

loimi ja kudel.  
vastaista pomsia  
yhdistetty.

33  
5K-8  
5P-8  
5T-8

2x  
2x  
2x  
8x  
6x

12 11 10 9 8 7 6 5 4 3 2 1

TREADING P.

34.57

# MASTER WEAVER

Thread from A to B  
Thread from B to C  
Thread from C to D  
Thread from D to E  
Thread from E to F

lines  
lines  
lines

ja

26-

Threads 880  
Inches Wide In Reed 12.5  
72D

D C

3-752 K

Oikeanpuoleisen  
rakente.

vasemmanpuoleisen  
rakente.

BI-MONTHLY BULLETIN  
FOR HANDWEAVERS



Z-HANDICRAFTS  
FULFORD, QUE., CANADA

MARY MEIGS  
A T W A T E R

DIED SEPTEMBER 6 IN SALT LAKE CITY  
SHE WAS THE GREATEST PIONEER OF THE  
REVIVAL OF AMERICAN HANDWEAVING.  
DURING FIVE DECADES SHE TAUGHT  
GENERATIONS OF CRAFTSMEN, BUT SHE  
HERSELF WAS NEVER TIRED OF LEARNING  
MORE. SHE HAS SHOWN US NOT ONLY  
HOW TO BE GOOD WEAVERS, BUT FIRST  
OF ALL HOW TO BE HONEST CRAFTSMEN.

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# MASTER WEAVER

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Z - HANDICRAFTS - FULFORD - QUEBEC - CANADA

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November, 1956

No. 30

## WEAVERS' GUILDS.

In the middle ages and as late as the beginning of the 18th century a Weavers' Guild was nothing else as a mixed labour-management union. Its aims were: to protect the members from unfair competition, to maintain a reasonable level of prices for both: work, and produced goods, and to supervise the training of young workers.

Protection of members from competition was easy since the Guilds had practically a monopoly in production. An "unfair competitor" would then be anybody, not a member of the Guild, who would produce similar goods. And of course if the goods were not "similar" then they would compete with another kind of a Guild. The Guilds would then see to it that such a free-lancer could not get any supplies of raw materials, and that the markets would be closed to his products.

Prices were maintained by eliminating competition, and by "lobbying" with the view to enact laws forbidding import of similar and cheaper goods from abroad.

Supervision of training was very strict and had as its purpose production of highly specialised master weavers. Even then it was obvious that a weaver can be very good only if he limits himself to a very narrow speciality.

Guilds were very exclusive, and joining one of them was often impossible unless one was born in a weavers' family, or if one came from another district or country already as an accomplished weaver. But then to be a weaver he had to belong to a Guild first.

In the countryside there were peasants weaving for their own or their community needs. They were not organised, although again the trade remained usually in the same family.

The industrial revolution destroyed the power of the Guilds, so that hardly anything but the name remained. The trade unions on one side, and the textile companies on the other took over.

The only weaver who was not affected for a few decades was the peasant and in more backward countries he was not affected at all until the last great war. For that matter he was doing his work with about the same yarns and on about the same looms for ten centuries or more.

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It is a peculiar coincidence that this peasant-weaver, who survived the industrial revolution precisely because he never belonged to the Guilds, inspired later on a new generation of hand-weavers, and thus became a spiritual forefather of a new network of Weavers' Guilds.

\*\*\*\*\*

What is a modern Guild, and what are its purposes?

Perhaps it is not very strange that in spite of completely different conditions in which we live, the essential purposes of a modern guild are the same as they were two hundred years ago.

Obviously a modern guild cannot protect the members from the "unfair" competition of power weaving. Nothing short of a total nuclear war can. But the guild can protect the members from the competition of other less scrupulous craftsmen who sell mass-produced cheap wares made on half-automatic looms - as exclusive hand weaving. We have discussed this point when speaking about standards.

It can also help to maintain reasonable prices. By "reasonable" we mean minimum prices. We have nothing against weavers who overprice their goods. If they cannot sell them it is their concern. But the Guilds can see to it that the members do not figure out their prices on the basis: "so much for the yarn and a little more". The Guild's approval seal should be given only for articles properly priced. This applies to the non-members as well.

