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A Braiding Project — Key-hanger No. 1

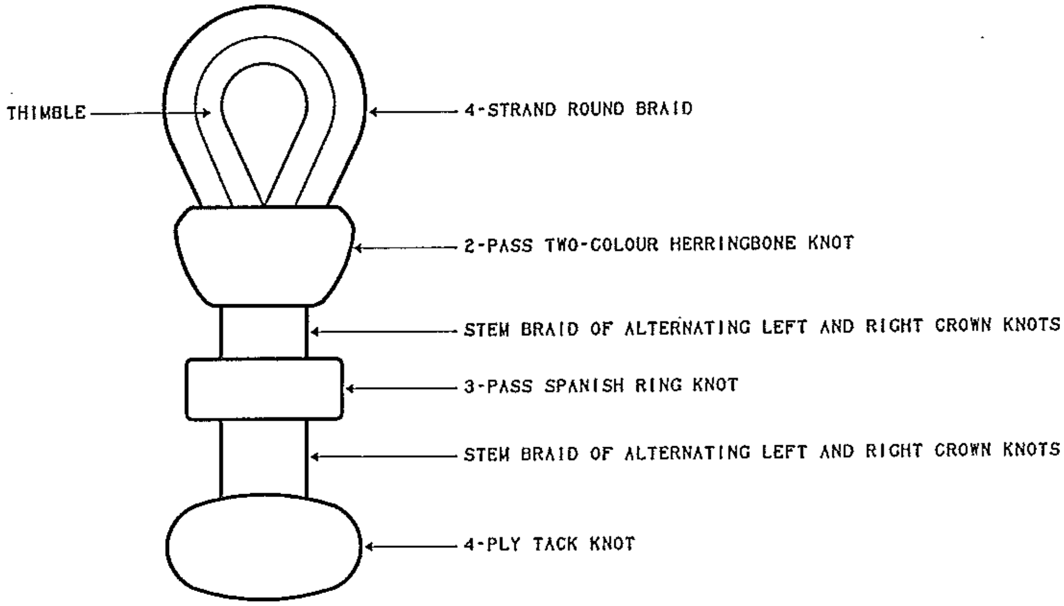


Fig. 843 — Key-hanger No. 1. Cord diameter 2 mm.

The braid, forming the eye around a thimble of 25 mm, is a 4-cord under-over Round Braid (see Fig. 844) made at the centre of the cord lengths.

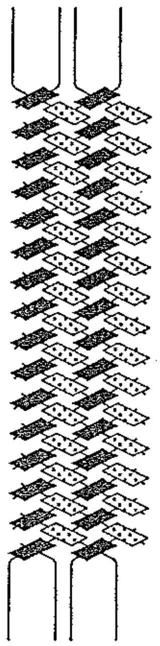


Fig. 844 — The 4-cord under-over Round Braid.

Put this braid tightly around the thimble and with a Double Constrictor Knot (see Fig. 845) secure both 'ends' immediately below the thimble.

Immediately below this constrictor knot start braiding the stem. The braid of the stem consists of a sequence of Crown Knots, one on top the other as shown in Figs. 846 and 847. The four cords of a Crown Knot have all the same colour while the colour of the four cords of the odd numbered Crown Knots differs from the colour of the four cords of the even numbered Crown Knots.

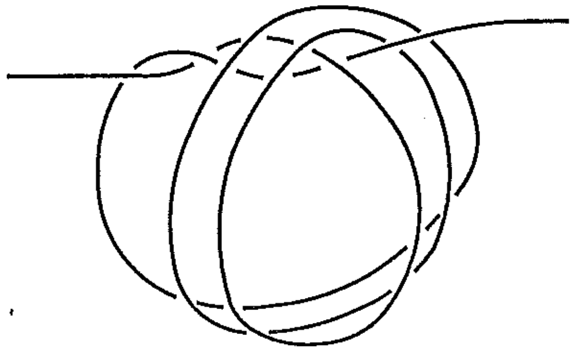


Fig. 845 — The Double Constrictor Knot.

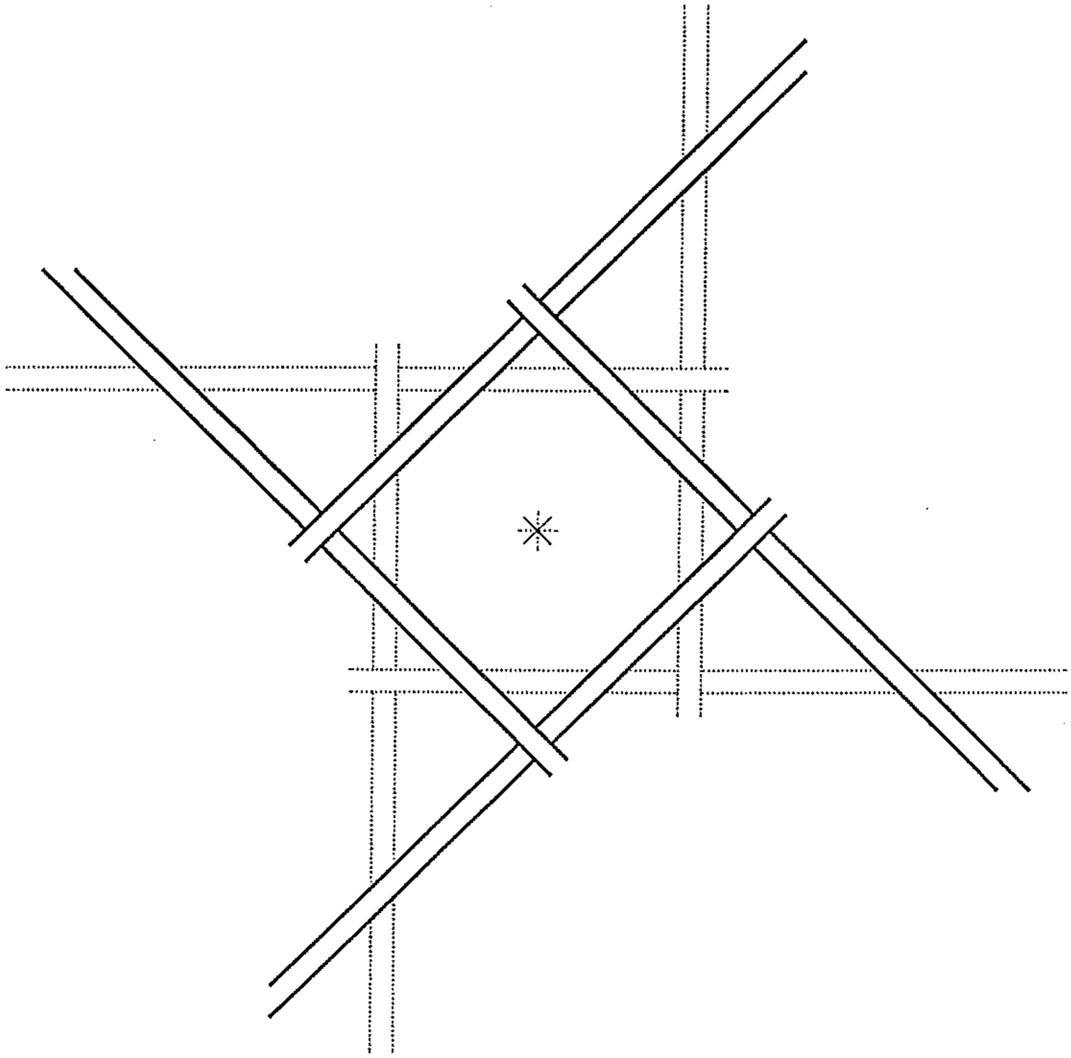


Fig. 846 — The position of two successive Crown Knots.

Fig. 847 shows the successive braiding of the odd and even numbered Crown Knots. At between 1/3 and 1/2 of the final length of the stem (final stem-length approximately 45 mm) place a cord diametrically across the stem; this cord will later be used for braiding the Spanish Ring Knot. When the final stem-length has been reached and the braid is nice and tight, tie off with a Double Constrictor Knot.

