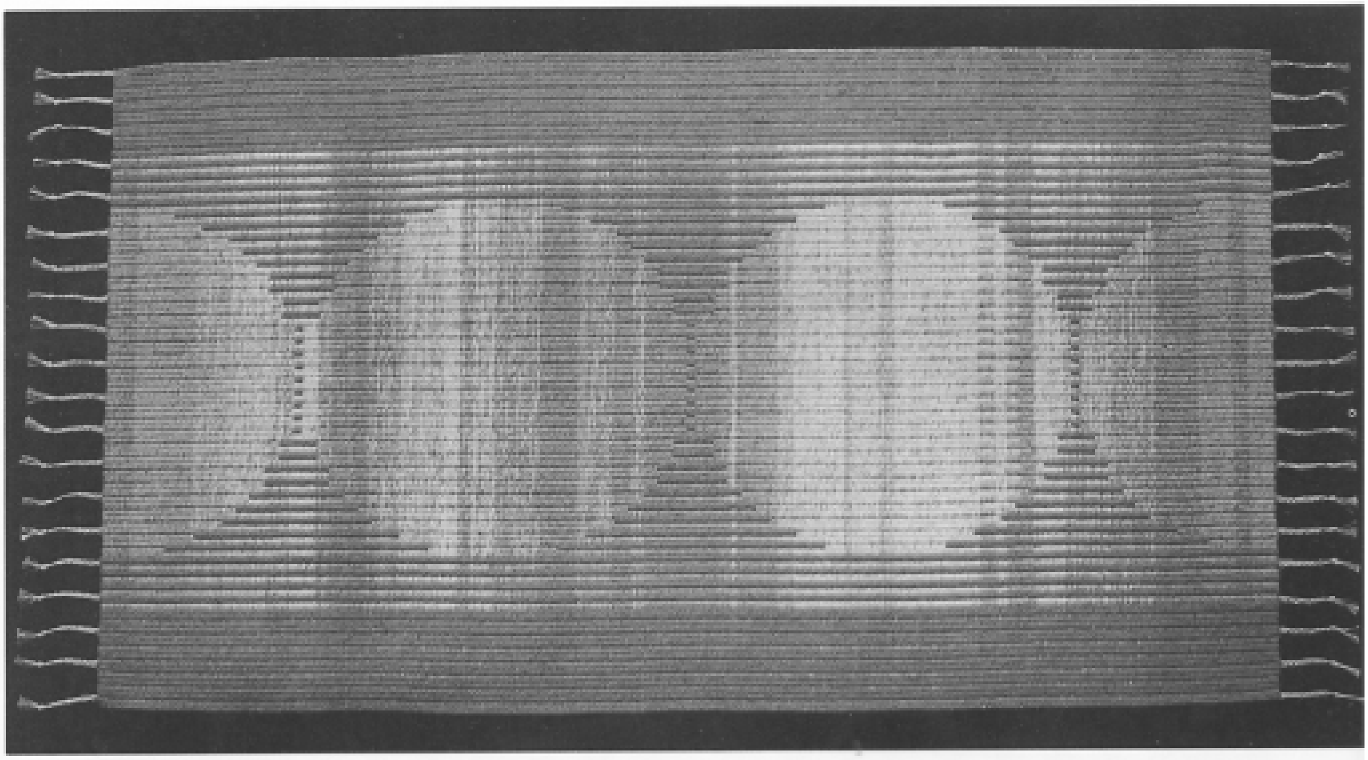
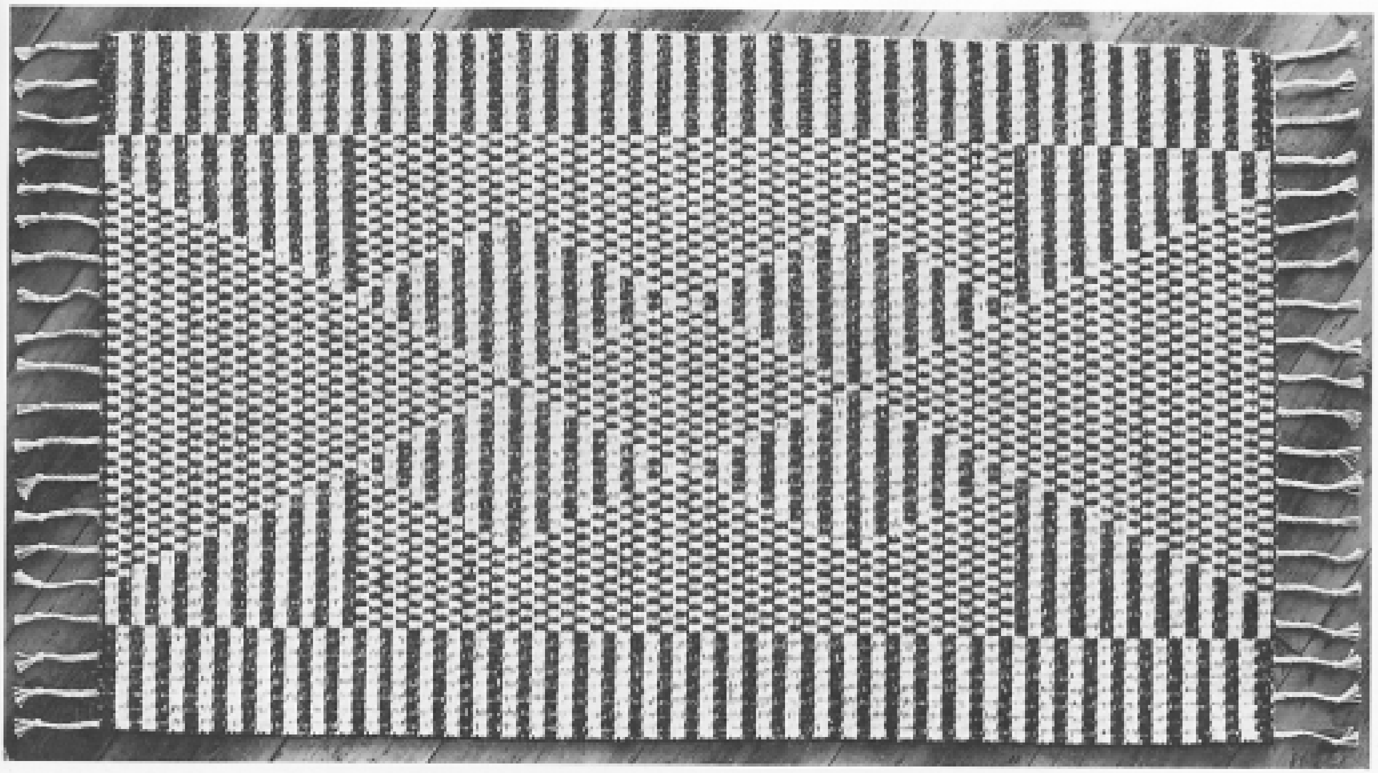


Plate 63 (see p. 128)

Plate 64 (see p. 128)



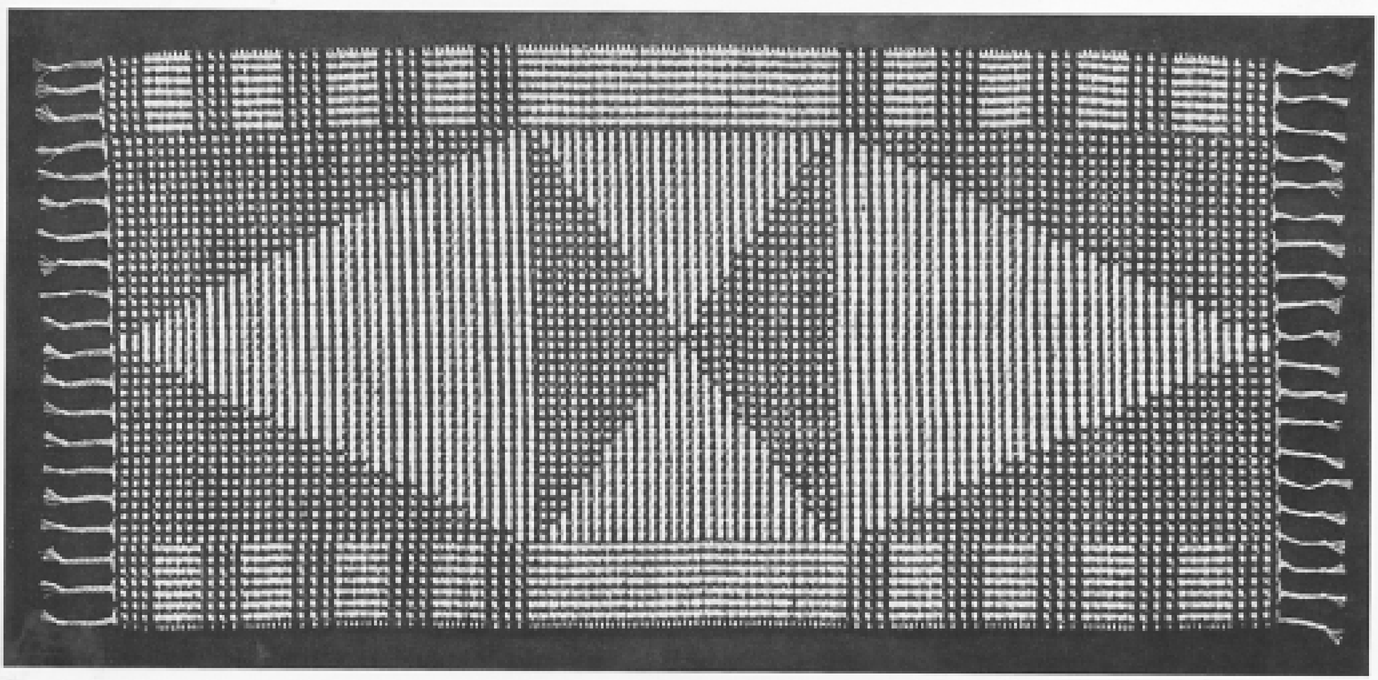


Plate 65 (see p. 128)

Plate 66 (see p. 129)

The warp is sleyed as shown in *Fig. 109(b)*; the pair of pattern ends going together in one dent of an 8 reed. The initial end on shaft 2 at the right, and the final end on shaft 1 at the left should be doubled. A weft of 2-ply carpet wool used two-fold is suitable.

It is possible to apply shaft-switching to this block weave, but for full freedom of design it entails switching a pair of pattern ends from shafts 3 and 4, to 5 and 6, or to 7 and 8. So one end of a pair has to be able to attach to shaft 3 or 5 or 7, and the other to 4 or 6 or 8, as in *Fig. 110(a)*. For convenience of working, it is obviously better to transpose the threading to that in *Fig. 110(b)*, and of course alter the lifts accordingly. Then each end of the pair can be switched between three adjacent shafts; see *Fig. 110(c)*. The set-up for just one of these ends would then be similar to that in *Fig. 101*. But as so many loops would be needed (six for each pair of ends), this is perhaps an instance where a simpler method, like snap hooks, would serve well, at least for an undemanding design.

(b) Three-colour Block Weave Based on the Four-end Draft

As *Fig. 111(a)* shows, this differs from the previous block weave in that there is a pair of pattern ends between every tie-down end on shaft 1 or 2; otherwise it is very similar. The lifts and the shuttle sequence are the same, as is the look of the woven result. The cross-section, *Fig. 111(c)*, shows that the central weft is probably better hidden as it is separated from the front and back weft by more ends.

Fig. 111(a) shows only one repeat of each of the three threading units. Notice the extra end on shaft 2 at the left selvage which is needed to make the three wefts catch satisfactorily. The warp has 9 epi, sleyed in a 6 reed, so a dent with a tie-down end alternates with a dent holding a pair of pattern ends.

Compared with the last block weave, this would require even more preparatory work to set it up for shaft-switching as it has so many pattern ends per inch.