But the main concern of every Guild should be the training of new craftsmen. First by supplying them with information about schools, teachers, books, publications, etc. Then, then by helping the members to test their own skill and knowledge in competitions, exhibitions, tests of skill with or without certificates. This subject has been also discussed in full in our articles about Standards. Guilds with large membership should also organise workshops, and lectures, possibly with lecturers or instructors from other guilds. This can be done at a reasonable rate or on exchange basis.

Much less important are "socials". They may be a pleasant addition to other activities, but if they are the only sign of a guild being alive, the members should do something about it.

Fortunately most of the guilds on this continent do what they can about at least the 3-rd point of the schedule, i.e. education. And there are quite a few thinking seriously about the seal of approval and other ways of protecting their members.

It is obvious then that each weaver can only gain by joining a guild. The fees as a rule are negligible, but the duties of each member should be taken seriously. A guild can be only as active as its members, and "honorary" members are of little use.

Now, which guild should I join? Usually the same territory is covered by several. There is one, two, or three local guilds in a large city. There may be a State or a Provincial one, or even a National one (there is not any so far, except for craftsmen guilds - much wider organisations than Weavers' Guilds).

But our choice is much wider than that, because in most cases the by-laws of a Guild do not forbid you joining it, even if you live thousands of miles away. We may say that there is not much point in doing it, but let's not forget that many guilds publish quite interesting bulletins, and have competitions and exhibitions for members only. Thus the choice is unlimited. But what kind of a guild should one select?

It is a good idea to write identical letters to several guilds we would like to join. Ask about the membership, and the by-laws. From the point of view of a new member the best guilds are of medium size. Very large ones become too impersonal in their relations with individual members, when the very small ones have very limited means.

Then study the by-laws carefully. The by-laws should be signed by the officers of the guild, dated, and registered somewhere. The laws about societies change from state to state and from province to province, but in general institutions of this kind can and must be registered before they can collect any fees from the members. When reading the by-laws we should pay attention to the character of the guild. A really "democratic" guild has officers elected by the General Assembly of all members. The officers can not serve for more than two years in the same capacity. If the membership is widely dispersed, the ballot can be taken by mail, but there must be a committee which receives and counts the votes.

The guilds without properly registered by-laws are at the best private enterprises, hardly "democratic". At the worst they are nothing but a source of potential trouble, since their right to collect fees from the members is extremely doubtful and may be questioned by the authorities.

The by-laws should also give you the answer to the most important question: whether you are eligible as a member.

Once you have selected and joined a guild, try to be an active member. Try to belong to all the branches, committees, and sections. Take your duties seriously. Remember that on your sharing in the interests of a Guild depends the future of handweaving and of crafts in general.

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There are also Guilds of an entirely different nature. They are organised by a person or a group of persons as a business venture. They do not pretend to be what they are not. They offer to the members definite services such as periodicals, books, lessons, sometimes even tests and certificates of skill. They are more expensive of course, but the member being always on the receiving end so to speak, they could not work otherwise. Personally each member gets much more from such an organisation, but his role is limited to paying the fees. They are run efficiently or do not stay long in business. Except for the name they have hardly anything in common with the Guilds under discussion, and the only reason we mention them here is to avoid confusion.

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# CROSS • WEAWE

Strangely enough this old weave acquires new interest in our so called modern weaving. This is because it gives us a freedom of choice in the matter of setting the warp. As we all know, there are two distinct limits of making an "open" warp, i.e. a warp with very few ends per inch. The first limit is set by the drawing-in of the edges. When we have too few ends of warp per inch, the take-up on the weft is much too high. The wefts winds around the warp without a similar action of the warp taking place. Therefore, unless we weave at a very slow rate, leaving plenty of weft in each shed, the edges will be drawn-in to a point where further weaving will be impossible because of the breaking edges. The second limit is encountered when in the finished fabric the weft slides along the warp either in washing or even when the fabric is being exposed to the normal tear and wear. We are only too familiar with spectacular modern fabrics which seem to desintegrate under their own weight.