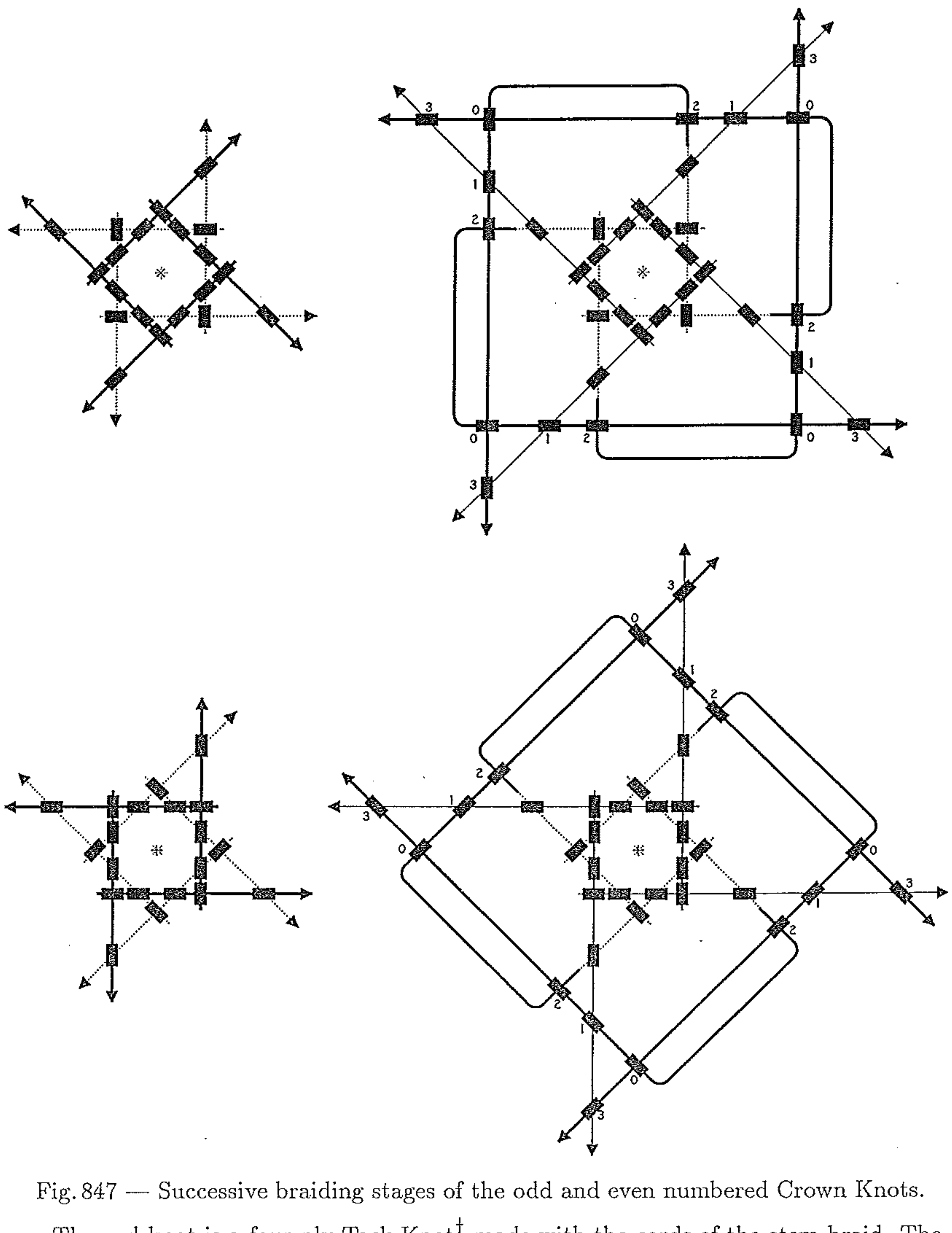


Fig. 847 — Successive braiding stages of the odd and even numbered Crown Knots.

The end-knot is a four-ply Tack Knot† made with the cords of the stem-braid. The upper grid-diagrams in Figs. 848 to 850 show one way of braiding this knot while the lower grid-diagrams in Figs. 848 to 850 show an alternative way.

† A Tack Knot is a Manrope Knot (first Wall, then Crown) with the string ends tucked under the Wall Knot along the stem of the rope.

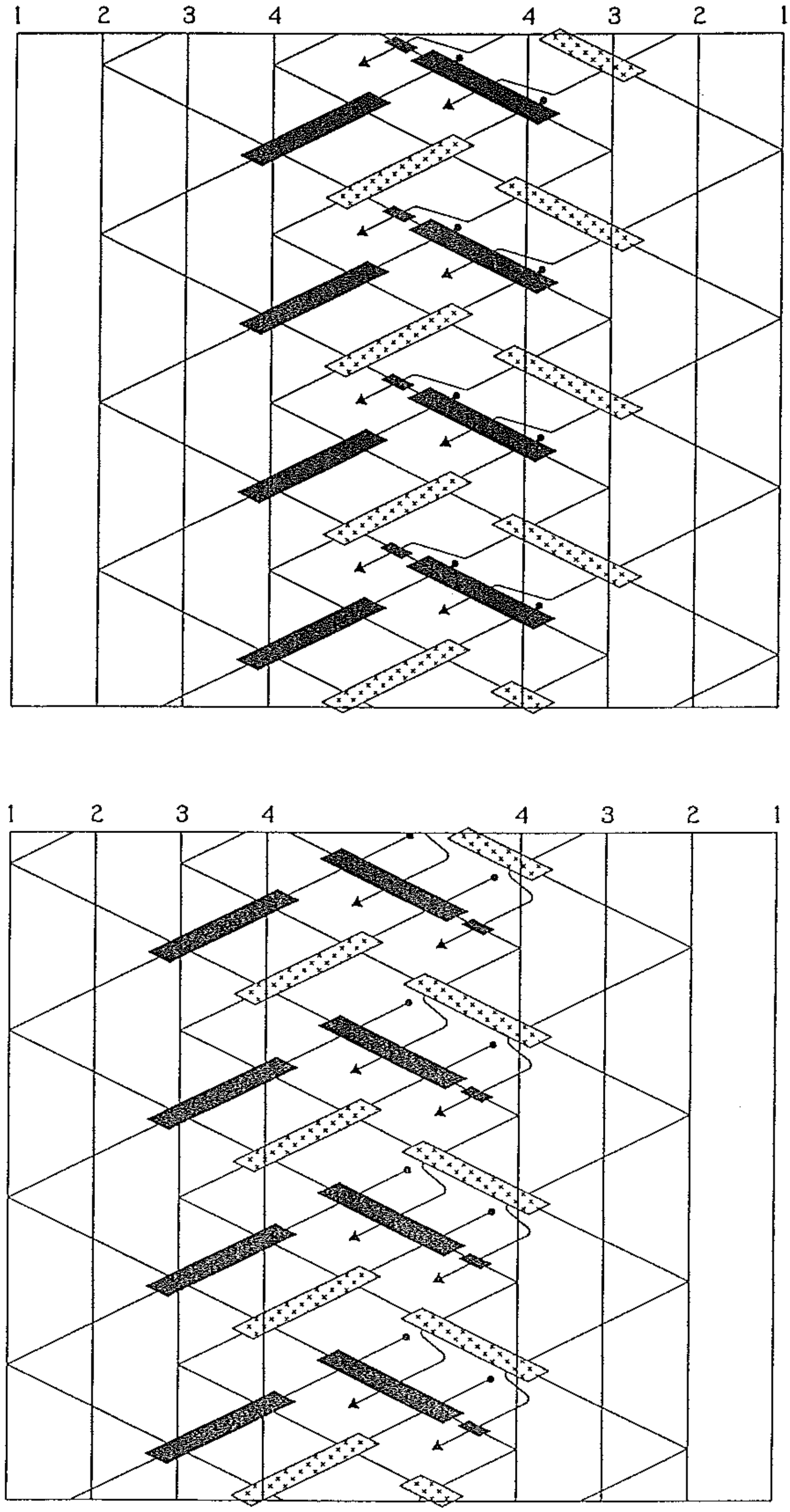
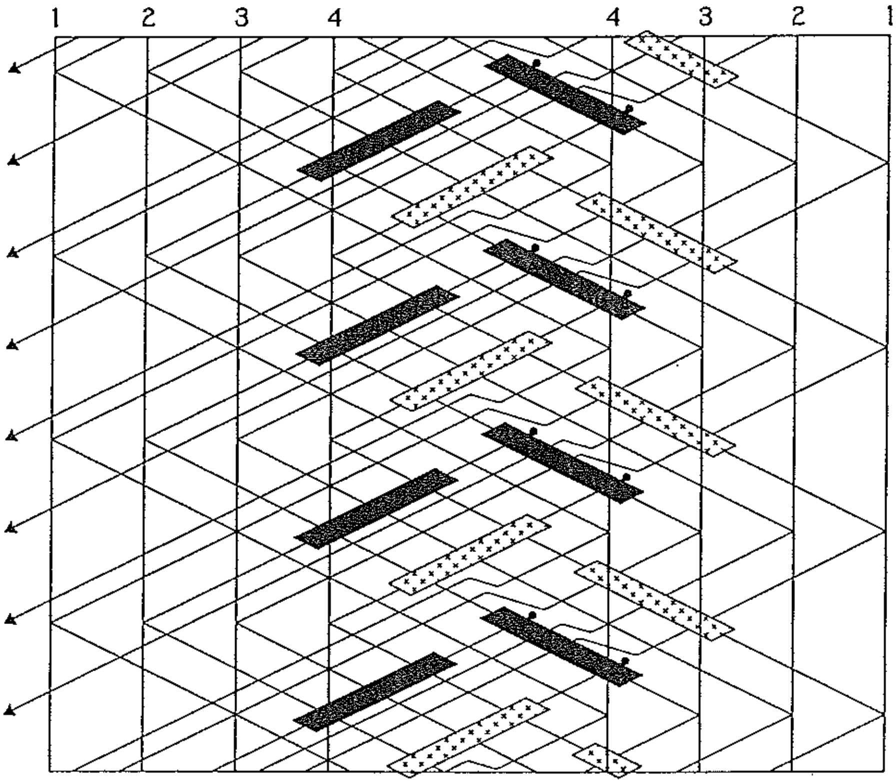


Fig. 848 — The first stage in the construction of the 4-ply Tack Knot.