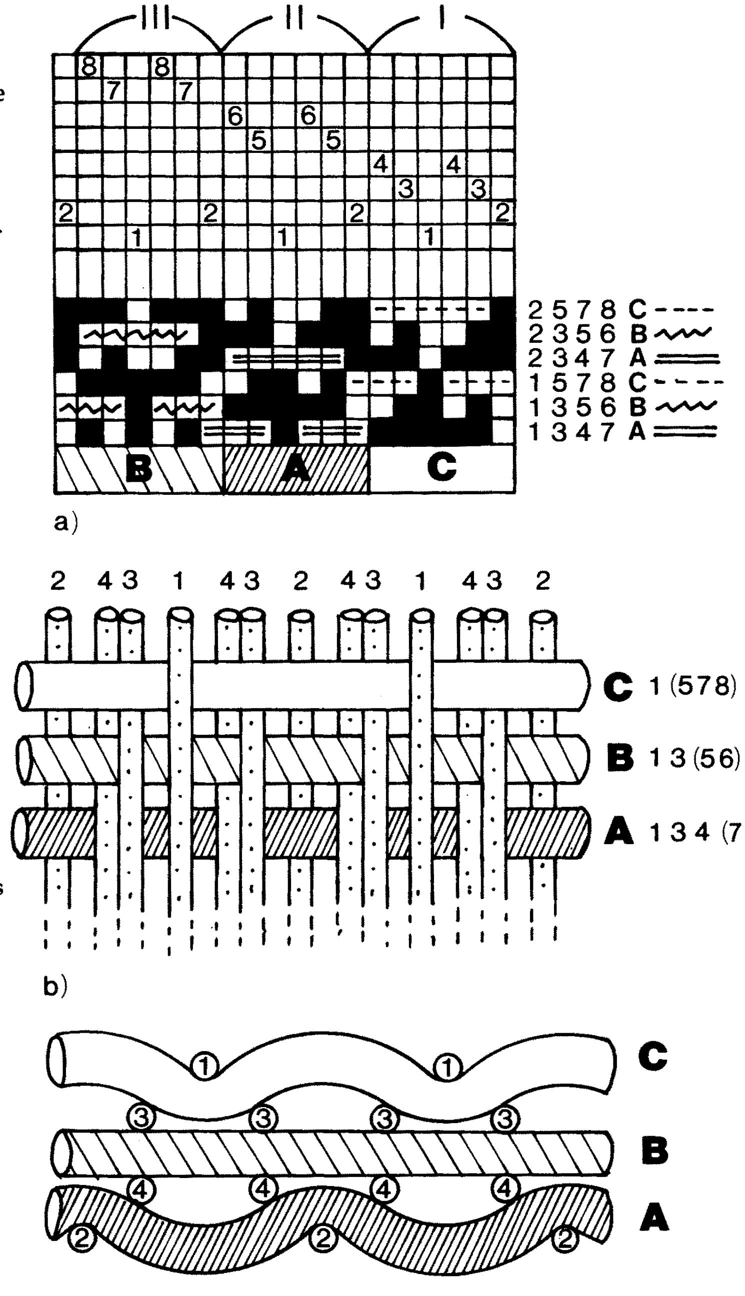


Fig.111

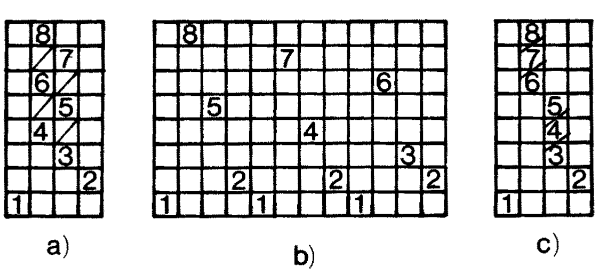


Fig.110

Warp-face Weaves

One of the most fruitful fields in warp-face design is the combination of a warp of alternate dark and light ends with a weft of alternate thick and thin yarns.

At its simplest, two shafts, threaded as in *Fig. 112(a)*, can give two blocks. If a thick weft is thrown when shaft 1 is raised and a thin when 2 is raised, then an A block will show mainly dark and a B block mainly light; see *Fig. 112(b)*, lower half. By reversing the thick/thin sequence of the weft (either by throwing the thin twice, or, what is better for strength, the thick twice), the colours of the blocks are counter-changed; see *Fig. 112(b)*, top half above arrows. These are *linked blocks*; when A is dark, B must be light, and vice versa. A cannot change without B also changing.

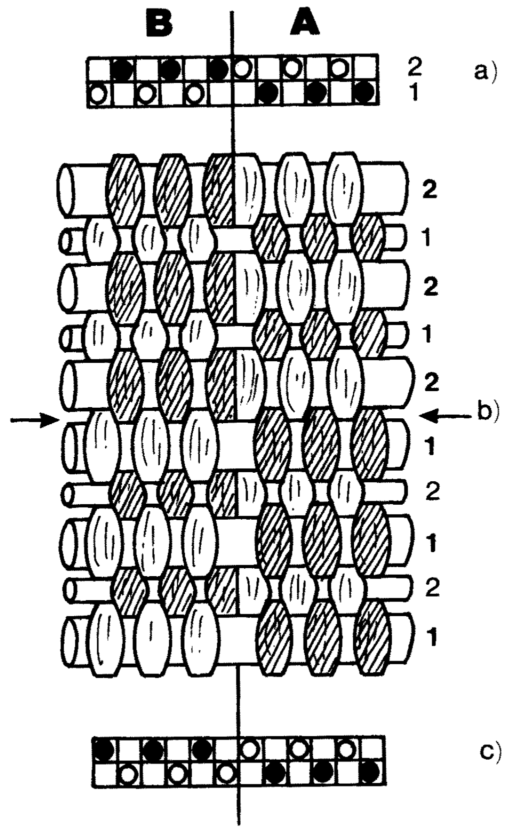


Fig.112

Note

— At the junction between blocks A and B, two ends of different colour are both entered on the same shaft. These two ends rise or fall together in every shed; see the junction running down the centre of Fig. 112(b). *The apparent error could have been avoided by threading two ends of the same colour on different shafts, as in the centre of* Fig. 112(c).

So there are two ways of handling the junction between linked blocks; either keep a constant colour sequence and alter the threading, as at (*a*), or keep a constant threading and alter the colour sequence, as at (*c*). The latter may seem preferable. In more complex multishaft designs, it is unavoidable that, at some junctions between blocks, two adjacent warp ends will move together in this way, no matter which method is used. So it is simpler to make an arbitrary rule that a block always begins on a dark thread and, because it has an even number of threads, always ends on a light one.

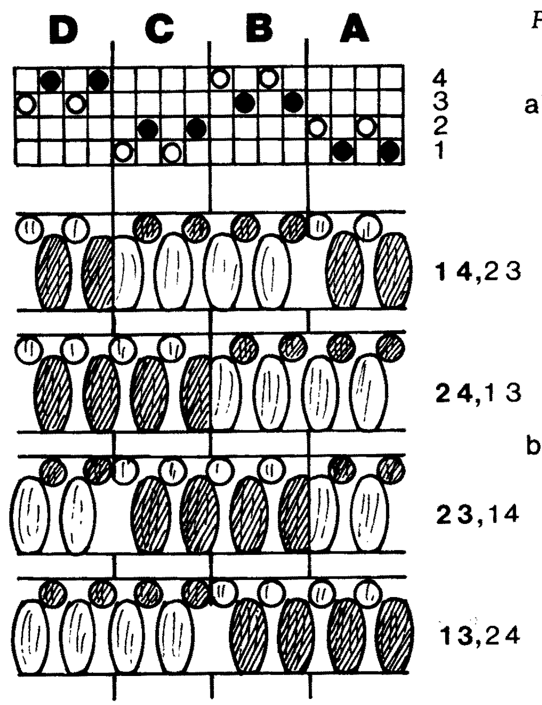


Fig.113

Note

— The width of each block is decided as the warp is threaded (the minimum being two threads); the length of each block in the warp direction is decided during weaving.

When extending the idea on to four shafts, the four possible blocks can be arranged in several ways; *Fig. 113(a)* shows one of these. It will be seen that blocks A and B are completely

Plate 67 (see pp. 142,144)

Plate 68 (see pp. 142,144)

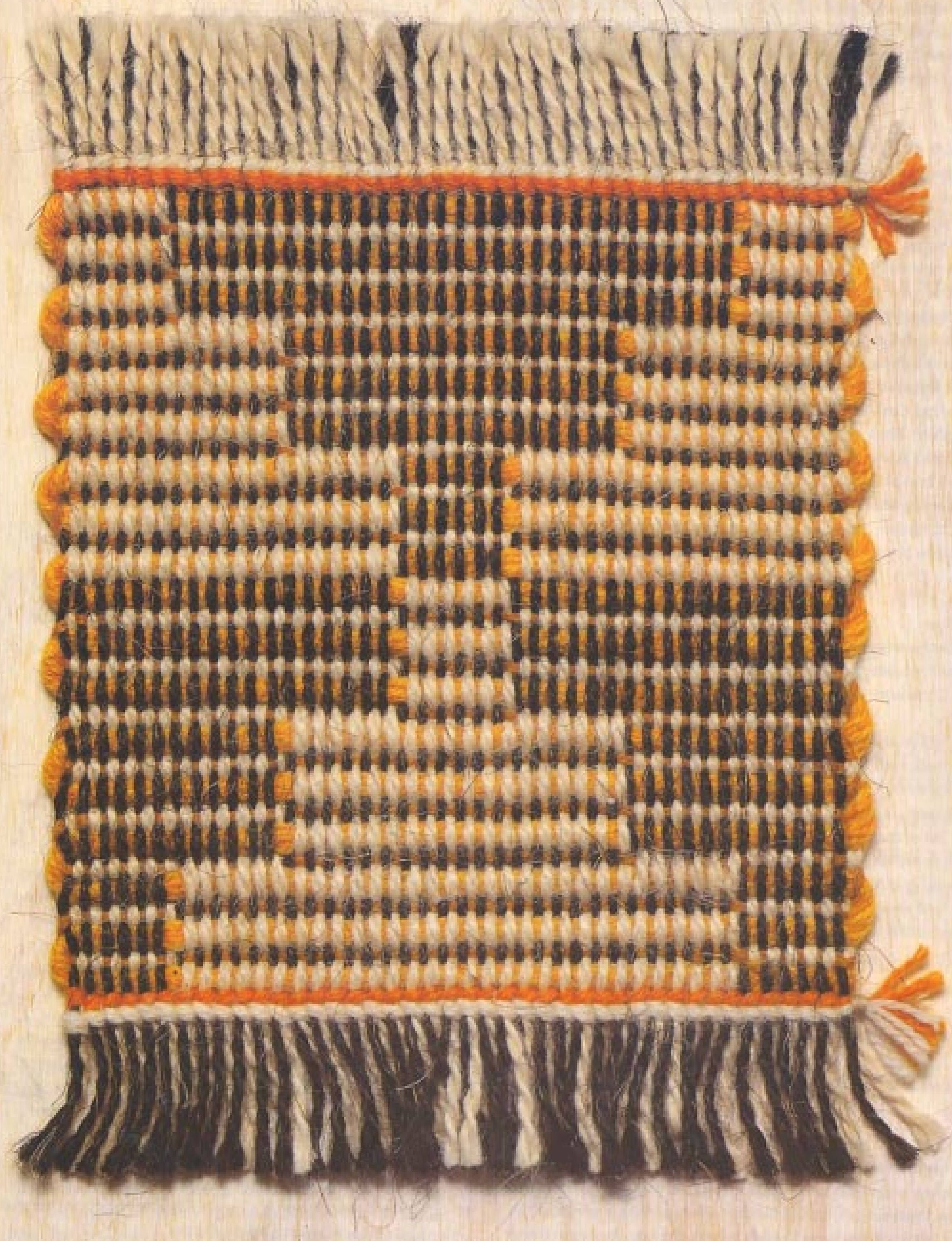


Plate 69 (see pp. 142, 144)

unlinked, so either can appear dark or light, irrespective of how the other appears. Using only these two blocks, designs such as in *Fig. 114(a)* can be produced where the lifts for the thick and thin wefts are shown at the side in heavy and light type respectively.