Thus, when we try to make a light fabric with comparatively heavy yarn, we can not go below a certain sett of warp - at least not with normal weaving techniques.

But there is a whole class of weaves, to which the rules governing the sett of warp (see MW 8/1, 19/3, 28/1) do not apply. These weaves are called Leno in power weaving, and Cross Weaves in handweaving.

The general principle of all Cross Weaves is that the ends of warp are not parallel to each other, but that they "cross" each other at regular intervals. Fig.1 shows the simplest case: the first pick of weft (C) goes under warp-end A and over end B. Then before the next pick of weft is made, the two ends are crossed, or twisted around each other. They really make only half of a turn. They are kept in this position when the second pick of weft (D) is made. This pick goes over B and under A. After the second pick the ends of warp are twisted in the opposite direction (or untwisted), and this is the end of one repeat of our weave.

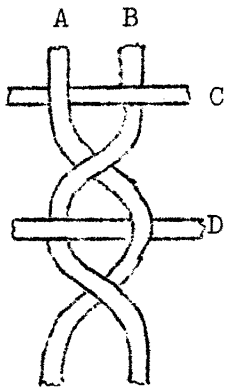


Fig.1

So far we are not concerned with the method which will produce the twist. For that matter there are several methods, of which four can be used by a handweaver.

But before we go any further we must say a few more words about the cross-weaves in general.

The weave shown in fig.1 is the basic cross-weave, properly called Gauze. The name should not be confused with so called Gauze fabrics, usually woven in tabby reinforced with some sort of size

(gluc, starch, etc.). These are really imitation gauze, and have nothing to do with cross-weaves.

If one repeat of gauze alternates with plain tabby (always an odd number of shots of tabby) as in fig.2, the weave is called

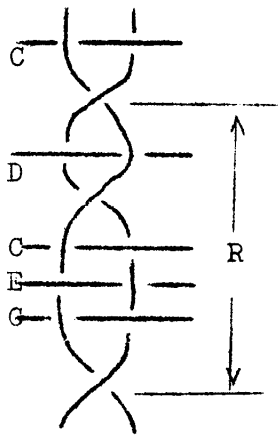


Fig.2

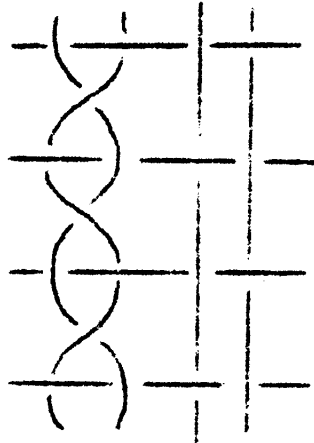


Fig.3

Leno. Here again we have confusion, because in industrial power-weaving all cross-weaves are called Leno, and many handweavers follow the industrial terminology. Then we have also the "Mock Leno", which is another imitation either of Gauze, or of Leno.

Not all the warp-ends must be crossed in weaving. We may have for instance one pair crossed, and the next woven as plain tabby; or several repeats of gauze may follow several repeats of tabby. Such a weave is (or rather has been)

known as Pickets. Fig.3 shows the simplest case of Pickets. Finally Leno and Pickets can be combined so that we have squares or rectangles of Gauze on a background of tabby. The old English name for such a weave is Riddles.

Gauze, Leno, Pickets, and Riddles are four cross-weaves which can be made on a four-harness-frame loom. We shall limit ourselves in these articles to the cross-weaves for four frames, because the higher weaves of this class are rather difficult to present on paper and still more difficult to weave. The weaver who will succeed with the technique described here will do well to study Murphy's "Art of Weaving" out of print but available in public libraries.

\*\*\*\*\*

Of the four above mentioned methods of crossing warp ends, we shall describe here only one - in our opinion the easiest and presenting more possibilities than any other, but first we shall enumerate all four:

1-st. Cross weaves by pick-up. This gives us a complete freedom of weave and pattern, but is so slow that it cannot be seriously considered except for making narrow borders on large articles. Many weavers are quite familiar with this method.