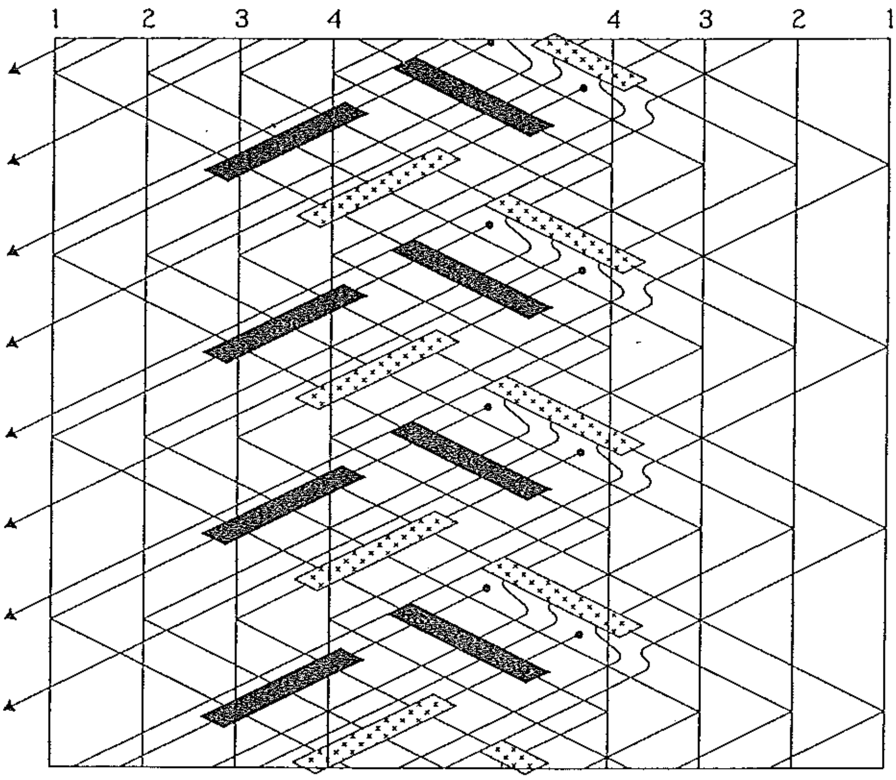
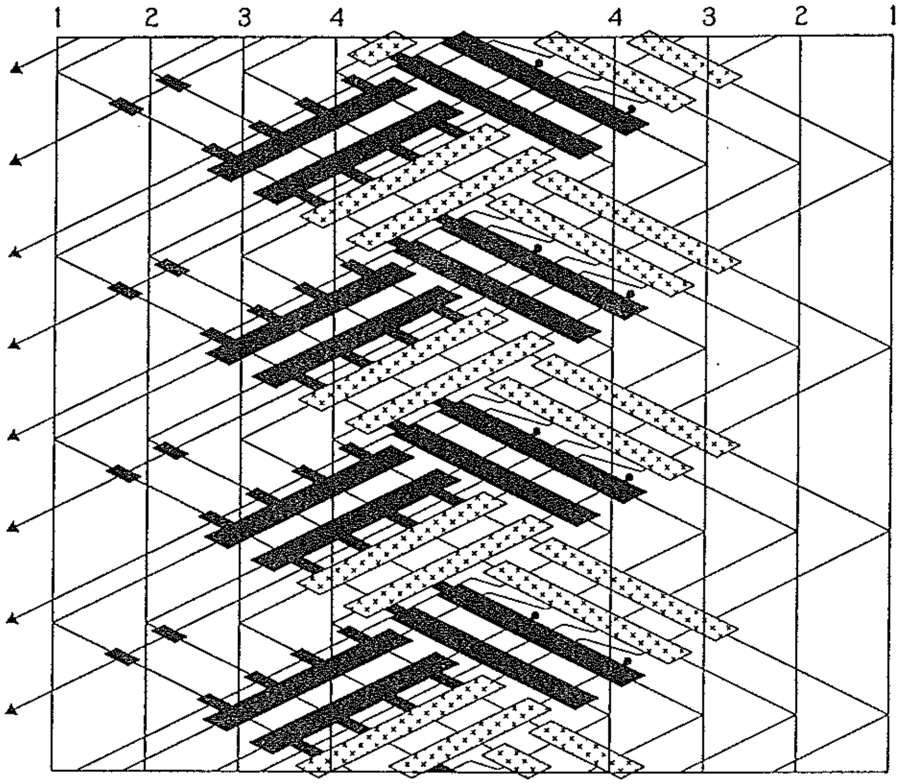


Fig. 849 — Fig. 848 with the continuation of the string-run of the 4-ply Tack Knot.



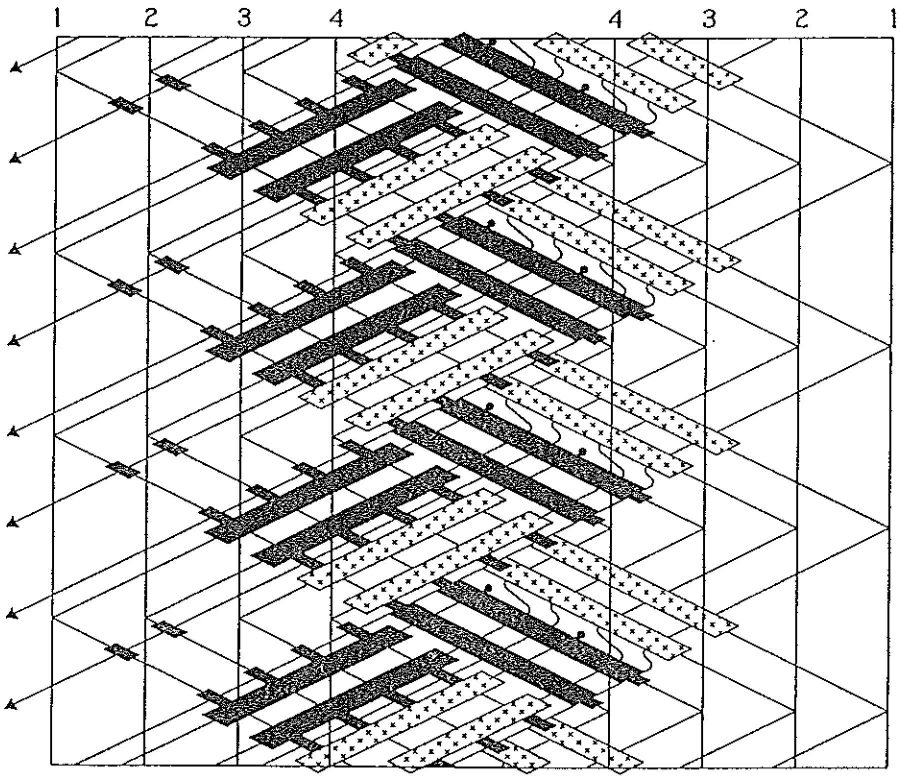


Fig. 850 — The 4-ply Tack Knot.

After the 4-ply Tack Knot has been finished, we braid a $p/b = 10/12$ two-pass Herringbone Knot, using two cords of a different colour. This two-pass Herringbone Knot covers the stem immediately below the thimble and rests hard agains it after it has been properly tightened by removing any slack in the two essential cords. These two cords pass, at their midpoints, between the two 4-string Round Braid ends immediately above their point of joining. The braiding procedure for this two-pass Herringbone Knot is the one discussed in *The Braider*, Issue No. 46, pp. 1091-1098. The details of the $p/b = 10/12$ two-pass two-colour Herringbone Knot and the algorithm diagrams for the two options in which to braid it are shown in Fig. 851.

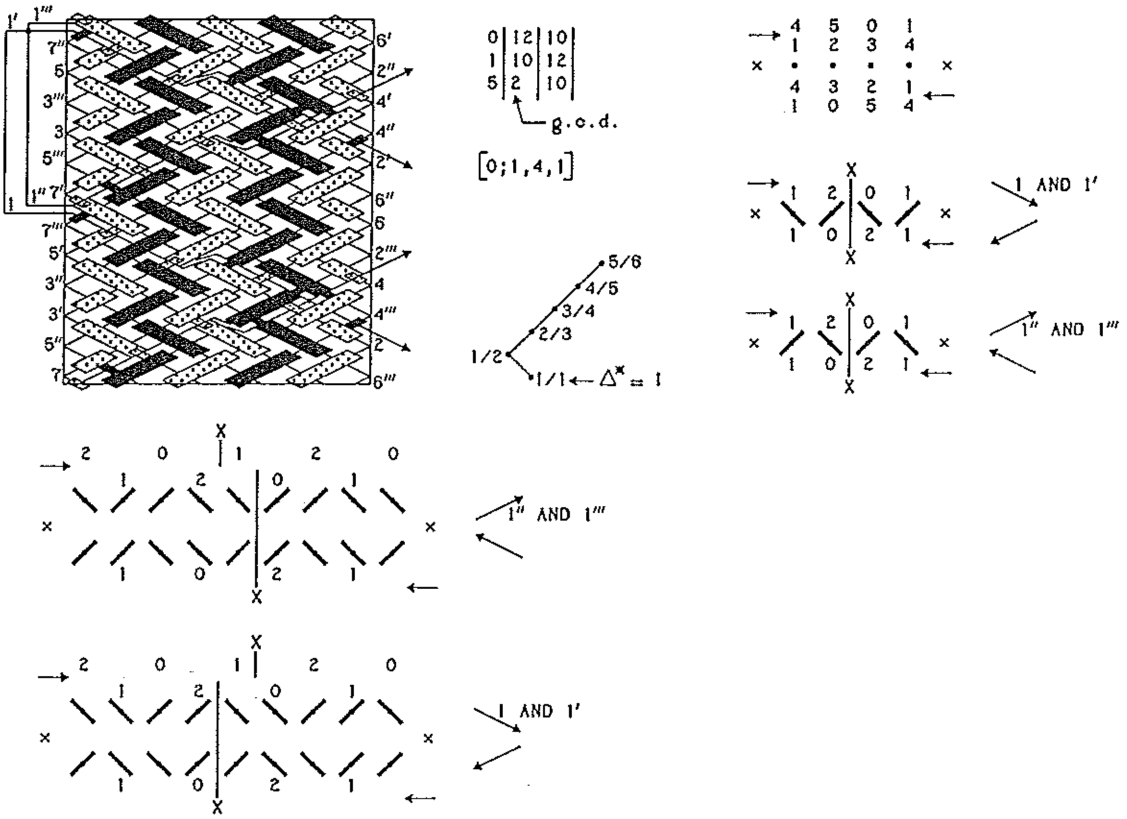


Fig. 851 — The two-pass two-colour Herringbone Knot.