Note

— There can be a solid dark border, as in Fig. 114 (a), *produced by threading part of block A with dark warp on both shafts 1 and 2. Applying this idea to both blocks greatly increases the design possibilities. The narrowest such warpway stripe is naturally two warp ends wide.*

Looking at *Fig. 113(a)* again, it is seen that blocks A and C are linked, i.e. they share the same two shafts but with reversed threading order; similarly, blocks B and D are linked. With this traditional arrangement of the blocks the similarly-coloured threads of any *two adjacent* blocks can be raised together. Thus lifting shafts 1 and 3 brings up the dark ends in blocks A and B, and the light in C and D; lifting shafts 2 and 3 brings the dark ends up in blocks B and C, and so on. This is shown in a very diagrammatic way in *Fig. 113(b)*. As a result, simple designs like that in *Fig. 114(b)* can be woven with the blocks threaded in the sequence shown.

Note

— Design areas under A and C are similarly arranged but with their colours reversed; hence they can be produced by the linked blocks A and C; the same applies to the areas under B and D.

Fig. 113(b) shows how, at the first pick of a new design area, the thick weft in some places lies in the same shed as the previous thin weft. This is inevitable, but as it happens in a different place each time, there is no cumulative effect on the fell of the rug.

If, however, the design areas are counter-changed as at the top of *Fig. 114(b)*, the last shed of one area is identical with the first shed of the new area all across the warp. Three possibilities then exist.

1. The last thin weft of the previous area can be omitted, so that two thick wefts follow in succession.
2. The thick and thin wefts can both lie in the same shed; a choice which preserves their side-to-side sequence.
3. The first thick weft of the new area can be omitted so that two thin wefts follow each other; this is not advisable as it weakens the rug.

The threading in *Fig. 113(a)* makes more sense if it is transposed and becomes a member of the well-known shadow weave family. *Fig. 115*, top, shows the previously used threading (with the blocks reduced to their smallest size of two threads each) and, below, the transposition into a shadow weave. At the bottom are the four possible design

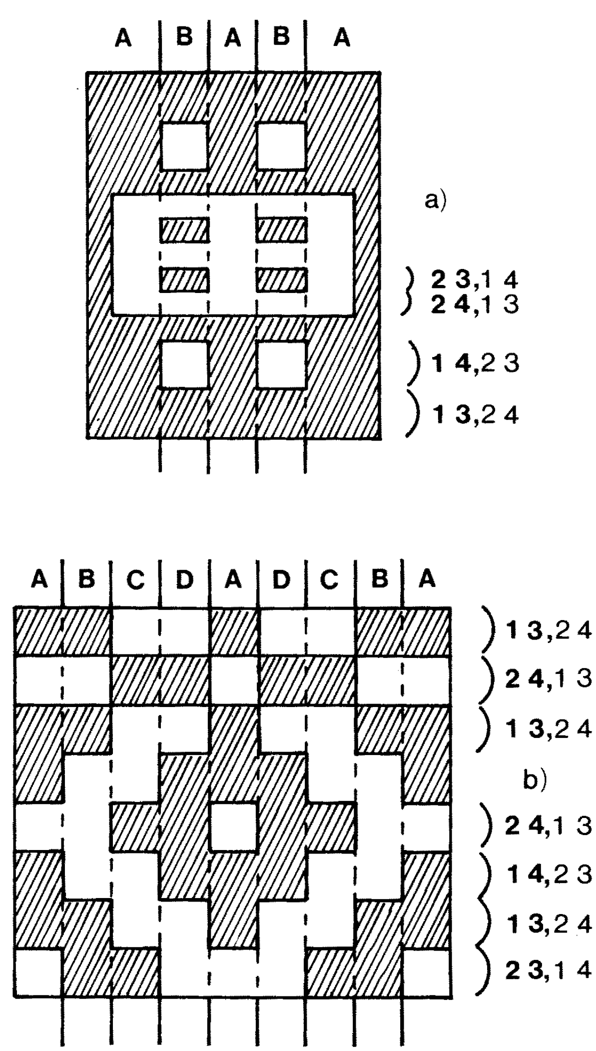


Fig.114

areas with, on the right, the lifts for the shadow weave threading, and on the left those for the other threading. The shadow weave both looks more logical and has the more memorable lifts of a 2/2 twill 'woven on opposites'. It also has the advantage that the ends in a threading block are not on adjacent shafts but are spread out, thus making shedding easier. This is more noticeable with the six- and eight-shaft developments of shadow weave; see *Figs. 116* and *117*.

In all the examples given, the lifts are of course repeated in pairs as often as desired for each design area, the thick and thin wefts alternating. It can be noted here, however, that with only one weft of uniform size and lifting the shafts in (12,23,34,41) order, the shadow weave draft gives a warp-face 2/2 twill 'woven on opposites'.

Fig. 116 shows a six-shaft shadow weave as a point draft and, below, how the block areas will appear if lifted in the conventional sequence, which happens to be the lifts of a 3/3 twill 'woven on opposites'. *Fig. 117* shows a straight draft of an eight-shaft shadow weave, again lifted in the conventional order as a 4/4 twill 'woven on opposites'.

It should be understood when designing that:

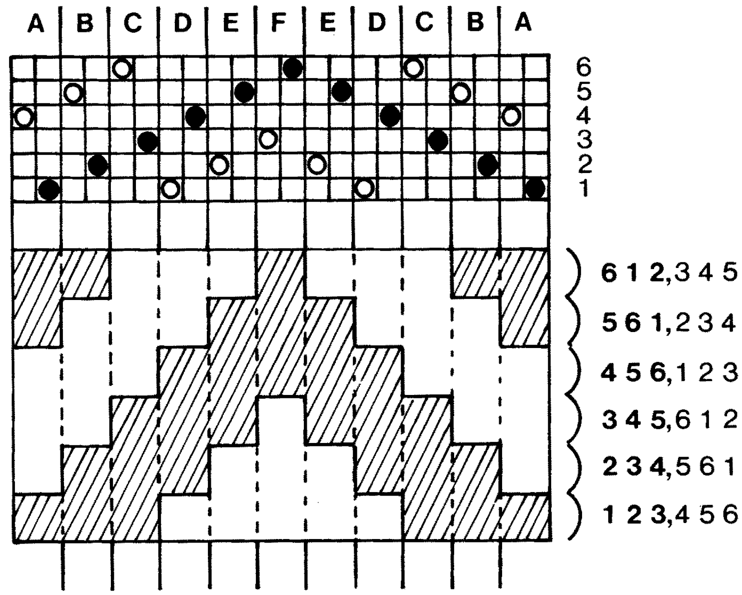


Fig.116

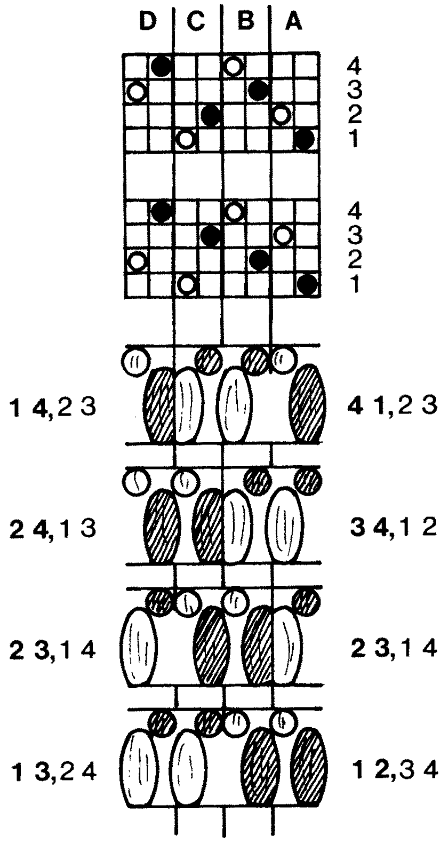


Fig.115

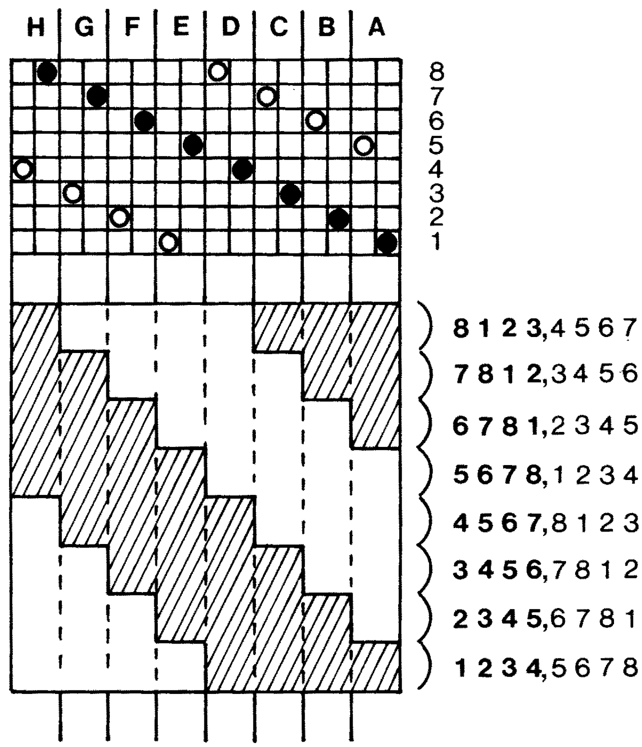


Fig.117

1. The blocks A,B,C and so on do not have to be threaded in that alphabetical order. For example, a (A,D,B,E,C,F) order could be used for the six-shaft version, or any order that produced the desired design.
2. The lifting sequence does not have to follow the order shown, which of course always produces diagonal lines and diamonds.
3. From the point of view of the designing, it may be found easier if the linked blocks are omitted, i.e. if only blocks A to C in the six-shaft version, and A to D in the eight-shaft version are used. This implies that there are three or four completely separate and unrelated areas in the design whose appearance is controlled by the way the shafts are lifted.

The relationship between linked and unlinked blocks can perhaps be demonstrated by considering a simple design like that in the centre of *Fig. 118*. If it is split up into its constituent parts, I to IV, it will be seen that there are four different areas running down the design. Now if this were woven without linked blocks, it would need eight shafts, two for each area; see the draft above and the lifts on the right. But the design shows that areas I and III are identical in design but opposite in colour, and the same applies to areas II and IV. So these areas can be woven on linked blocks and only four shafts are needed; see the bottom of *Fig. 118* and the lifts on the left.

Both drafts produce an identical result. If, however, a solid colour is wanted all across the design, this could easily be obtained with the eight-shaft draft by lifting (1234,5678), but is impossible with the four-shaft draft.

Plates 67, 68 and 69 (pp. 138–9) show samples woven on a pointed variety of the eight-shaft draft in *Fig. 118*.

Practical Details

To produce a true warp-face structure, i.e. one with the weft completely covered, the warp has to be set so close that shedding is difficult. This dictates the type of warp material, which should be as smooth as possible coupled with strength; a hard-twisted worsted or cotton is suitable.

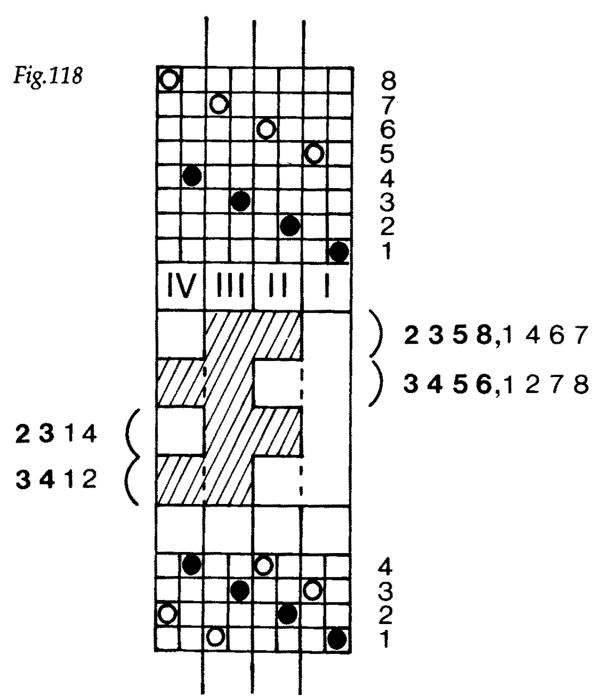
The shedding can be eased by using breaker pedals. If, for instance, shafts 1 and 2 have to be raised for one shed, tie a pedal which raises only 1, and another which raises 2 (or 1 and 2). With one foot press the breaker pedal which raises 1. Make sure this half-shed is clear, then with the other foot add the pedal raising 2 (or 1 and 2). Make sure the full shed is clear and throw the shuttle.