2-nd. Traditional method which requires half-heddles (doups), and plain heddles (standards) to cross the ends. It has been described several times, recently in the Handweaver & Craftsman. It is a very good method but with four frames gives only Gauze or Leno.

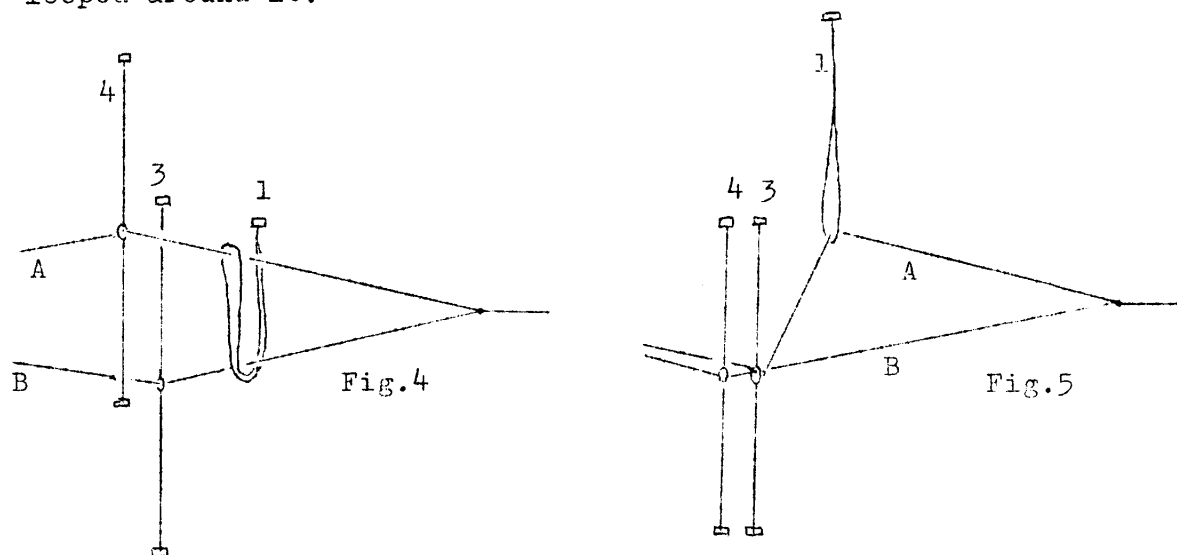
3-rd. A variation of the above method (without "standards") which we shall describe presently.

4-th. Industrial methods with patent steel heddles. These heddles fit hand looms as well. They are rather expensive, and from the point of view of a handweaver hardly superior to the classical doups and standards.

\*\*\*\*\*

The doups are loops of fine thread slightly longer than half the length of a wire or steel heddle. The material of which the doups are made is of prime importance. They should be strong, resistant to friction, but at the same time pliable. Ordinary sewing thread No.40, doubled - is quite satisfactory. Two threads can be twisted together on a spinning wheel, the direction of twisting opposed to the twist of the thread. For the first experiments about 100 heddles will do. We shall need therefore close to 40 yds of the double thread. The thread is cut first into pieces about 6 feet long. Each piece is hung from a nail with a small weight tied to the lower end. Let it hang for a minute or so until the weight stops spinning around. This operation is necessary to remove the excessive twist which otherwise would result in kinks and snarls in the finished doups. Then we drive two 2" nails in a piece of wood 6" apart, and make doups around these two nails. Each doup will be about 6" long.

To weave gauze or leno we do not need any wire heddles either on the 1-st or the 2-nd frame. For the time being we shall not use the second frame at all. All doups are hung on the top bar of the first frame. They are not threaded on the bar, but simply looped around it.



Now we prepare a warp of plain or mercerized cotton No.10/2. We can set it at 16 ends per inch, and use No.8 reed. The threading is done as follows (see fig.6, next page). In each repeat of gauze we take first the end A and pass it through the heddle on frame No 4, and then through a doup on frame No.1. Then we pass the threading hook to the left of the doup (which is already threaded), and



through a heddle on frame No.3 to the right of the already threaded heddle on No.4. This is one repeat of Gauze. It is absolutely essential that both warp ends of the same repeat go into the same dent of the reed. In the same way we thread all warp ends.