In option 1 we first braid component 1, that is the half-cycles $1-2-3-\cdots-5-6-7$ and $1'-2'-3'-\cdots-5'-6'-7'$ by parallel braiding. Then we braid component 2, that is the half-cycles $1''-2''-3''-\cdots-5''-6''-7''$ and $1'''-2'''-3'''-\cdots-5'''-6'''-7'''$ by parallel braiding. From the algorithm diagram of the first component (the component with the initial half-cycles 1 and $1'$ from upper-left to lower-right) we read the following half-cycle braiding algorithms:

half-cycles:

$1\ \&\ 1'$: : $L \longrightarrow R$: Free run.
$2\ \&\ 2'$: $i = 0$; o for $i = 0$ left of X–X: $L \longleftarrow R$: o.
$3\ \&\ 3'$: $i = 0$; : $L \longrightarrow R$: o.
$4\ \&\ 4'$: $i \leq 1$; o for $i = 1$ left of X–X: $L \longleftarrow R$: $3o$.
$5\ \&\ 5'$: $i \leq 1$; : $L \longrightarrow R$: $2o - u$.
$6\ \&\ 6'$: $i \leq 2$; o for $i = 2$ left of X–X: $L \longleftarrow R$: $o - u - o - u$.
$7\ \&\ 7'$: $i \leq 2$; : $L \longrightarrow R$: $o - 3u$.

Option 1 gives for the second component (the component with the initial half-cycles

$1''$ and $1'''$ from lower-left to upper-right) the following half-cycle braiding algorithms:
half-cycles:

$1''$ & $1'''$: u for uppermost $i < 2$ left of lower X line and
u for uppermost $i = 2$ adjacent left bight-boundary and
$\star - o = 2o$ for uppermost $i = 2$ right of both X lines:
$L \longrightarrow R\colon 3u - 2o - u$.

$2''$ & $2'''$: $i = 0$; o for $i = 0$ left of lower X line:
$L \longleftarrow R\colon u - o - u - 2o - u$.

$3''$ & $3'''$: $i = 0$; $o - \star = 2o$ for uppermost $i = 0$ left of upper X line and:
$\star - o = u - o$ for uppermost $i = 0$ right of upper X line:
$L \longrightarrow R\colon u - 2o - u - 2o - u - o$.

$4''$ & $4'''$: $i \leq 1$; o for $i = 1$ left of lower X line:
$L \longleftarrow R\colon u - 2o - u - 3o - u$.

$5''$ & $5'''$: $i \leq 1$; $\star - o = u - o$ for uppermost $i = 1$ right of upper X line:
$L \longrightarrow R\colon u - 2o - u - 3o - 2u$.

$6''$ & $6'''$: $i \leq 2$; o for $i = 2$ left of lower X line:
$L \longleftarrow R\colon u - 2o - 2u - 2o - 2u$.

$7''$ & $7'''$: $i \leq 2$; u for uppermost $i < 2$ right of lower X line and
$o - \star = o - u$ for uppermost $i = 2$ left of both X lines and
$u - \bullet$ for uppermost $i = 2$ right of both X lines:
$L \longrightarrow R\colon o - u - 2o - 4u - \bullet - 2u$.

In option 2 we first braid component 1, that is the half-cycles $1'' - 2'' - 3'' - \cdots - 5'' - 6'' - 7''$ and $1''' - 2''' - 3''' - \cdots - 5''' - 6''' - 7'''$ by parallel braiding. Then we braid component 2, that is the half-cycles $1 - 2 - 3 - \cdots - 5 - 6 - 7$ and $1' - 2' - 3' - \cdots - 5' - 6' - 7'$ by parallel braiding. From the algorithm diagram of the first component (the component with the initial half-cycles $1''$ and $1'''$ from lower-left to upper-right) we read the following half-cycle braiding algorithms:
half-cycles:

$1''$ & $1'''$: : $L \longrightarrow R$: Free run.
$2''$ & $2'''$: $i = 0$; o for $i = 0$ left of X–X: $L \longleftarrow R\colon o$.
$3''$ & $3'''$: $i = 0$; : $L \longrightarrow R\colon o$.
$4''$ & $4'''$: $i \leq 1$; o for $i = 1$ left of X–X: $L \longleftarrow R\colon 3o$.
$5''$ & $5'''$: $i \leq 1$; : $L \longrightarrow R\colon 2o - u$.
$6''$ & $6'''$: $i \leq 2$; o for $i = 2$ left of X–X: $L \longleftarrow R\colon o - u - o - u$.
$7''$ & $7'''$: $i \leq 2$; : $L \longrightarrow R\colon o - 3u$. .

Option 2 gives for the second component (the component with the initial half-cycles 1 and $1'$ from upper-left to lower-right) the following half-cycle braiding algorithms:
half-cycles:

1 & $1'$: u for uppermost $i < 2$ left of lower X line and
u for uppermost $i = 2$ adjacent left bight-boundary and
$\star - o = u - o$ for uppermost $i = 2$ right of both X lines:
$L \longrightarrow R\colon 2u - o - u - 2o$.

2 & $2'$: $i = 0$; o for $i = 0$ left of lower X line:
$L \longleftarrow R\colon o - u - 2o - u - o$.

3 & $3'$: $i = 0$; $o - \star = o - u$ for uppermost $i = 0$ left of upper X line and:
$\star - o = 2o$ for uppermost $i = 0$ right of upper X line:
$L \longrightarrow R\colon 2o - u - 2o - u - 2o$.

$4 \,\&\, 4' : i \leq 1\,;$ o for $i = 1$ left of lower X line:
$L \longleftarrow R$: $2o - u - 2o - u - 2o\,.$
$5 \,\&\, 5' : i \leq 1\,;$ $o - \star = 2o$ for uppermost $i = 1$ left of upper X line:
$L \longrightarrow R$: $2o - u - 3o - 2u - o\,.$
$6 \,\&\, 6' : i \leq 2\,;$ o for $i = 2$ left of lower X line:
$L \longleftarrow R$: $2o - 2u - 2o - 2u - o\,.$
$7 \,\&\, 7' : i \leq 2\,;$ u for uppermost $i < 2$ right of lower X line and
$o - \star = 2o$ for uppermost $i = 2$ left of both X lines and
$u - \bullet$ for uppermost $i = 2$ right of both X lines:
$L \longrightarrow R$: $3o - 5u - \bullet - 2u\,.$

The coding which is associated with the $\bullet$ crossing can be freely chosen, however, it is convenient to take for this coding the one which simplifies braiding. Hence in option 1 we would braid the half-cycles $7'' \,\&\, 7'''$ as $o - u - 2o - 7u$, and in option 2 we would braid the half-cycles $7 \,\&\, 7'$ as $3o - 8u$.

Finally we braid a three-pass $p/b = 7/10$ Spanish Ring Knot with the cord which passes diametrically through the stem (see pg. 1100). Say we braid this knot by the parallel braiding method.† Its grid-diagram and algorithm diagram are shown in Fig. 852.

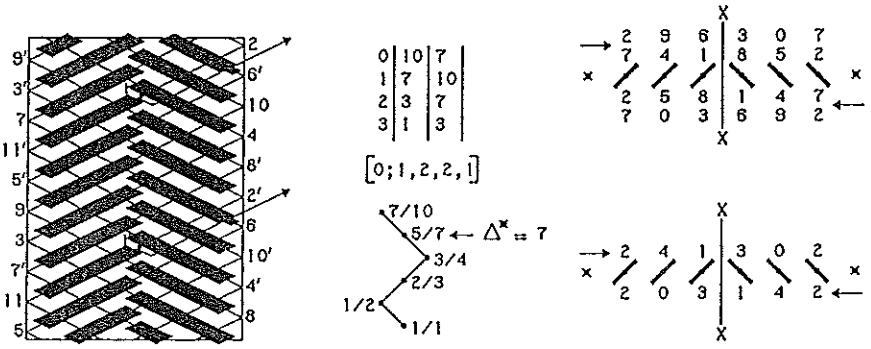


Fig. 852 — The three-pass $p/b = 7/10$ Spanish Ring Knot.

From its algorithm diagram we read the following half-cycle braiding algorithms:

half-cycles $1 \,\&\, 1'$:		:	$L \longrightarrow R$:	Free run.
half-cycles $2 \,\&\, 2'$:	$i = 0\,;$	$i \neq 0$ left of X–X :	$L \longleftarrow R$:	Free run.
half-cycles $3 \,\&\, 3'$:	$i = 0\,;$	:	$L \longrightarrow R$:	$u\,.$
half-cycles $4 \,\&\, 4'$:	$i \leq 1\,;$	$i \neq 1$ left of X–X :	$L \longleftarrow R$:	$o - u\,.$
half-cycles $5 \,\&\, 5'$:	$i \leq 1\,;$	:	$L \longrightarrow R$:	$o - u\,.$
half-cycles $6 \,\&\, 6'$:	$i \leq 2\,;$	$i \neq 2$ left of X–X :	$L \longleftarrow R$:	$2o - u\,.$
half-cycles $7 \,\&\, 7'$:	$i \leq 2\,;$	:	$L \longrightarrow R$:	$2o - 2u\,.$
half-cycles $8 \,\&\, 8'$:	$i \leq 3\,;$	$i \neq 3$ left of X–X :	$L \longleftarrow R$:	$2o - 2u\,.$
half-cycles $9 \,\&\, 9'$:	$i \leq 3\,;$	:	$L \longrightarrow R$:	$2o - 3u\,.$
half-cycles $10 \,\&\, 10'$:	$i \leq 4\,;$	$i \neq 4$ left of X–X :	$L \longleftarrow R$:	$3o - 3u\,.$
half-cycles $11 \,\&\, 11'$:	$i \leq 4\,;$	unders right of X–X :	$L \longrightarrow R$:	$3o - 3u\,.$

Ensure that all braidwork has been properly tightened, then put the free ends of the cords under tension before cutting off their excess lengths in order for the ends of the cords to pull back under the braid and hence to be properly hidden from view.

† Refer to *The Braider*, Issue No. 41, pp. 973-975.

Monkey's Fists

The Monkey's Fists are dealt with in many books on knots, and as usual one has copied the story from another without giving it much or even any thought. Even *The Ashley Book of Knots* forms no exception.

A Monkey's Fist is a single string knot of three sets of n parallel loops each with the three sets perpendicular to each other. We shall in our general discussion take $n = 4$.

Hence the string-run must pass from one set of n parallel loops to the next set of n parallel loops and consequently the knot must contain two transitions. The four 4-ply transition forms are shown by the left-hand column in Fig. 853.