Because of this shedding problem, rugs are often woven which are more warp-dominant than true warp-face. In other words, the weft is visible to a varying degree. If the weft is the same colour as one of the warp materials, areas where it is passing under that warp will appear solid in colour and the other areas striped. The weft can be a colour halfway between the two warp colours and so blend with both; or it can be something quite different. So its partial visibility obviously adds to the design possibilities and means several rugs woven on the same warp can have a slightly different colouring; this was done in the three samples Plates 67–9 (pp. (pp. 138–9), all woven on the same warp of black horsehair and white goathair, set at 8 epi.

The alternation of the thick and thin wefts means they have to be linked at each selvage. One way to improve the selvage is to throw the thin weft in every shed, adding the thick to every other shed. The loop of thick weft at the selvage can be made firmer by twisting it strongly before it is finally positioned and beaten.

It is true that a stronger, harder yarn can be used as the warp in a warp-face rug than as the weft in a weft-face one, suggesting that the former has a more hard-wearing surface. Against this is the fact that it is almost impossible to cram ends in a warp-face rug as closely as wefts are beaten in a weft-face rug. So it is difficult to say which has the better wearing properties.

Fig.118



Weft Twining

One or two rows of two-strand weft twining at the start and end of a rug make a strong, firm, intermediate line between the woven structure of the rug itself and whatever finish is employed. The yarn used can be the same as the warp (perhaps three- or four-fold) in which case the twining blends in visually with the rug finish; or it can be some coloured yarn, such as the rug weft (again using several thicknesses), in which case the twining becomes decorative as well as practical.

There is a simple way of working two rows of twining simultaneously and, if two colours are used, these rows can produce six different small-scale patterns; see *Fig. 119(a)* to *(f)*. These result from the three possible ways of arranging the colours at the start, as in *Fig. 119(i)* to *(iii)*; and on working either in countered twining, i.e. a row of S- above a row of Z-twining or vice versa, as in *Fig. 119(a), (c)* and *(e)*; or working both rows in S- or both in Z-twining, as in *Fig. 119(b), (d)* and *(f)*.

The top six rows in Plate 70 (pp. 146–7) correspond exactly with rows (*a*) to (*f*) in *Fig. 119*.

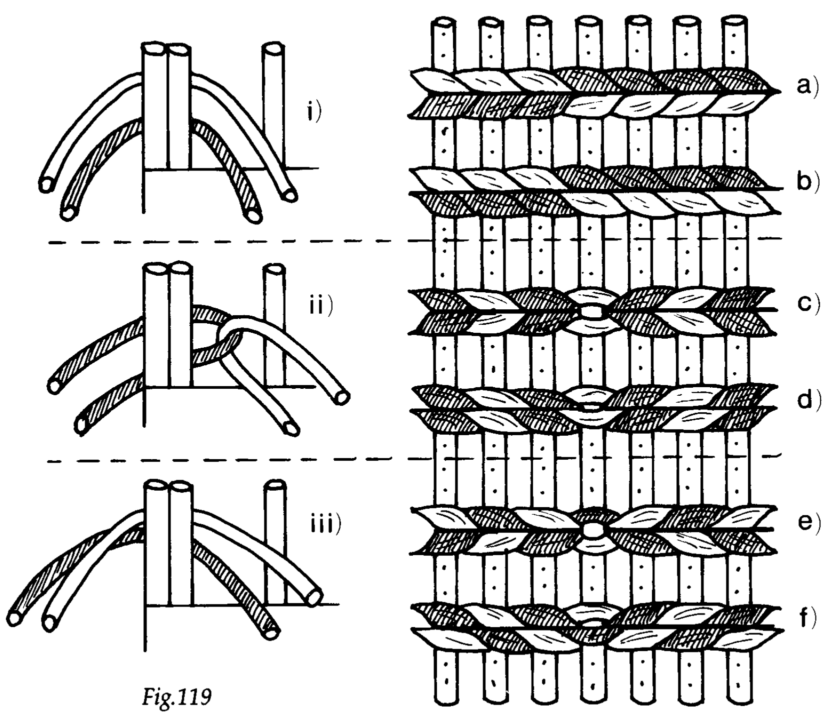


Fig. 119

Countered Twining

This is by far the easier of the two types and with practice takes no longer to work than a single row of twining.

Start with two long strands centred under the selvage end; *Fig. 120(a)*.

Open the right-hand pair, A and B, and pass the left-hand pair, C and D, to the right between them; see (*b*).

Immediately pass C and D under the next warp end; see (*c*).

Again open the right-hand pair, (which is now C and D), and pass the left-hand pair, A and B, between them and under the next warp end; see (*d*).

Continuing thus gives a row of Z-twining above a row of S-twining.

If the strands being used are of two colours and are arranged as in *Fig. 119(i)*, a white row will lie above a black; see *Fig. 119(a)*, left, and Plate 70 (pp. 146–7) top row and both ends of warp-face samples in Plates 67–9 (pp. 138–9).

If the strands are arranged as in *Fig. 119(ii)*, linked into each other, the two rows appear as alternating chevrons of the two colours; see *Fig. 119(c)*, left, and Plate 70 third row down.

If they are arranged as in *Fig. 119(iii)*, the pattern, seen at (*e*) and Plate 70 (pp. 146–7) fifth row down, is produced.

Variations

1. To reverse the twining direction as at the centres of *Fig. 119* (*c*) and (*e*), pass the right-hand pair through the left-hand pair which then goes under the next warp end; i.e. the exact opposite of the previously described movement. See centre of third and fifth row down in Plate 70 (pp. 146–7).
2. In pattern (*a*), the colours are easily counter-changed as shown at the centre. When two strands have been passed under a warp end, as in *Fig. 120(c)*, cross them so D is now above C. Now open C and D and pass A and B through between them. Pass A and B behind the next warp end and again cross these so B is above A. Once these two crossings have been made, the work proceeds normally with the coloured lines reversed. This has happened twice in top row of Plate 70 (pp. 146–7).
3. If only the first of the above crossings is made and the twining continued normally, then pattern *Fig. 119(e)* is produced. See right-hand end of bottom row in Plate 70 (pp. 146–7).
4. To move from pattern (*a*) to (*c*). See *Fig. 121*, top. After C and D have been passed through between A and B, bring down C (the upper black) and pass it under the next warp end, 3. Bring D up, double twist it with A (the other black strand) which itself then goes behind warp end 3.
5. To move from pattern (*c*) to (*a*); see *Fig. 121*, bottom. Pass C and D through the opened A and B. Bring the upper black, C, down and pass it under warp end 3. Give a double twist to the lower white and black, B and D; bring B upwards and place it behind end 3.

Though a little difficult to master, the above two transitions have a neat appearance, and can be seen on bottom row in Plate 70 (pp. 146–7).

Two Rows of S- or of Z-twining

Start as for countered twining, but when the right-hand pair, A and B, are opened pass only the lower of the left-hand pair through, i.e. D, and pass the upper of the pair, C, over them. So the four strands interpenetrate as shown in *Fig. 120(e)*. Continuing thus gives two rows of S-twining.

To make two rows of Z-twining, pass the upper of the left-hand pair, i.e. C, through between A and B; and pass the lower, D, under them, giving the situation shown in *Fig. 120(f)*.

Of the three possible patterns in two colours shown in *Fig. 119(b)*, *(d)* and *(f)*, the latter is perhaps the most striking with its strong oblique stripes; see sixth row down in Plate 70 (pp. 146–7).

Alternating the above S- and Z-twining manoeuvres gives four picks of plain weave. So starting with the colours arranged as in *Fig. 119(ii)*, woven pick-and-pick stripes are produced.

Using the above manipulations, it is possible to move from any one pattern to another, mid-row; such transitions can be related to the design of the rug itself.

When the right selvage is reached, tie the four strands in a temporary knot. Later these can be braided when the rug is being finished. If a braid is wanted at all four corners of the rug, start the twining by knotting the four strands together, leaving enough length to be braided later.

Each of the four strands should be 20–40 inches (50–100 cm) longer than the width of the rug, depending on the length of braids wanted. They should be of such thickness that when they are pulled tight after each movement, the warp sett is unaltered. This is usually a little thicker than the weft yarn being used for the woven structure.

Taaniko Twining

If immediately after the left-hand pair have been passed through the right-hand pair the movement is repeated (with the *new* left-hand pair going through the *new* right-hand pair), a double twist will be given to the twining pairs exactly as in Taaniko twining. This enormously enlarges the design possibilities as a colour can be kept on the surface as long as desired and then changed by making only a single twist, as at the centre of *Fig. 122*. Its use is limited, however, because it is a one-sided technique.

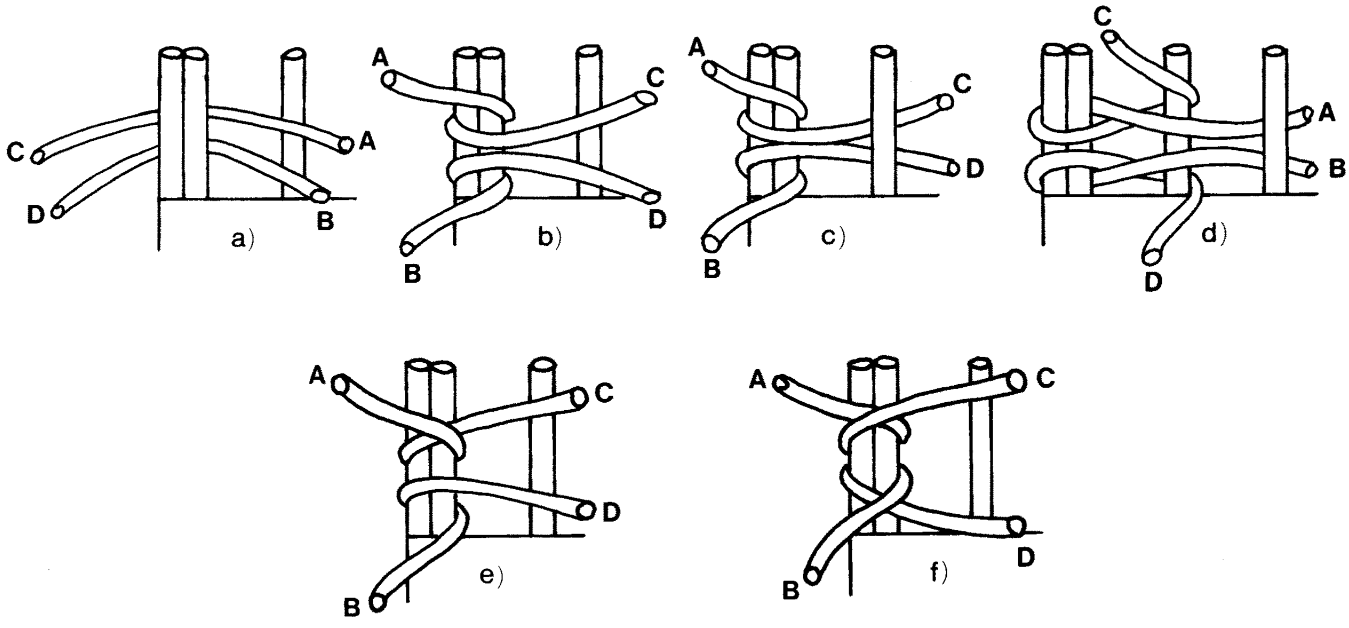


Fig.120

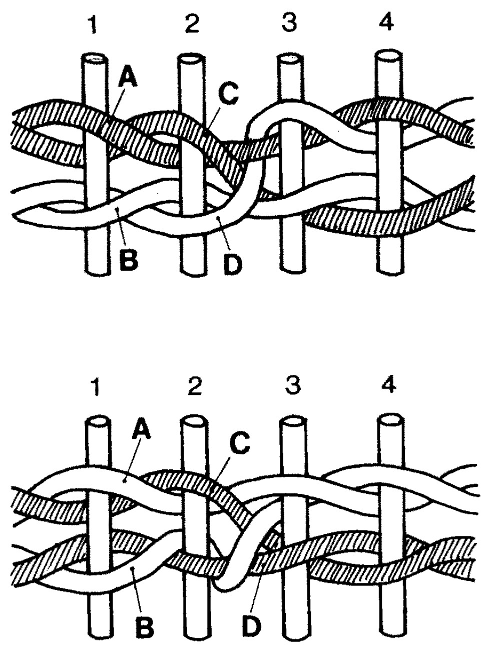


Fig.121

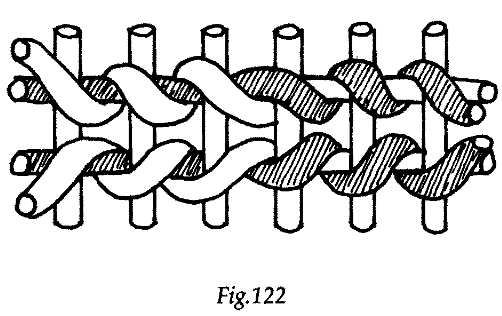


Fig.122

Plate 70 (see p. 144)