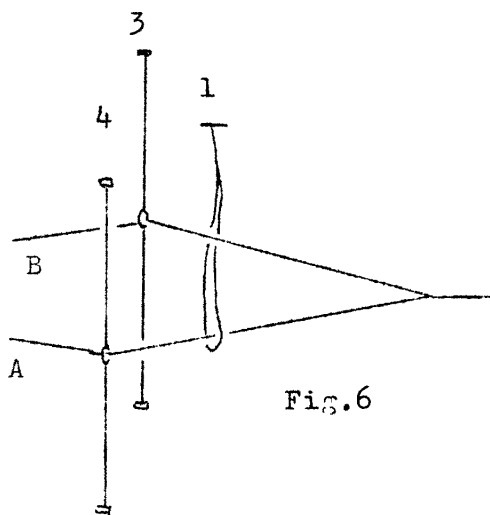


Fig.6

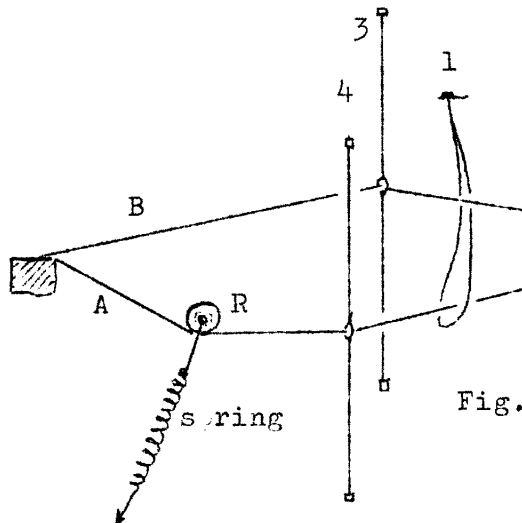


Fig.7

Before we start making the tie-up we must understand how the whole set-up is going to work. To get the first shed of Gauze (fig.4) we must raise frame No.4, and sink No.3, because this is one of the tabby sheds. But we must also lower frame No.1 to get the doup around the warp-end B. Otherwise the doup would pull B up, and A down, so that we would have no shed at all. The tie on frame No.1 must be a little shorter than the tie on No.3. Thus our first treadle will be tied to sink frames 1 and 3, and raise No.4.

The gauze shed (with twisted warp ends) is shown in fig.5. Both frames 3 and 4 are sunk, and No.1 raised. This shed is always the one which gives us trouble. It is clear from fig.5 that to get a good shed we would have to have the warp-end A much longer than B. We shall come later to this problem, but we may say here that this is the reason why most of the doup leno sheds hardly open at all. Our second treadle will be tied so as to sink No.3 and 4, and to raise No.1.

Two treadles are enough for plain gauze. To weave tabby between shots of gauze, we must have a third treadle which will produce the second tabby shed (fig.6). Here No 3 is raised, No.4 sunk, and No.1 half way between the two. This "neutral" position is achieved by making the tie about 2 to 3 inches longer than normal ties. The third treadle then will sink No.4, raise No.3, and half-sink No.1 .

Fig.8 shows the whole tie-up for the sinking shed, and fig.9 the tie-up for rising shed.

0	0	
	0	0
0		0
3	2	1

Fig.8

		0
0		
0	0	
3	2	1

Fig.9

To weave plain tabby we shall treadle: 1, 3. For Gauze: 1, 2. For Leno: 1, 2, 1, 3, or:

1,2,1,3,1,3, or 1,2,1,3,1,3,1,3, etc.

Before we can try more complicated weaves, we must concentrate on the adjusting of the tie-up, so as to have all sheds open, and clear.

We start with treadle 3. Adjust frames 3 and 4 so as to have good tabby shed, and then No.1 so that the doups will not tangle in the shed (the frame No.1 too low), or pull the lower part of the shed up (the frame too high).