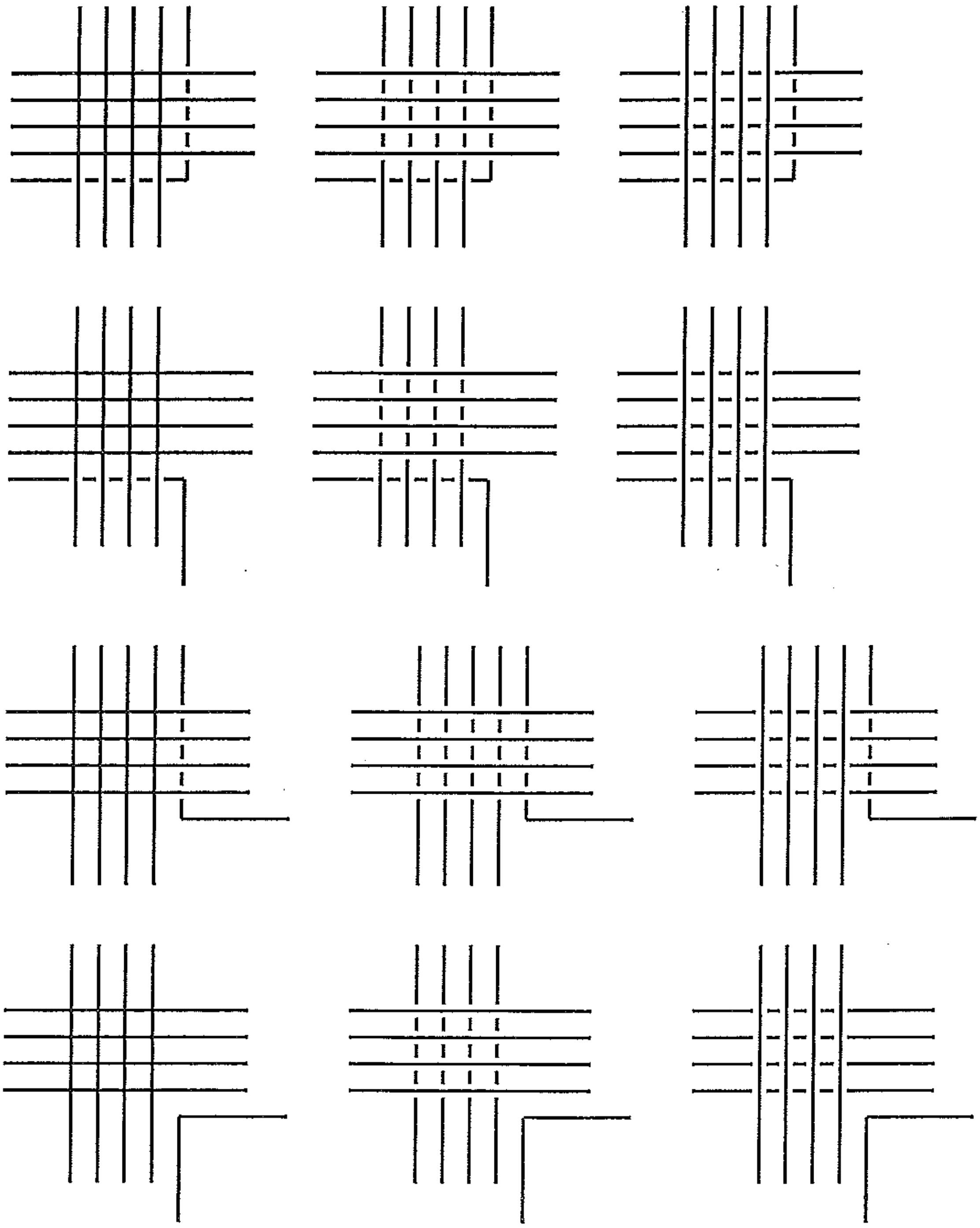


Fig. 853 — The four 4-ply transition forms.

Each of these transition forms is associated with the two coding forms shown at their right. With these coding forms we build the twelve transition sets in Fig. 855, each of which contains two similar transition forms, an essential requirement for a **regular** Monkey's Fist. For a good regular Monkey's Fist each transition form should be hidden within the braid and we should be able to join the string-ends diagonally over a crossing-point. The transition sets 2, 2A, 5 and 5A of Fig.855 don't fulfil the diagonally joining requirement for the string-ends. Furthermore, the diagonally joining of the string-ends should take place over a crossing-point which contains a transition, which requirement is not fulfilled by the transition sets 3, 3A, 6 and 6A. This leaves us with the four good transition sets 1, 1A, 4 and 4A for the regular Monkey's Fists. Of these four Monkey's Fists only the ones with the transition sets 1A or 4A of Fig. 855, with the arrows as indicated, and the ones with the transition sets 1 or 4 of Fig. 855, with the arrows reversed to those indicated, are of practical value since they are the easiest to braid. A 4-ply Monkey's Fist containing the transition set 1A of Fig. 855 is shown in Fig. 854.

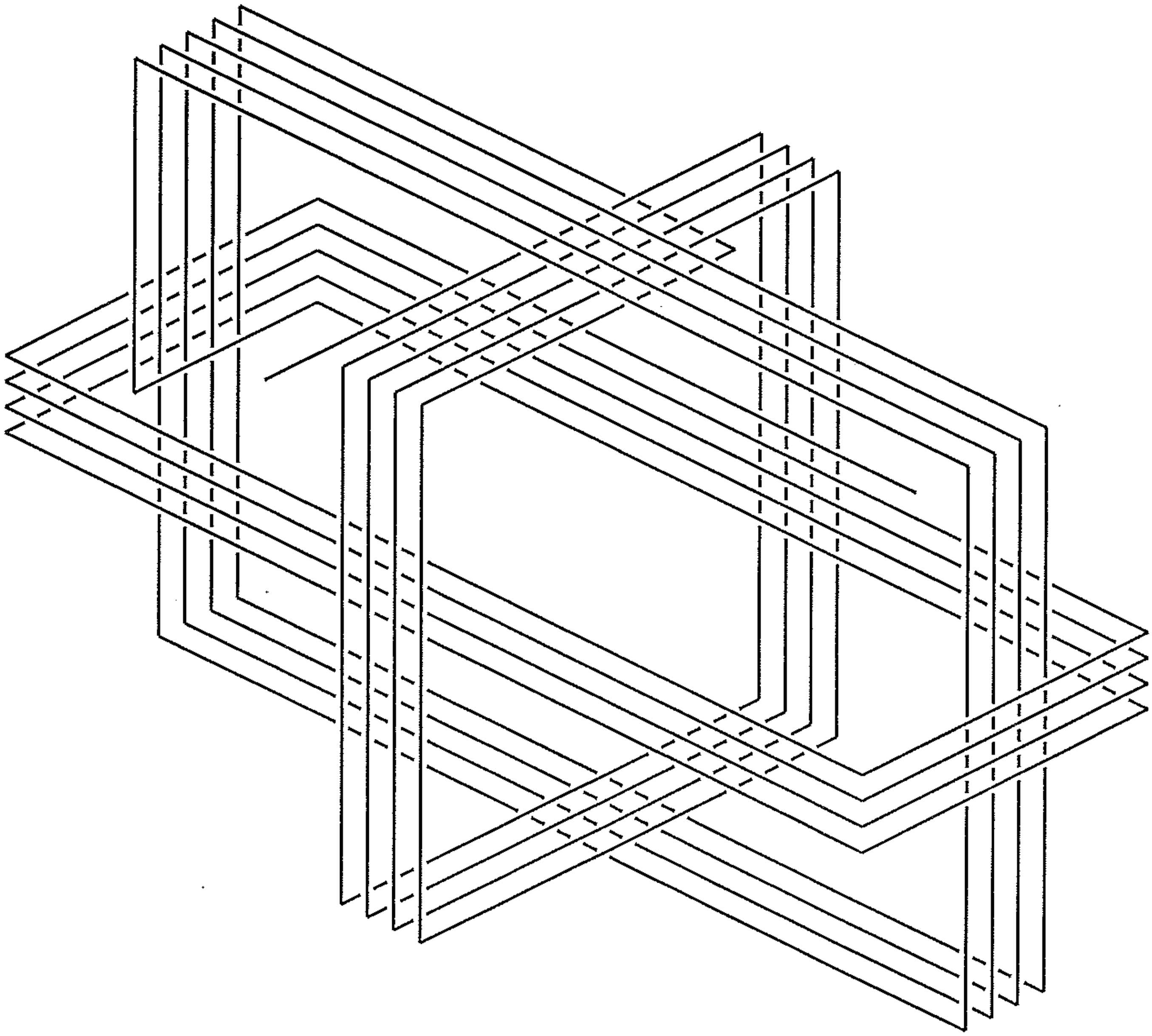


Fig. 854 — A 4-ply Monkey's Fist containing transition set 1A.