Rug Finishes

Weft Protector

This finish was seen being worked on a weft-face camel-hair rug in Rajasthan, India. The rug had been made on a horizontal ground loom so its warp ends were loops which had been lapped around the end bars of the loom. These uncut loops were the elements used in the finish, but for simplicity single ends are here described and illustrated.

Starting at the right edge, take the second end down to the left across ends 3 and 4, then up to the right behind them, emerging between ends 2 and 3, pointing upwards; see *Fig. 123(a)*. This is a common knot or hitch used in many weft protectors. Before it is tightened, take the first end over end 2 and down between ends 3 and 4, as in *Fig. 123(b)*. Discard end 3.

Knot end 4 around ends 1 and 5 with the same knot as used before; the result is shown in *Fig. 123(c)*. Again, before this is tightened, take end 2 over end 4 and down between ends 1 and 5, as indicated by the dotted line and arrow. Discard end 1.

Knot 5 around 2 and 6; take 4 over 5 and down between 2 and 6. Discard end 2.

This sequence is repeated. Always knot a single end around two ends (one of which is the next unused end to the left, the other is the one brought down from the right), then bring the end which lies to the right, pointing upwards, over the single end and down between the two ends. Discard the right-hand of the two ends.

Adjust the tension after every repeat, pulling one of the relevant ends upwards, the other downwards. The result on the upper surface looks like two rows of countered twining; see *Fig. 123(d)*, where the part contributed by one end is shaded. The edge is secure as, once it is established, each end is involved in two knots. It was worked across twice in the Indian example seen.

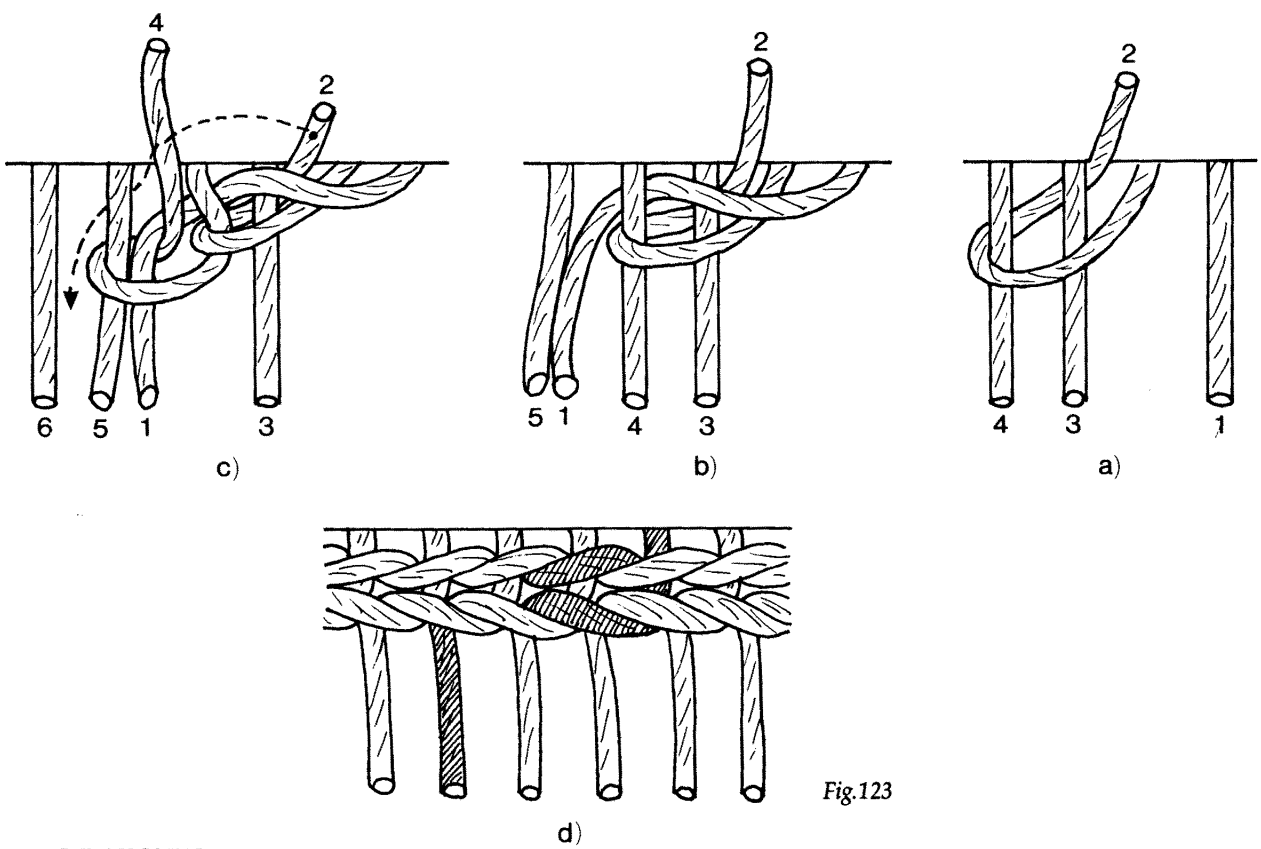


Fig.123

Preparing the End of the Rug for Large Braids

If a few large braids, rather than many small ones, are wanted at the end of a rug, a neatly structured way has to be found of gathering the warp ends together for each braid; otherwise the outermost threads of a group lie loose and unprotected. A traditional method, seen on some Middle Eastern rugs, builds up a triangle in which the warp ends wrap around each other, working towards the centre of the group, from which the braid then springs. It is done as follows.

There should be an odd number of ends in each group; only eleven are used here in the description and diagrams, but more would probably be used in reality. So end 6 is the central one.

Start at the right side of the rug and imagine the ends numbered 1 to 11 from right to left, as in *Fig. 124(a)*.

Wrap end 1 round 2,3,4,5 and 6. Bring it down to lie beside 6, so there are now two ends in the centre; see *Fig. 124(a)*. The wrapping movement is the one sometimes called locking soumak.

Now wrap 11 around 10,9,8,7 and finally around the two central ends, 6 and 1. Bring 11 down to lie beside 6 and 1, to make three central ends; see *Fig. 124(b)*.

Wrap 2 around 3,4,5 and the central three, then bring it down to make four in the centre; see *Fig. 124(c)*.

Wrap 10 around 9,8,7 and the central four, and so on.

Continue in this way, always wrapping the outermost thread from right, then left, into the centre. As this central group grows, the nearby ends are forced outwards.

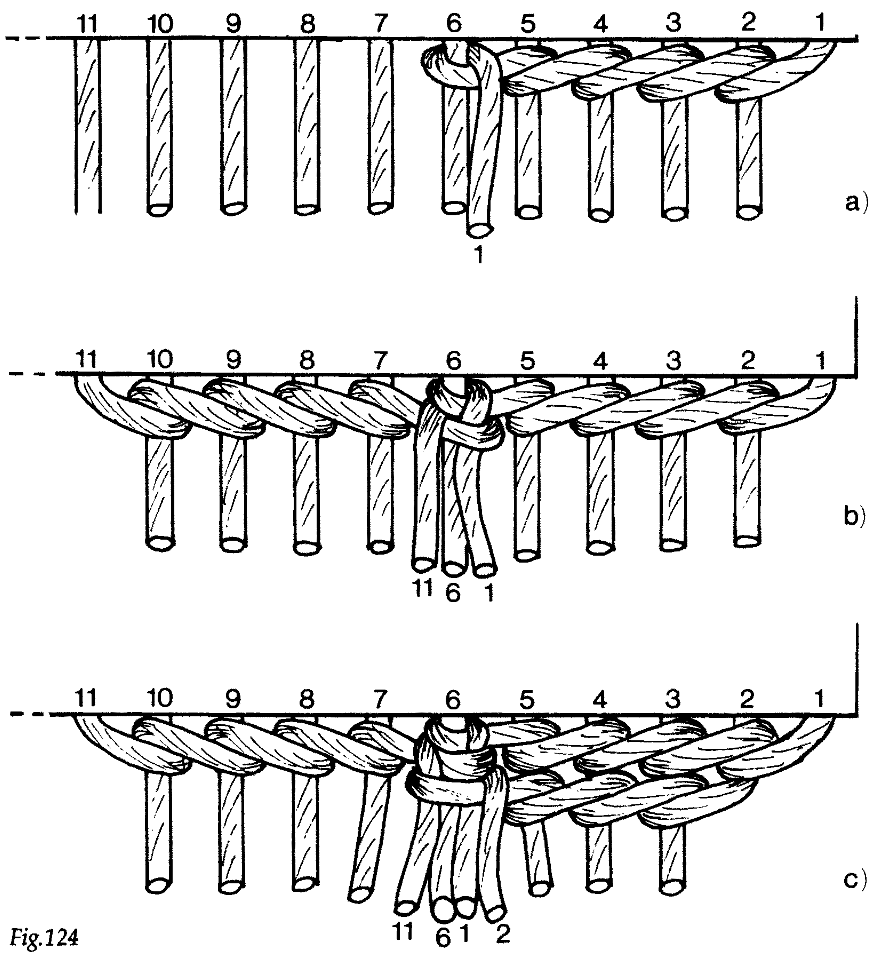


Fig.124

Plate 71 (see p. 152)

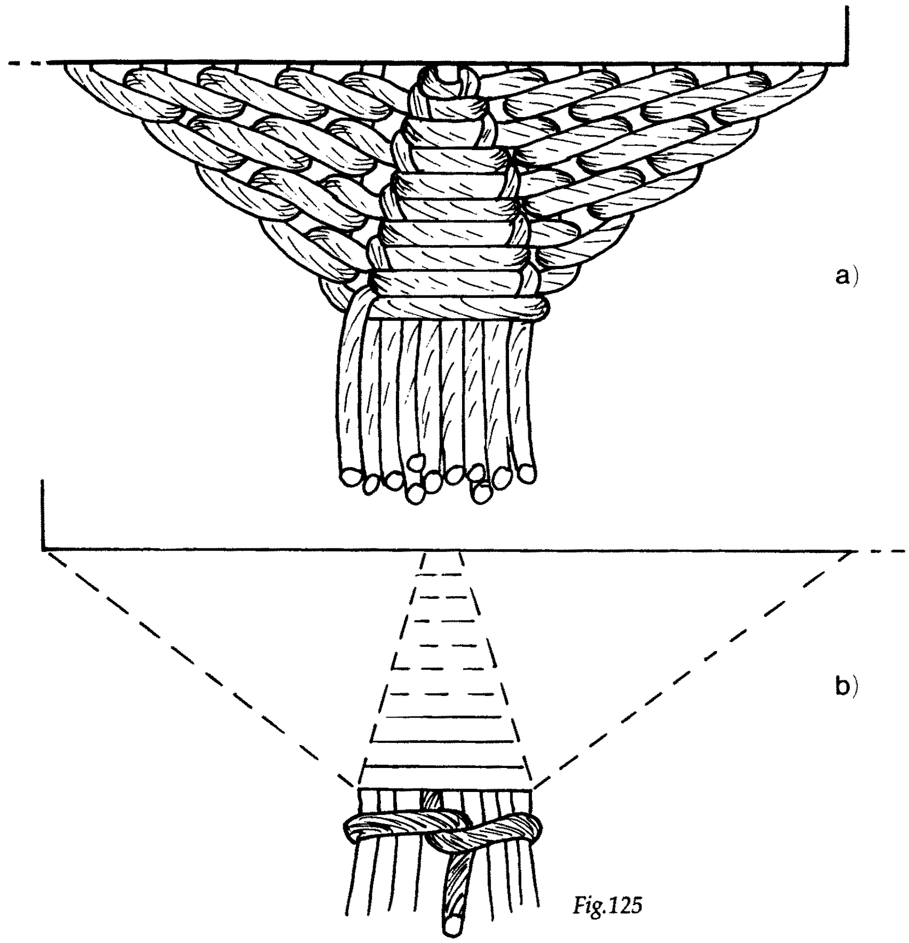


Fig.125

The two final wraps will be of end 5 around the central nine ends, then end 7 around the central ten. The triangle of wrapping will then look as in *Fig. 125(a)* and Plate 71 (pp. 150–1).