Then comes treadle No.1. We adjust first frames 3 and 4, and then shorten the tie on No.1 until the top bar of the frame nearly touches the open shed. Even so the doups may tangle in the shed. Increase the tension of the warp, and press firmly on the treadle. If this does not help, try treadle 2 before treadle 1. Treadle 2 should clear the shed (of course we do not throw the shuttle on this treadle). If even this does not work, the doups are too stiff. Try to soften them by forcing the shed No.1 open with fingers if necessary. Keep changing sheds for several minutes until shed No.1 becomes clear, or until we decide that the doups must be replaced with softer ones.

Finally we come to the shed No.2. First we adjust ties to frames 3 and 4. They must be both on the same level. Then we get No.1 to rise quite high - higher than normal. Even so the shed will be very poor. To get a better shed we must provide the extra length for warp-ends A.

To do this we need an extra roller which would pull down all warp-ends threaded through frame No.4 (fig.7). We can make this roller from an old broomstick. Cut a length equal to the width of the reed. Drive one nail (1½") in each end of this roller, so that about ½" will project. Then tie one screen-door-spring to each nail. Tie a length of string to the other end of each spring.

Now we open shed No.3, pass the roller through the back shed, so that both ends of the roller will project from the warp to the left and right, and tie both springs to the loom frame. There should be a fair amount of tension on these springs.

To provide the extra length of A, we shall weave plain tabby for several inches. There will be more take-up on ends B, since they are not pulled down by the springs, and consequently the length of A will increase when compared to B. If we decided that this process went far enough, we can try again to open shed No.2. If "A" (see fig. 5) rises but it pulls up "B" at the same time, then the difference in length between A and B is not sufficient - keep on weaving tabby. If the shed hardly opens, and the roller R (fig.7) does not rise, the springs are too tight - release some of the string at the lower end of each spring. If, finally the roller rises, but the shed is still poor, then the tension of the warp is too high. Release it.

This is the most tricky part of cross-weaving, and we should spend quite a lot of time on experiments at this stage, until we get all sheds properly open. With a good loom there is no reason why we should not succeed. The best looms for cross weaves are double-tie-up (Swedish), or counterbalanced. Very light jack-type, and table looms will give only a very poor shed.

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# DESIGNING NEW FABRICS

## A SHORT CUT

This article will concern all weavers who have multiharness looms with a comparatively easy tie-up. As we all know only too well designing new experimental fabrics is a tedious occupation, because each fabric requires a new threading, and it is a rule and not an exception, that it takes several samples to find finally the fabric which will satisfy all our requirements. Thus it is very important to be able to make these samples with a minimum of effort.

Fortunately in case of multiharness looms there is a short cut based on the principle that whenever we use straight threading (12345678 etc), and also straight treadling - the tie-up draft is identical with the draw-down. In other words the tie-up gives the picture of one repeat of the fabric, although turned at right angle.

The whole problem of designing a fabric is reduced to making its draw-down in the space reserved for the tie-up, and then replace the black spaces in the draw-down with marks for the ties.

We start with outlining on a piece of graph-paper a rectangle with as many divisions in the horizontal direction as the number of frames in our loom, and with as many divisions in the vertical direction as the number of treadles. In case of an 8 frame loom with 12 treadles we have a rectangle as in fig.1:

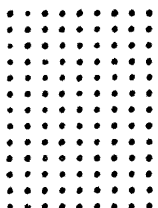


Fig.1



Fig.2



Fig.3



Fig.4

In this space we may design anything we like. With a definite idea of a fabric in mind we shall probably mark first the floats in weft, and then in warp as in fig.2. Then we mark the floats in weft black (fig.3). Finally we decide what to do with the rest of the free space. We can fill it with tabby or some sort of twill. Anything goes except that none of the floats can go right across the whole space from end to end, or this particular warp-end or pick of weft would not be woven at all. Each must be tied at least once. Thus we reach the final stage as in fig.4.

To translate the draw-down into a tie-up we first turn the rectangle by 90°, and then make a sign for a tie in each black square as in fig.5.