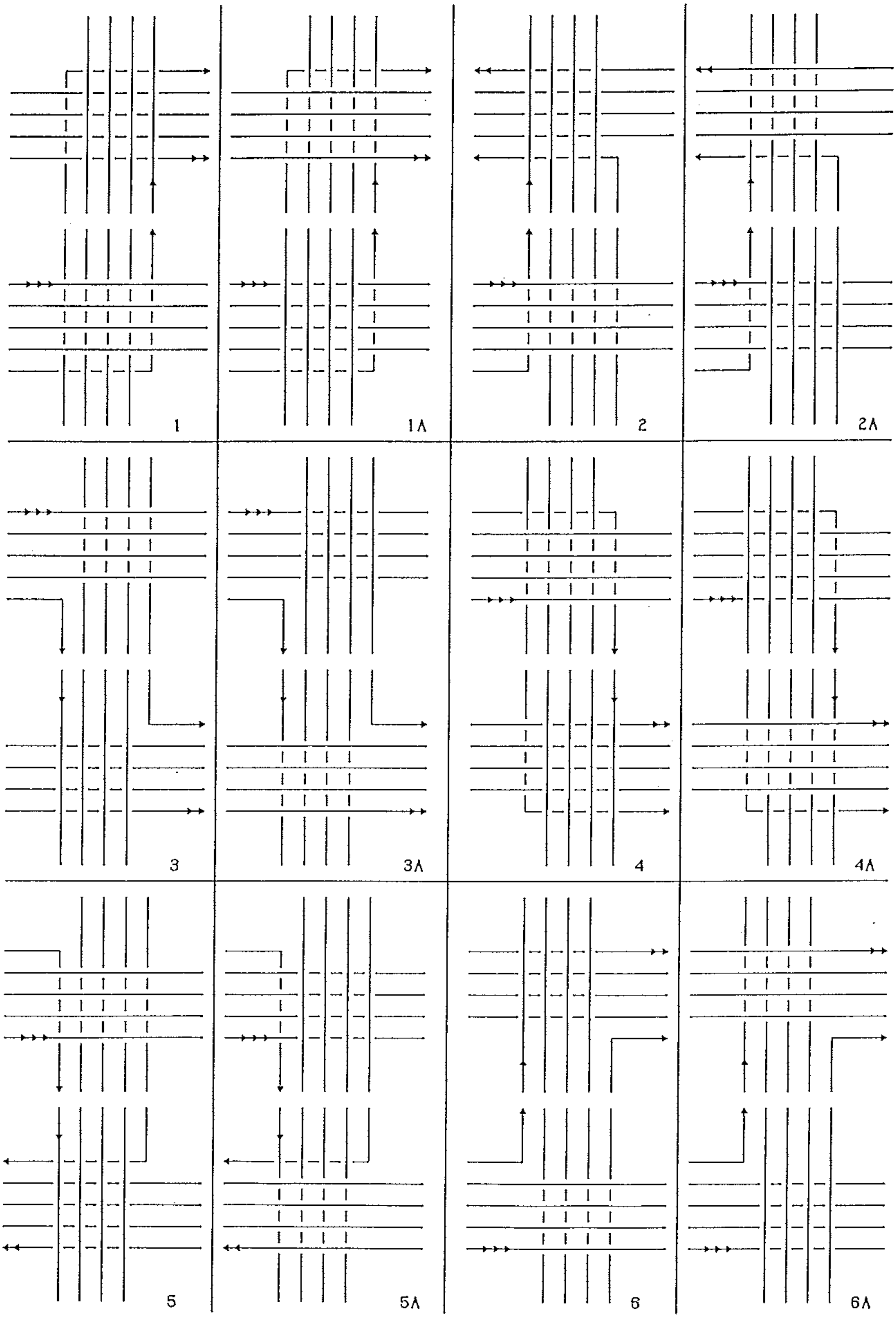


Fig. 855 — The twelve regular transition sets.

The Monkey's Fist of Ashley #2202 (resulting from the common sailor's method of construction) has the transition set 3A of Fig. 855, and hence is not a good regular Monkey's Fist. Note that Ashley #2202 is identical to Ashley #2200 (see Fig. 856).

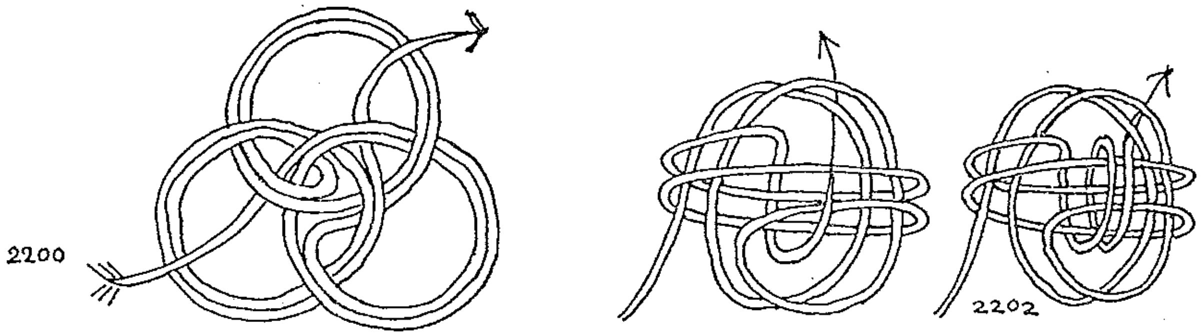


Fig. 856 — Ashley #2200 and #2202.

The associated 4-ply form is shown in Fig. 857.

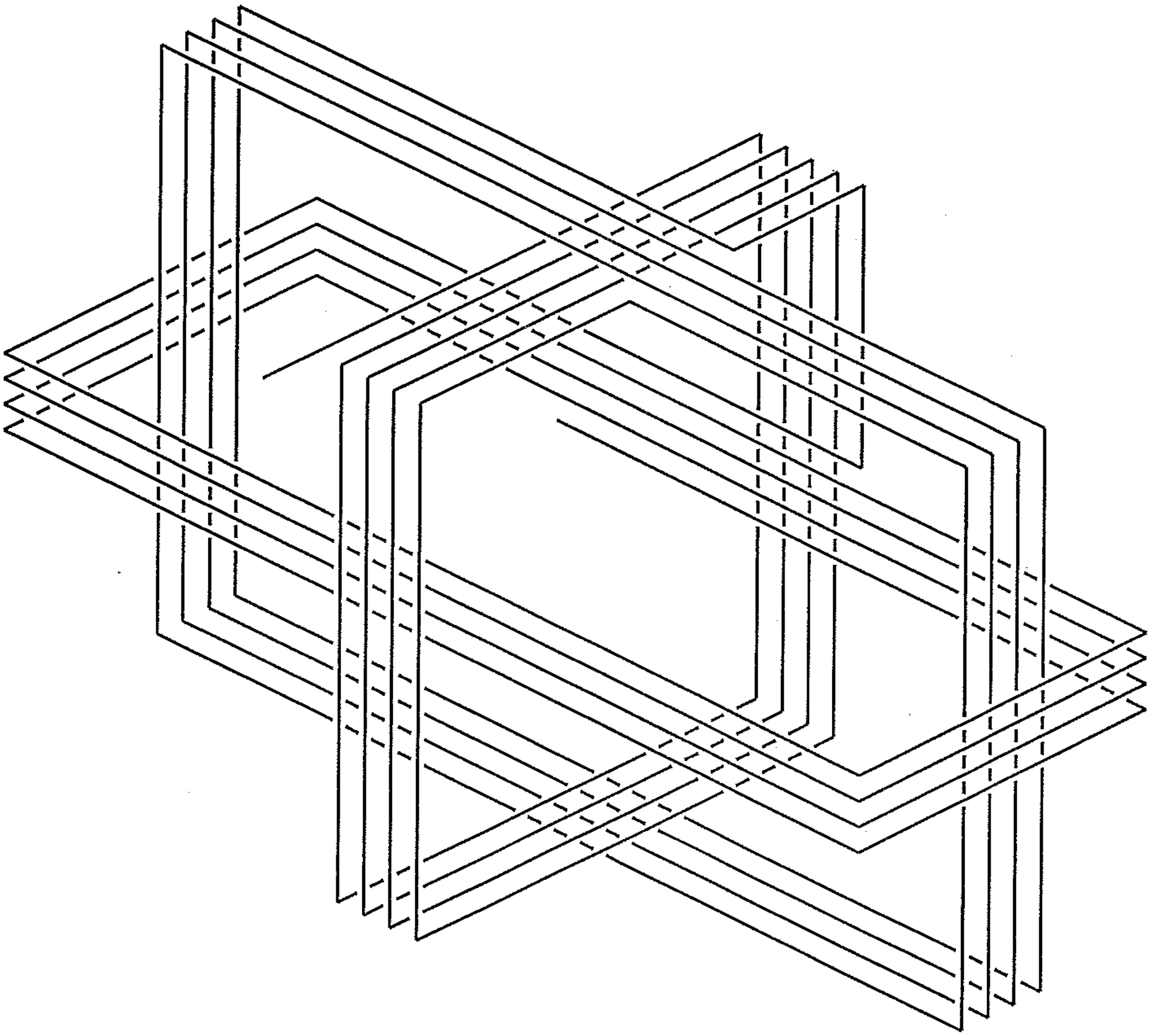


Fig. 857 — A 4-ply Monkey's Fist containing transition set 3A.

The Monkey's Fist of Ashley #2201 (see Fig. 858) does not contain a regular transition set, hence is not a regular Monkey's Fist.

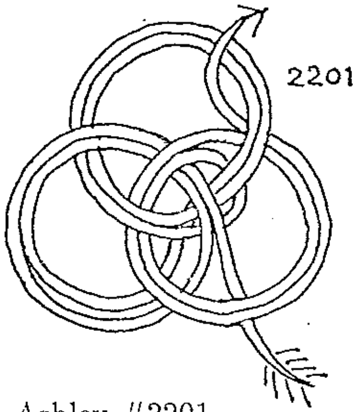


Fig. 858 — Ashley #2201.

The associated 4-ply form is shown in Fig. 859.