Now, at the *back*, select one end and tie it in a hitch, as shown in *Fig. 125(b)*, to hold everything secure before the braiding begins.

The odd number of elements is a slight disadvantage if the braid is to be a square braid, which needs an even number to give a perfectly symmetrical structure. For instance, if a four-strand is now to be worked, one of the strands will consist of only two ends, compared with the other three strands of three ends each (making the total of eleven). But this slight imbalance is hardly noticeable in the finished braid. Starting with an even number of ends (preferably divisible by four), would give a perfect braid but it would come out of the wrapped triangle a little off-centre.

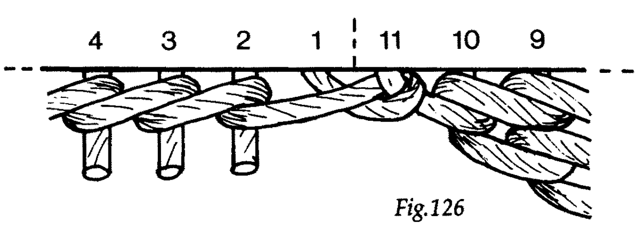


Fig.126

Working the next group of eleven ends to the left, start with end 1 as before. But first take it round end 11 of the previous group, as shown in *Fig. 126*, then wrap it round 2,3 and so on, as before. This is done to avoid any gap between adjacent groups where weft could bulge outwards.

The back of this structure has a different, but still neat, appearance.

Whipping

The normal way of whipping the end of a braid on a rug finish uses an extra length of yarn. In a very neat method, employed by the camel-girth-makers in Rajasthan, one of the elements of the braid itself is tied into a constrictor knot of the type shown, in an untightened state, in *Fig. 127*. It is made as follows; see *Fig. 128(a)* to *(e)*.

1. Tie a knot at the lower end of the element to be used so it can be recognized in later stages. Then pull a long loop forwards and twist it clockwise, securing the crossing point with the left thumb; spot in (*a*).
2. As shown by the arrow, carry the loop behind the braid with the right hand; see (*b*).

3. Bring its lower part over the threads in front and take a new grip with the left thumb to hold it in place; spot in (c). Let the loop fall downwards behind the braid. Slip the whole of the braid backwards through the loop; arrow in (*c*). Push the loop upwards, as in (*d*).
4. Pull the first wrap really tight.
5. Repeat stages 2 and 3 with the new loop, i.e. take it behind as shown by the arrow and so on. Do this three or four times, making sure that each wrap lies above the previous one (i.e. nearer the rug), and that it is as tight as possible. It will then look as in (*e*).
6. Finally pull down on the knotted end of the wrapping element to tighten; arrow in (*e*).

If at any stage, the loop becomes too small to manipulate, draw up some slack from the knotted end.

The knot can of course be worked with a separate element, perhaps a different colour or material from the warp. In this case, the wraps need not be made so tightly, because both ends of the element can be pulled in the final stage, one upwards, one downwards, thus taking up any slack in the wraps.

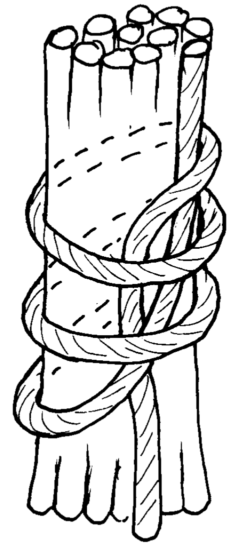


Fig.127

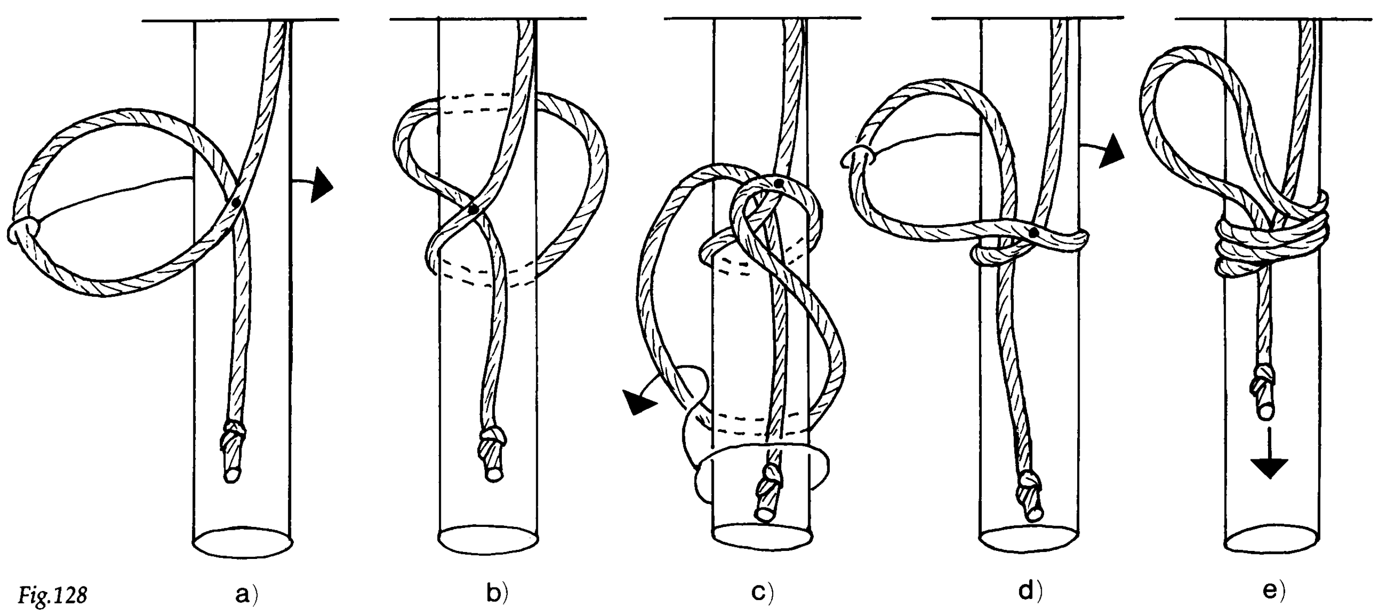


Fig.128

General Workshop Notes

Loom and Workshop Equipment

Bench height

Weave with the bench or loom seat as high as possible. This is because the more the arms incline downwards, rather than forwards, to the batten and shuttles, the less strain is put on the shoulder and neck muscles. Also, the more nearly straight the leg is when depressing a pedal, the stronger the force it can exert.

Loom light

A fluorescent light as long as the loom is wide will give good shadowless illumination. Hang it directly over the average position of the fell of the rug and use a colour-matching tube.

Shuttle catcher

If the cloth-protecting strip of wood, often positioned in front of the breast beam (TRW p. 54), is raised ¾ inch (19 mm), it will stop shuttles from falling off when beating.

Weighting the batten

A more heavily weighted batten than previously advised – e.g. 1 lb per inch (180 gm per cm) of batten width – may seem cumbersome at first, but very soon feels normal. Combined with a straight-armed backward pull it gives a really efficient beat; only one such beat is necessary after each pick.

Marking the centre of the batten in some way, e.g. with a dome-headed nail, acts as a visible and palpable guide which ensures the two hands are equidistant from the centre when beating.

Universal tie-ups for countermarch looms

Fig. 129 shows two different universal pedal-to-lam tie-ups for a four-shaft countermarch loom; A being devised by the late Lore Yongmark, B by myself. Once made they never have to be changed, because by depressing *two* pedals at a time, one with each foot, all the fourteen sheds possible with four shafts can be obtained.

Of the eight pedals in use (A to H), the four on the left (worked by the left foot) control only two shafts – 1 and 3 in Method A, 1 and 2 in Method B – being unattached to the other two shafts which are controlled by the four pedals on the right (worked by the right foot).

The sheds are produced as follows.

	Lifts	Method A	Method B
Plain Weave	13	B + H	C + E
	24	A + G	D + F
2/2 Twill	12	D + E	B + H
	23	C + E	D + E
	34	C + F	A + G
	41	D + F	C + F
1/3 Twill	1	D + H	C + H
	2	A + E	D + H
	3	C + H	A + E
	4	A + F	A + F
3/1 Twill	123	B + E	B + E
	234	C + G	D + G
	341	B + F	C + G
	412	D + G	B + F

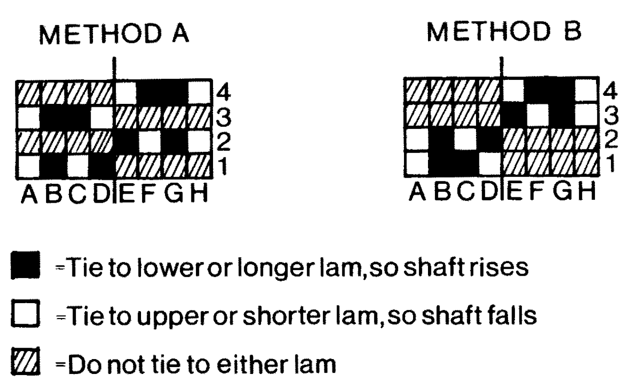


Fig. 129

Gate for pedals

A wooden frame with uprights separating the pedals, known as a gate, can prove helpful. It is fixed under the loom in front of the pedal-to-lam ties; see *Fig. 130*. It prevents any side-to-side swinging of the pedals which are therefore always exactly where the feet expect them to be. The gate can also be used to make the pedals fan out as they pass from the back to the front of the loom; see Plate 72 (p. 156).

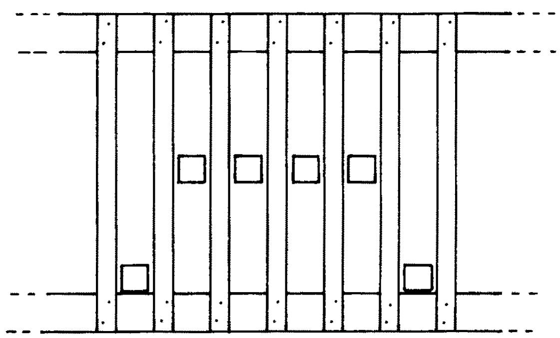


Fig.130

Warp extender

The extension advised for difficult warps (TRW p. 54) combined with a sectional warp beam, really solves all problems of even warp tension for the rug weaver. As previously described, this extends horizontally backwards and takes up much space; but the idea works equally well if the extension is upwards; see *Fig. 131* and left-hand loom in Plate 72 (p. 156).