The main object of our work is to experiment, to make samples, therefore the warp which we shall make will be a comparatively

narrow one, from 6 to 8 inches. The sett of warp must be average, as for twills, and not for tabby. The yarn for warp should be fairly

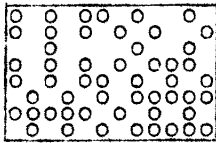


Fig. 5

fine and of a neutral colour. The length of warp depends on the number of samples we intend to make. By the way, one should not try to make all samples possible with plain threading on a 8-frame loom. The theoretical number of them is so high that it even has no name, and when written would have 160 zeroes.

The more frames and treadles, the more possibilities. Let us take for instance a case of 12 frames with 16 treadles. We have a space of 12 by 16 or 192 squares to play with (fig. 6 ). In such a space a variety of weaves and even small patterns can be designed.

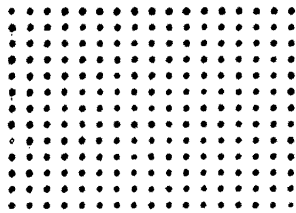


Fig. 6

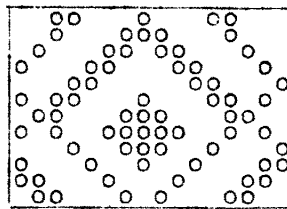


Fig. 7

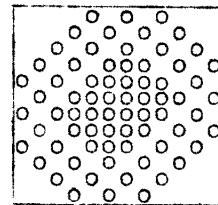


Fig. 8

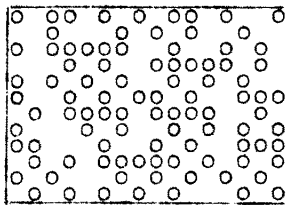


Fig. 9

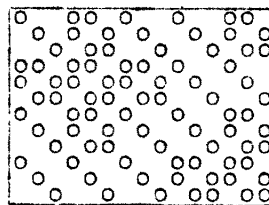


Fig. 10

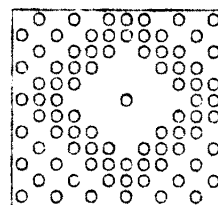


Fig. 11

Examples are shown on figs: 7,8,9,10, and 11. Fig. 7 is an unsymmetrical diamond twill with the longest float of 5. Suitable for curtains etc. Fig. 8 is a sort of a very strong waffle - baby blankets, and blankets in general, bath-towels. Fig. 9 is a modern "texture", and can be used practically for anything except upholstery. No. 10 is based on 1:2 turned twill, and it is definitely a pattern weave; since it has very short floats it is very suitable for upholstery. No. 11 is a firm weave because of the large percentage of tabby - curtains, table covers.

Obviously the method described is good only for making samples. A larger project would require some sort of borders which would have to be threaded in a different way, and also a different order of treadling, which would allow the weaver to alternate the feet when treadling.

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E R R A T A : Master Weaver No. 29, page 3, figure 7. There should be a black square right in the center of the pattern. We apologise!

# ANALYSIS • B

In the example described in the last lesson we had three different stages of analysis: threading, treading, and tie-up. But in practice there are often two more intermediary operations.

Let us take another example (fig.1). We find first the threading in the same way as in the last lesson (fig.2). But here we may