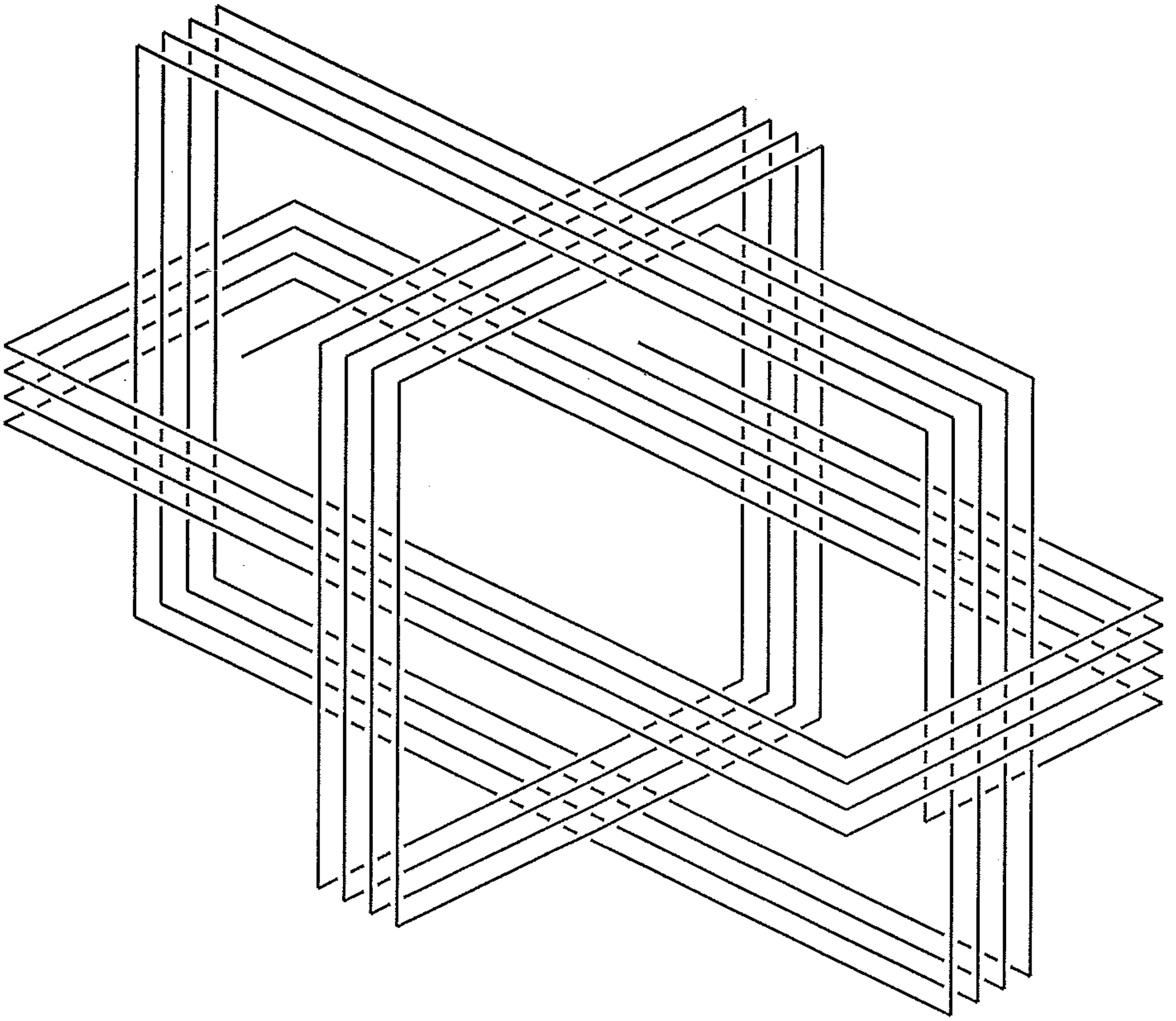


Fig. 859 — The 4-ply Monkey's Fist associated with Ashley #2201.

The Monkey's Fist of Ashley #2205 (see the three leftmost figures in Fig. 860) does not contain a regular transition set, hence is not a regular Monkey's Fist.

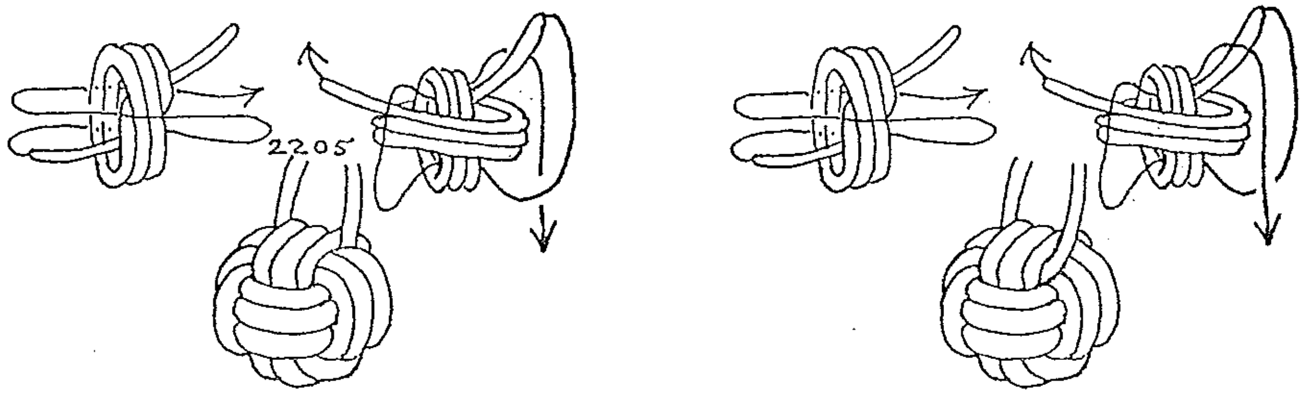


Fig. 860 — Ashley #2205 and its rectified form.

The associated 4-ply form is shown in Fig. 861.

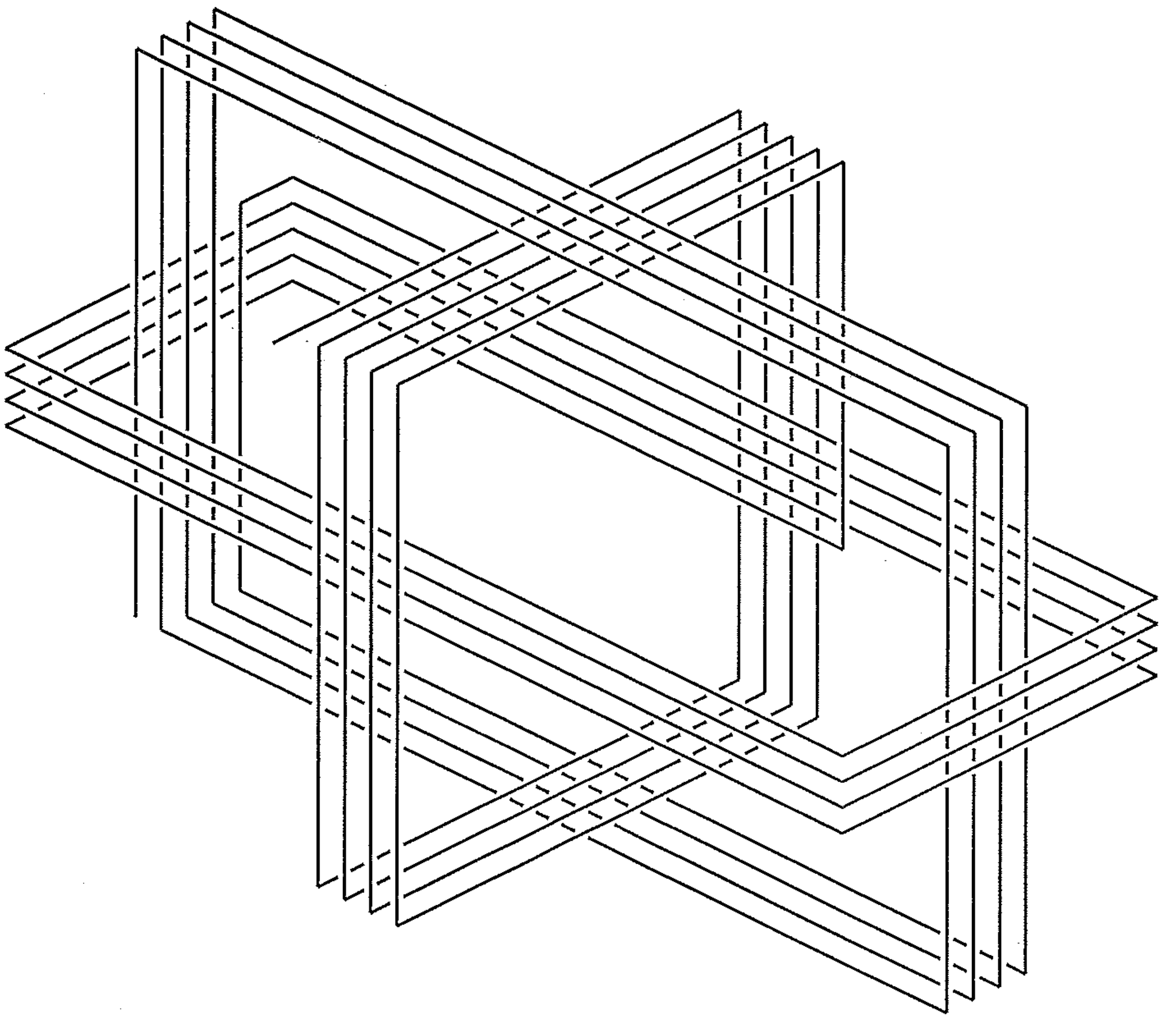


Fig. 861 — The 4-ply Monkey's Fist associated with Ashley #2205.

The Monkey's Fist in Ashley #2205 can readily be modified into a good regular Monkey's Fist by changing the string-run in its upper-right figure to the string-run in the upper-rightmost figure of Fig. 860. The resulting Monkey's Fist is then a good regular one containing the transition set 1A of Fig. 855 (it thus becomes the 2-ply form of Fig. 854). It is interesting to note that there seem to be no publications which contain a good regular Monkey's Fist; they all fail by either not having a **regular** transition set and/or by not having the desired joining of the string-ends. Note also that transition sets 1, 1A, 4 and 4A are the only ones in which each transition is properly hidden.