The extension pieces can be slotted angle iron fixed to the inside of the back uprights of the loom as shown. To these the cross-bar, A, is bolted. The warp passes from the warp beam up to and over A, then down and under B to the shafts. A, which may initially have to be reached by ladder, is gradually lowered as more warp is wanted, the beam never being touched during the weaving of a rug.

A rug loom with a more sophisticated control of A is seen in Plate 72 (centre). A small handle at one side turns two threaded rods in unison and these, passing through A, control its height with ease and accuracy.

A raddle, fixed on top of A or near it, should be used to keep threads parallel in their long journey from beam to shafts. The raddle should have at least 3 or 4 dents per inch.

When a rug has been woven, wind on the cloth beam until the last picks of the rug are some way under the breast beam. Now release the warp beam and move the bar A to its furthest or highest position, drawing warp from the beam for the next rug; then fix the beam again. Only now cut the rug from the loom, leaving at least 10 inches (25 cm) of warp for the fringe. This sequence of first moving the cross bar then cutting the rug off avoids several problems.

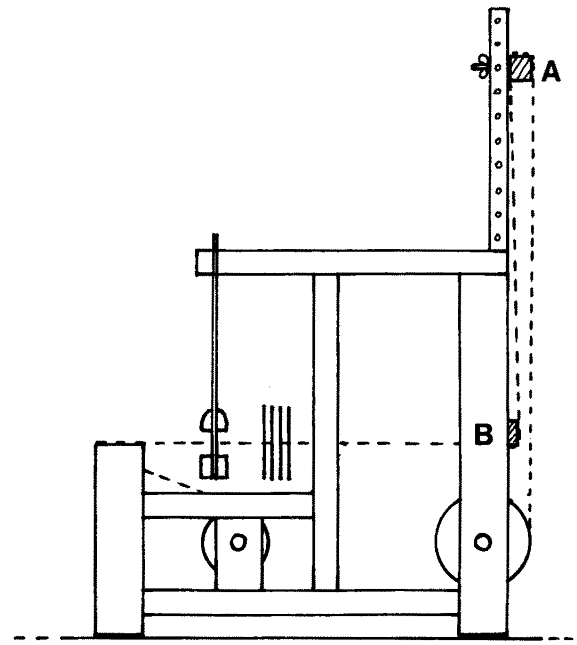


Fig.131

Beaming the warp

Using the above warp extender, the only requirement in beaming the warp is that the ends go on so tightly that they do not shift during weaving. A warped beam with an uneven surface, which would normally lead to progressively worse tension problems, is acceptable because the length of warp going into the rug is *off* the beam before weaving starts and so stays at a perfectly even tension. This implies that, when using a sectional beam, a tensioner less elaborate than the one formerly described (TRW p. 64) is adequate. For instance, the common tensioner with a set of dowels works well as long as the drag on the warp is increased by wrapping ends round one or more dowels, as shown in *Fig. 132*.

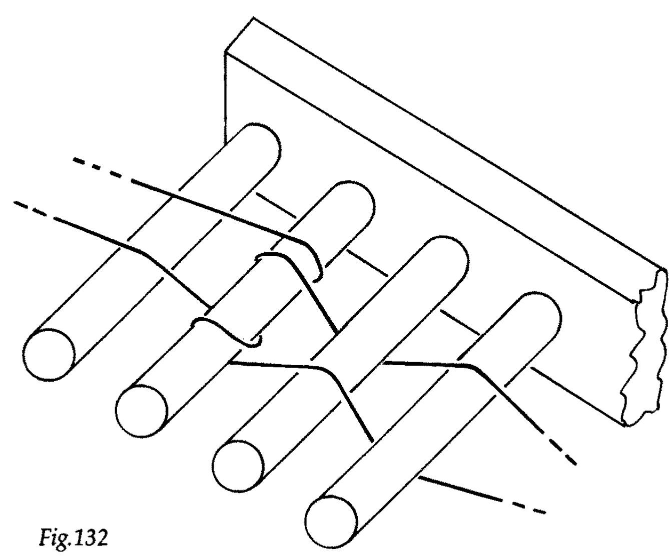


Fig.132

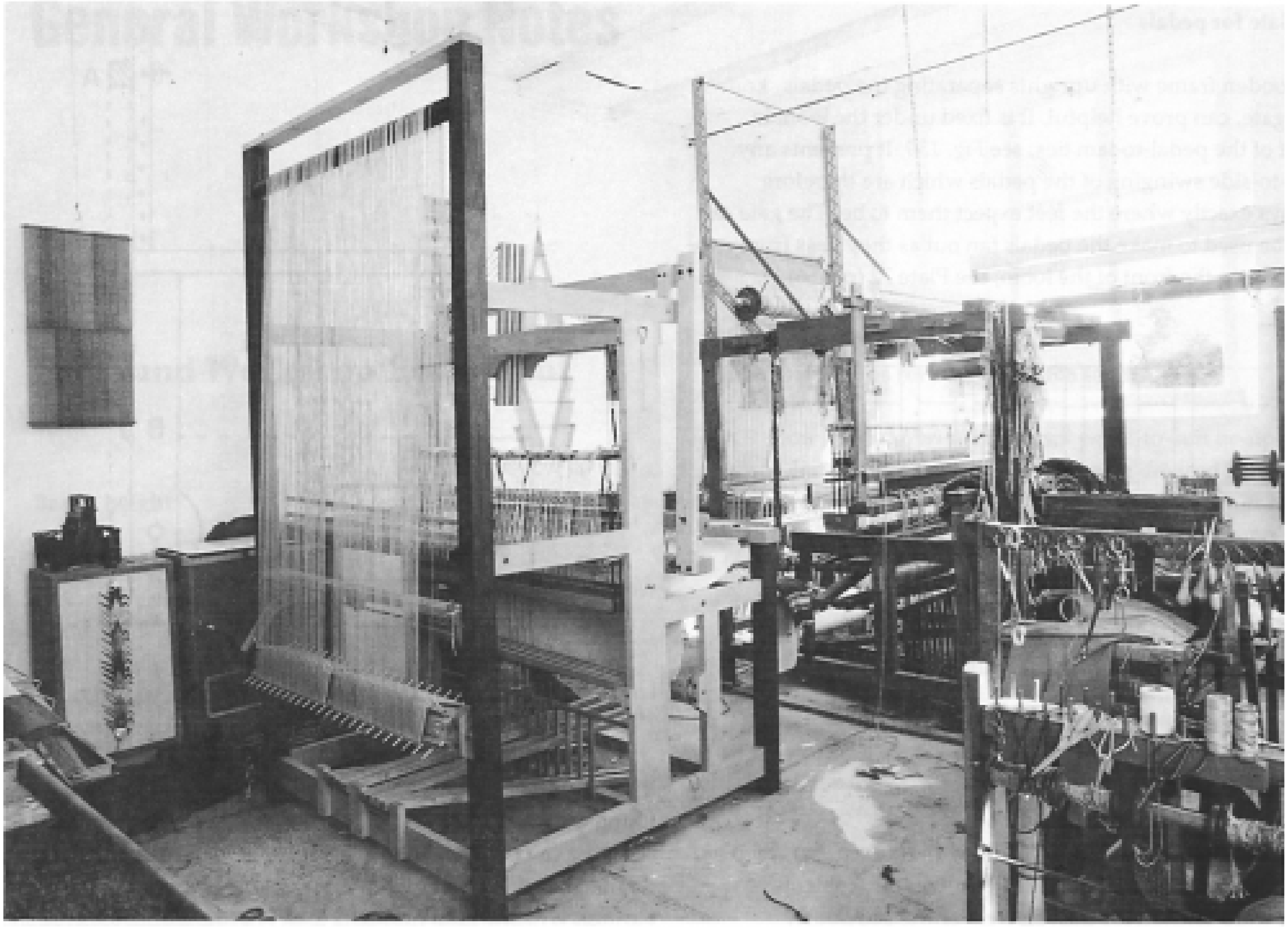


Plate 72 (above): Warp extender on the rug loom designed by the author and Harrisville Designs (Harrisville, NH, 03450, USA).

Storing ski shuttles

Ski shuttles can be neatly and compactly stored hung on wooden dowels. Find the maximum size of dowel which will fit under the hooked end and fix it horizontally into the wall. Shuttles can then be threaded on to the dowel, facing alternately to right and to left, to take up least space; see *Fig. 133*.

Bumping bar or donkey

To make sure a skein unwinds easily and without tangling, it should first be 'bumped'. Slip it over the end of a strong, smooth bar (the bumping bar or donkey) – e.g. a length of old warp beam bolted to the loom frame. Take care that the correct opening of the skein is made; see *Fig. 134*. Then insert two hands into the lower loop from opposite sides and bang downwards (see arrow), slip the skein round a little, bump it again and so on. Doing this will make previously loose threads disappear and the skein will gradually return to the ordered state it was in when first made. Transfer it carefully to the skeiner and it should unwind with no trouble.

Tying hanks

If tying hanks for dyeing or washing, make a minimum of three equidistant ties, one where the two ends of the threads are joined, and two other figure-of-eight ties using a contrasting material or colour. Then if the skein is held up by one tie there is always another at the side which can be pulled outwards to find the opening of the skein, as in *Fig. 134*.

Skeiner

Carpet wool sometimes comes in very large skeins which will just slide off a skeiner of the umbrella type, especially if it is set up with the axle vertical. It is best to have a skeiner which revolves round a horizontal axis. Then it can be used for winding skeins (by inserting a stick into the spokes to make a turning handle) as well as for unwinding them. Here, as anywhere in the workshop, industrial equipment if obtainable will probably outlast any equipment made specifically for handworkers.

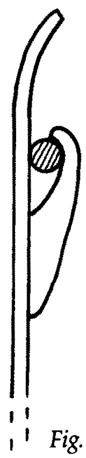


Fig.133

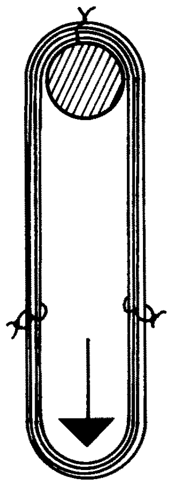


Fig.134

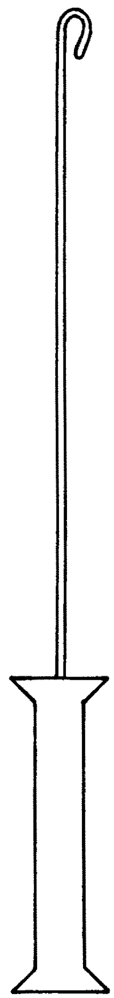


Fig.135

Threading hooks

Most hooks have an end with a stamped-out notch. Though well suited to normal warps they are troublesome with a thick rug warp, especially if two or more ends are drawn in together through one heddle eye. Much more satisfactory is a hook made of stiff wire, mounted in a handle, such as a wooden bobbin; see *Fig. 135*. The wire should be about 1/20 inch (1.25 mm) in diameter and the whole can be about 8 to 10 inches (20 – 25 cm) long. Such a hook will handle several ends at once and, being smooth, cannot snag or split the warp material.

Temples

Very neat temples are now available from Finland. Being made of metal, they are strong without being bulky and without obscuring the part just woven. They allow 2/5 inch (1cm) adjustments in length, which, though not ideal, is adequate. When the temple is inserted right at the start of the rug, be sure that some pins are not imbedded in the front stick, if wooden, and then snapped off by the beating.

Weaving

Tying linen

Linen rug warp has strength but also an annoying slipperiness. But, remember, this vanishes if the linen is damp. For example, when tying to the front stick, a licked finger applied to the relevant part of the yarn will ensure that the first half of a square (reef) knot will not slip while the second is tied.

Also, when working a weft protector, like the Damascus Edge, keep dabbing water (with small paint brush) on to the next few ends where they emerge from the rug and the simple knots will not shift.