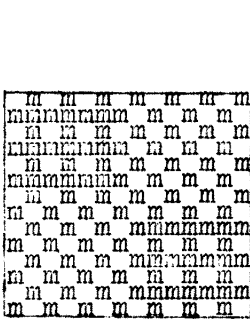


Fig.1

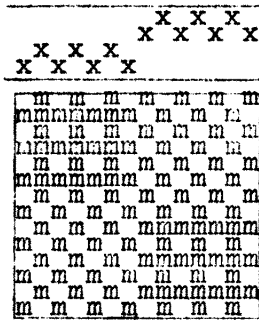


Fig.2

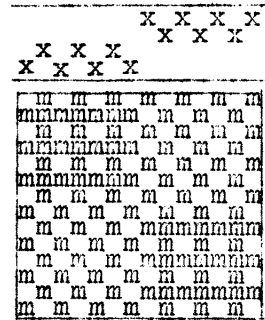


Fig.3

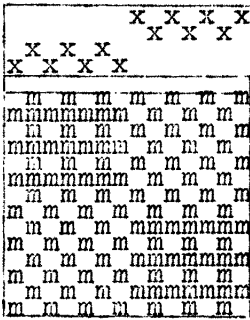


Fig.4

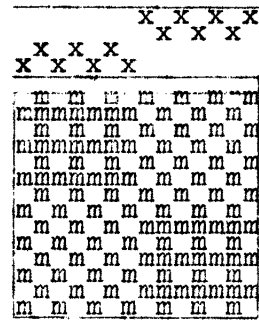


Fig.5

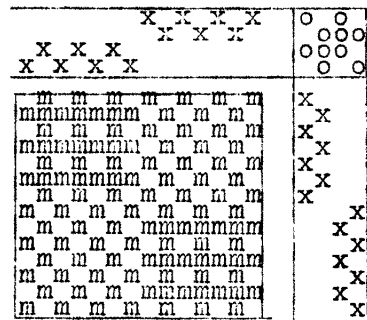


Fig.6

stop for a while. First of all - the reason why we start with threading (we could as well start with treading) is that if we discover at this stage that the number of frames required is too high for our purposes, we may as well stop here, and save time and effort. The other reason is that we may find the threading rather unorthodox, with unusual sequence of harness-frames. At this stage it is quite easy to change the threading into a simpler or more conventional draft, because neither the tie-up or the treading are made as yet. For instance in fig.2 we have a draft which is quite correct, but unconventional. We may find the threading easier if we change it into the draft in fig.3 simply by exchanging frames 3 and 4. This is the first intermediary stage: the rearranging of the threading draft.

Then we find the treading draft as usual, and in result we get the draft on fig.4. There is nothing wrong with it, except that if we use it for weaving, we shall not be able to alternate the feet, which spoils the rhythm of weaving.

Here again by exchanging the last two columns we can get a better draft as in fig.5. Now we can use the right and the left foot alternately. And this is the second intermediary stage of analysis. The last stage is the same as before: we find the tie-up from both: threading and treading (fig.6).

Thus we have now 5 stages of analysis:

1. Finding the threading draft.
2. Rearranging it.
3. Finding the treading draft.
4. Rearranging it.
5. Finding the tie-up.

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When rearranging a draft we must remember that there are not less than twenty four ways of writing the same draft for 4 frames, and it would be pointless to try all of them before deciding which one we like best. We must have a definite purpose when changing a draft. Usually we would like to make it simpler, easier to thread, or to adapt it to a standard tie-up. For instance in fig.7 we made a simple draft from an apparently complicated one:

$$\begin{array}{c}
 \overline{x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x} \\
 \underline{x \ x \ x \ x \ x \ x \ x \ x}
 \end{array}
 =
 \begin{array}{c}
 \overline{x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x} \\
 \underline{x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x}
 \end{array}
 \text{ Fig.7}$$

In fig.8 we have changed the original draft into an easier one:

$$\begin{array}{c}
 \overline{x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x} \\
 \underline{x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x}
 \end{array}
 =
 \begin{array}{c}
 \overline{x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x} \\
 \underline{x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x}
 \end{array}
 \text{ Fig.8}$$

In fig.9 the second draft can be woven on a standard tie-up:

$$\begin{array}{c}
 \overline{x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x} \\
 \underline{x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x}
 \end{array}
 =
 \begin{array}{c}
 \overline{x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x} \\
 \underline{x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x \ x}
 \end{array}
 \text{ Fig.9}$$

\*\*\*\*\*

Not every treading draft can be arranged so that the feet can be used alternately, therefore one should not try too hard. For instance if one repeat of treading has an odd number of picks then it can not be arranged to our entire satisfaction. However if the same treadle is used twice in succession, then it counts as one pick. E.g.: 121334243 has 9 picks or an odd number, but it can be arranged as follows: 232441314. Of course such rearrangements can be done only before the tie-up is figured out, or it would mean changes in the tie-up as well.

In the next lesson we shall deal with drafts which are too long for ordinary analysis.

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IN THE NEXT ISSUE: Gadgets in Handweaving. Pickets and Riddles. Satins and Sateens. Doubling the Weft. Analysis 4.

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