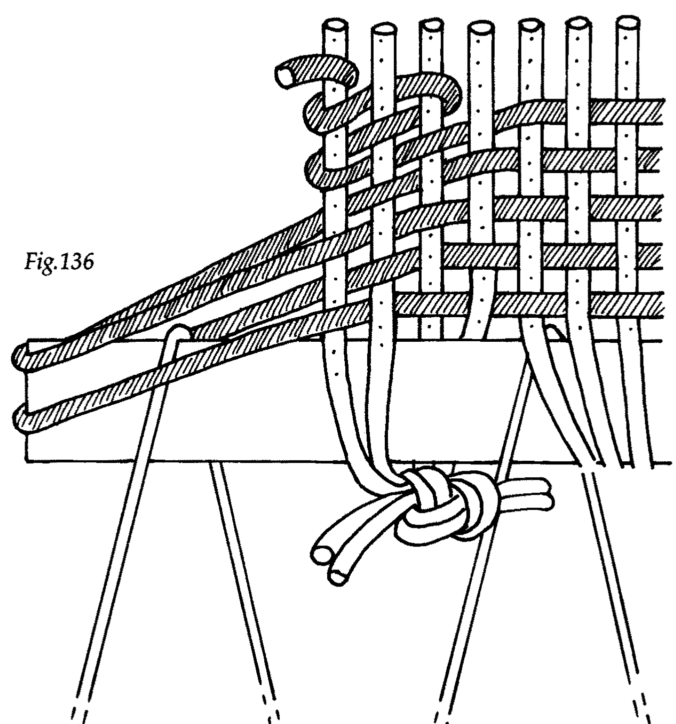
Opening warp groups

Weaving the heading picks under tension increases their ability to spread the warp. Pull each pick tight, then catch it around the end of the front stick (to prevent pull-in) before throwing it back. If the fell, so produced, has a slight curve, straighten it with some extra picks just at the edge, as in *Fig. 136*.

Weft yarn

The carpet wool often referred to in the text has a count of about 2/50 . This means it is 2-ply and has 50 yards to the ounce; i.e. 800 yards to the pound, (1600 metres to the kg).

Fig.136



Of course, other yarns of other counts can be used; the ideal wool yarn being 2- or 3-ply, worsted-spun from long staple wool and with a fairly light twist. A highly twisted yarn will not cover the warp so easily. Remember that the *visible* thickness of a possible weft yarn is of little relevance because it is the size it will compress to when woven and beaten in which is important. So overtwist it and roll between the fingers to get an impression of its compressed size and then compare this with the recommended carpet wool, similarly twisted and tested.

A rough and generous estimate for the weft of a flat-weave rug is ½lb per square foot or 2.5kg per square metre.

It is always useful to know which yarns in a workshop can be snapped by hand and which need to be cut with scissors. I know I can break three strands of 2-ply carpet wool (the thickness I often use on a shuttle), but not four strands. Searching for scissors to cut easily breakable threads wastes time.

Weft tension

Always remember to pull slightly on the weft coming from the selvage before throwing the shuttle into the next shed, in order to eliminate the small degree of slack which inevitably exists in the last few inches of the previous pick. Failure to do this leads to vertical ridges of loose weft near both selvages.

Using a ski shuttle

Wind the weft round the two hooks in a circular, not figure of eight, manner, as the latter increases the depth of the loaded shuttle thus making throwing harder.

Without even looking, the weaver should be able to catch a ski shuttle somewhere near its centre as it emerges from the shed. The eyes should be fixed on the selvage the shuttle has just left, ensuring the weft is properly positioned and tensioned there. Practice this with an empty shuttle.

Only unwind from the shuttle enough weft for the next pick. Working with a great length of slack weft which has to be hauled through every shed is very time-consuming.

A ski shuttle, unless overloaded with weft, should pass easily through a shed only 2 inches (5 cm) deep. So the large, much-favoured, sheds produced with a jack loom on a lightly tensioned warp are not necessary; in fact, with a correctly taut linen warp they are impossible to make. I ask weavers with this deep shed obsession whether they intend to crawl through themselves, dragging the weft behind them.

There is a tendency for the hook on a ski shuttle to catch a warp thread as it enters the small half-shed above a floating selvage. This can be avoided if the shuttle is slightly twisted at this moment, so that the hook is more towards the reed and its underside more towards the weaver. Once past this danger point, it is straightened and thrown normally.

Beating

In rug weaving, beating does not require finesse as the weaver is usually beating as hard as possible. It is not like the controlled or varied beat required in fine weaving. Only when weaving a narrow sample does the heavy beat have to be modified otherwise an over thick fabric will be woven, which is impossible to reproduce at full width. An overslung batten can act as a pendulum giving a regular speed to the weaving. After a weft is beaten, the batten swings back freely, then forwards, then back again. By this time, the next shuttle should be poised and ready for throwing and, while the non-throwing hand holds the batten in that backward position, it is shot across and the cycle repeated.

Darning in weft

A suitable wire to use when darning in the weft ends with a needle and wire loop is an unwound guitar string with a diameter of .016 or .017 inch. One of these will make four or five loops. Simply double over an 8-inch length. Make a handle by bending over the cut ends, as shown in *Fig. 137*, wrapping tightly with yarn to bury the sharp points and then dipping in glue. Alternatively, the wire can be fixed into a proper handle; an Exacto knife handle works well.

An even simpler darning-in implement is made by tying a loop of fine strong yarn through the eye of the darning needle, making the knot as small as possible. The weft end is placed through this loop and as the needle is darned down into the rug in the usual way it draws the weft in after it. So the weft is never actually threaded through the needle's eye.

A magnet fitted to some upright of the loom near the breast beam is a simple and efficient way of holding the needle and threader.

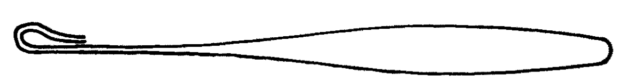


Fig.137

Floating selvages

All selvage problems can be solved in rug weaving by using a floating selvage – i.e. by leaving the outermost working end on each side unthreaded through the shafts, but sleyed normally through the reed. The shuttle always enters a shed by passing over the floating selvage and always leaves by passing under the floating selvage at the opposite side. The latter will happen naturally if the height of this selvage is carefully adjusted.

But this rule, if followed blindly, can lead to over-long weft floats at either selvage. So if a floating selvage is in use, the weft both when entering and leaving the shed must negotiate the floating selvage in a way which avoids such a float. It may take several repeats of a pattern sequence to arrive at the neatest solution, but once found it should be adhered to.

Unweaving

Preserving the weft

Sometimes, when using a complex weave or a pick-up technique, it is hard to trace in reverse sequence the sheds which were used and so release the weft. One solution is to use the weft itself as a leash.

On a flat warp, pull up a loop of weft from the last pick, as shown in *Fig. 138(a)* (which does not show a complex weave). This will lift ends 1,3 and 5 and so allow the shuttle to pass under them to the left and draw out this section of weft.

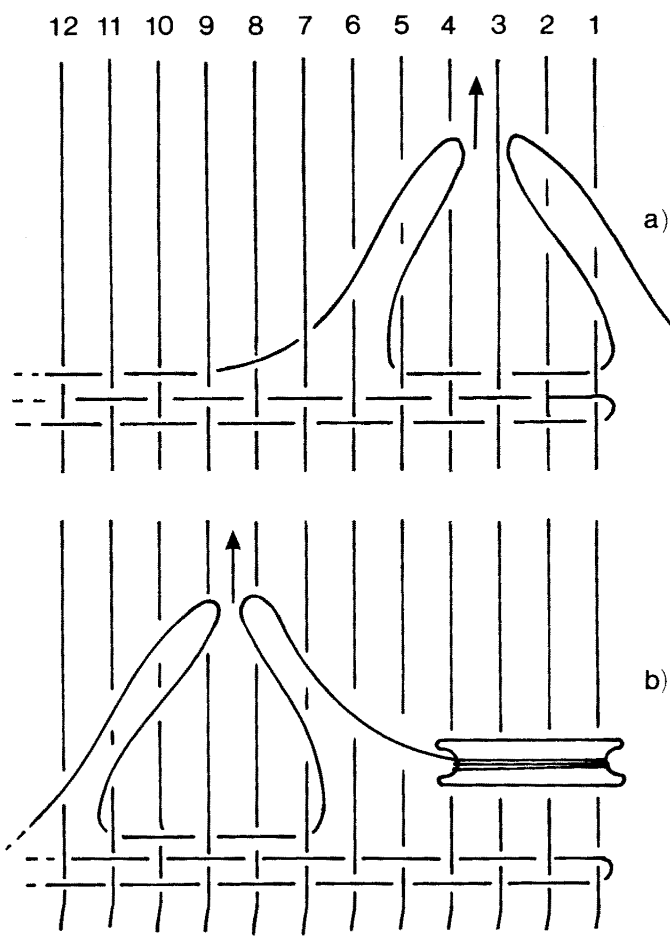


Fig.138

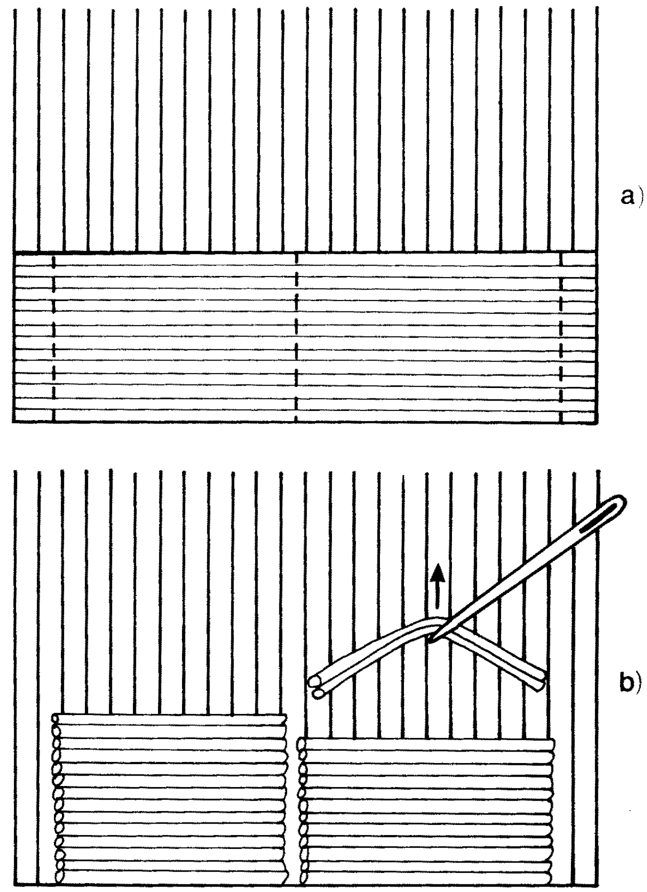


Fig.139

Now pull up another loop to the left, as in *Fig. 138(b)*. Working like this all across the warp, first to the left and then to the right, each pick can be extracted slowly but surely.

Destroying the weft

Occasionally, pressure of time or a cheap weft make the following method preferable.

Cut through the weft in three places, carefully inserting the scissor blade *between* two warp ends. As the dotted lines in the diagrammatic *Fig. 139(a)* show, cut at the centre and close to each selvage. The small outer sections can be easily pulled out by hand. To remove a central section, repeatedly drag a large needle up over its top edge. This will push up several lengths of weft which the other hand can remove; see *Fig. 139(b)*.

Conclusion

Remember that, in all the operations of handweaving, it is regularity which is the aim. Visible irregularities which say 'This is handwoven' usually say, as well, 'This is badly handwoven'. Luckily the loom is a fairly advanced bit of machinery and it only requires the hands and feet to do relatively simple and unskilled actions. There is nothing in weaving requiring the manual skill possessed by a potter. A beginning weaver can press a pedal as 'skilfully' as an experienced professional. The one skill vital to the weaver is the ability to judge tension in threads. As there is no operation in ordinary life requiring this sensitivity, it has to be gradually acquired until an evenly tight warp can be tied to the front stick and an evenly relaxed weft laid in the shed. To spend time tying and retying a warp only to have the teacher point out loose groups is one of the humiliations suffered by every learning weaver. Good equipment helps, but sensitivity to thread tension has to exist in the weaver's hands before a good rug can be woven.