Round Bihelix Braids

In *The Braider*, Issue No. 17, pg. 378, we introduced the Regular Cylindrical Bihelix Braids and discussed how they were derived from Round Bihelix Braids. The weaving pattern in a Round Bihelix Braid always has a spiral effect, and hence creates with strings of different colour a spiralling colour pattern. Furthermore, Round Bihelix Braids not only enable us to construct Round Braids with an even number of strings, but also enable us to construct Round Braids with an odd number of strings, which is often important when further integrated knots require an odd number of strings. Although a Round Bihelix Braid will always have a spiralling pattern, the spiralling effect can be disguised by twisting the braid when the difference between the number of left-helix strings and right-helix strings is small.†

When in the $[n_l, n_r]$ Round Bihelix Braid‡ $n_l < n_r$, the braid has a left helix with a helix angle of $(45° - arctan\frac{n_l}{n_r})$, and when $n_l > n_r$, the braid has a right helix with a helix angle of $(arctan\frac{n_l}{n_r} - 45°)$.

Fig. 862 depicts Ashley's five-strand square sinnet #3013 on page 496 of *The Ashley Book of Knots*. This Round Bihelix Braid of 5-strings with $[n_l, n_r] = [2, 3]$ is more or less half-round in cross-section and the braid has a left-helix with an angle of $(45° - arctan\frac{2}{3}) = (45° - 33.69°) = 11.31°$. We braid this braid as indicated by the rightmost diagram in Fig. 862, hence 1 around the back from right to left, then $2u - o$ along the front from left to right; next 2 around the back from left to right, then $u - o$ along the front from right to left; continue with these two braiding sequences, hence next 3 around the back from right to left, then $2u - o$ along the front from left to right; next 4 around the back from left to right, then $u - o$ along the front from right to left, and so on. If we want to disguise the left helix in the braid, we turn the braid anti-clockwise through an angle of $11.31°$.

Fig. 863 depicts the same [2, 3] Round Bihelix Braid but where string 3 only differs in colour from the other four strings.

† It is important to realise that a Round Bihelix Braid always has a spiralling pattern when braided properly. Many braiders fail to keep that in mind, especially when the difference between the number of left-helix strings and right-helix strings is small; even Ashley in his book fails to draw attention to this and consequently his drawings #3013 and #3014 on page 496, for example, are misleading.

‡ Refer to *The Braider*, Issue No. 17, pp. 378-379, for the construction process of its associated string-run diagram.

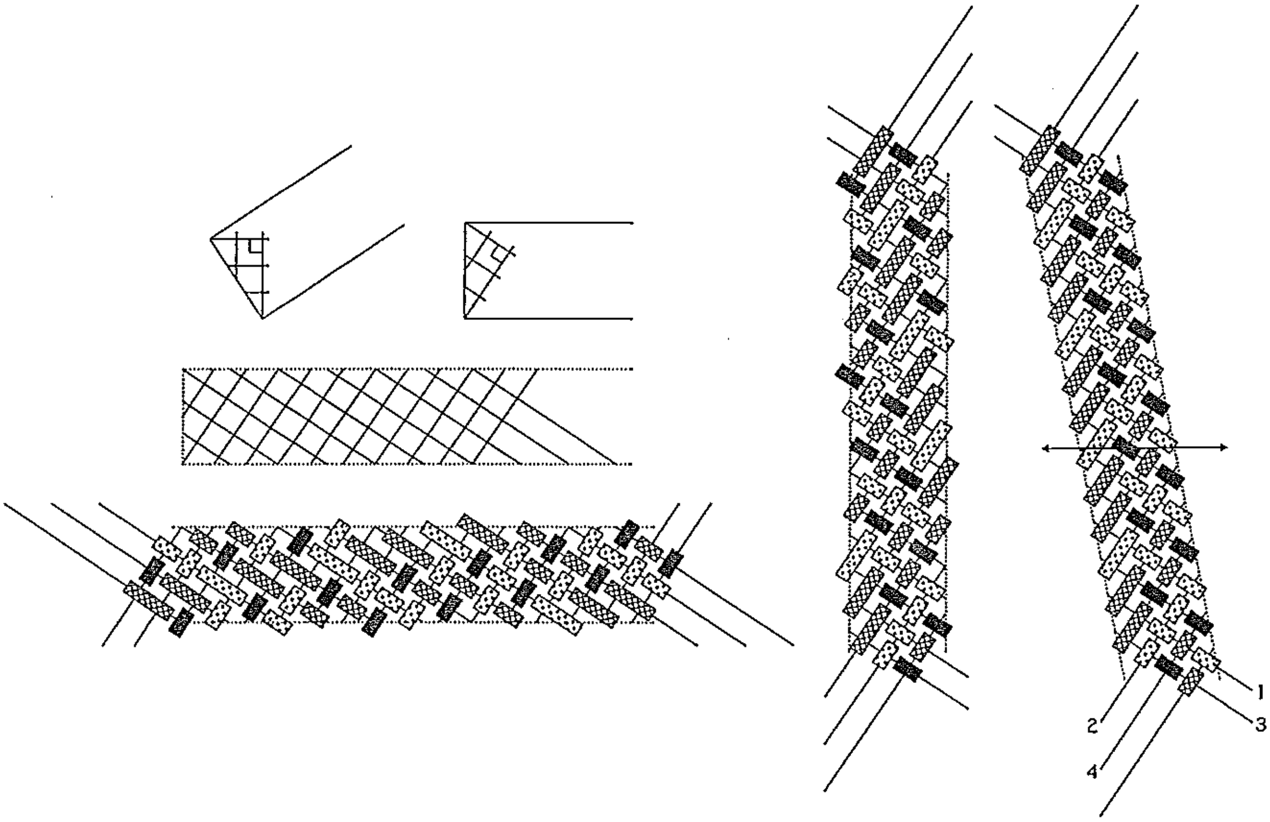


Fig. 862 — A 5-string Round Bihelix Braid with $[n_l, n_r] = [2, 3]$.

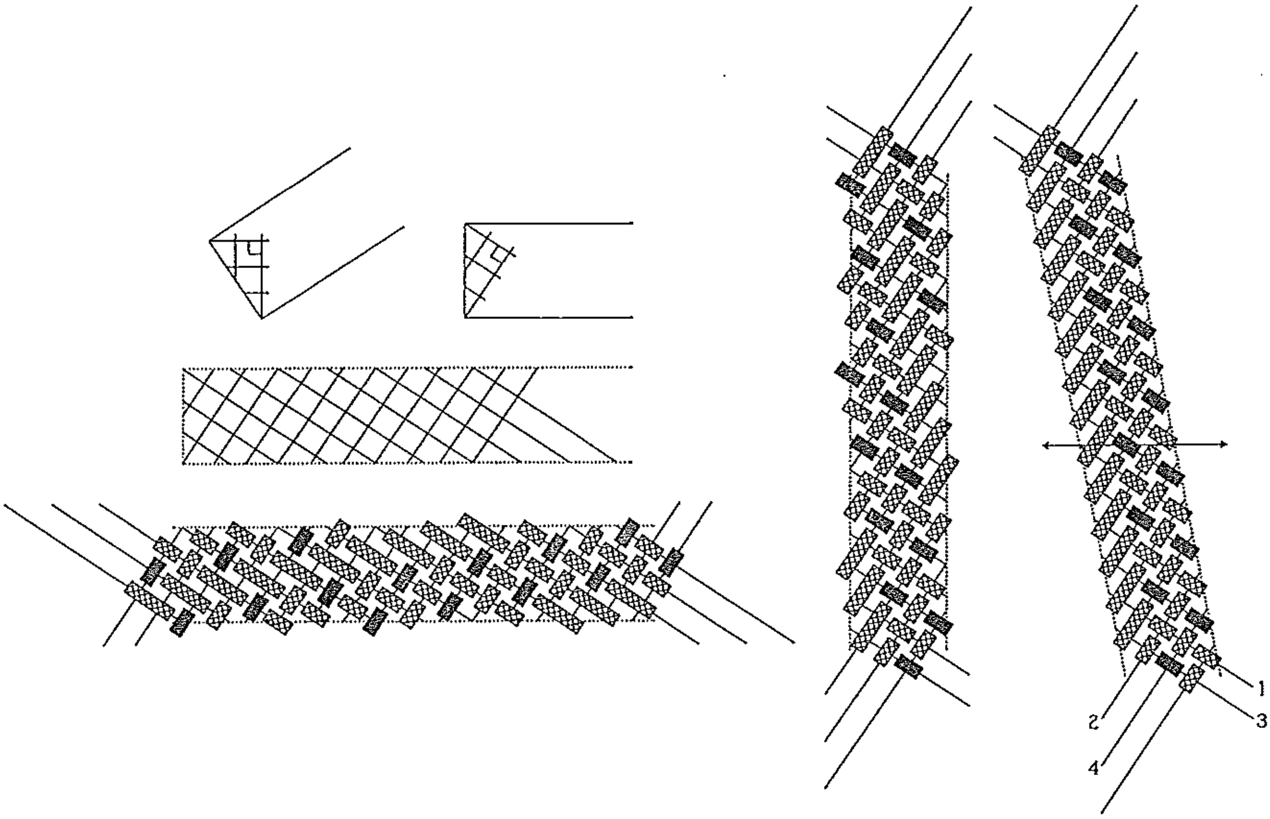


Fig. 863 — A 5-string Round Bihelix Braid with $[n_l, n_r] = [2, 3]$.

We like to stress again that the braider should be aware of the fact that the braids in Figs. 862 & 863 have a spiralling pattern when braided properly. This will readily be overlooked since the helix angle of this spiralling braid, when braided properly, is only 11.31°, and as mentioned above, the spiralling pattern created can readily be disguised, knowingly or unknowingly, by twisting the braid anti-clockwise through an angle of 11.31° or by not braiding it properly.

In the Figs. 864 to 867 we show a few of the many patterns which can be designed for Round Bihelix Braids:

In Fig. 864 is depicted a 9-string [4, 5] Round Bihelix Braid in which the colour of the four left-helix strings differs from the colour of the five right-helix strings. When this Round Bihelix Braid has been braided properly, the colour-pattern will have a left-helix angle of $(45° - arctan\frac{4}{5}) = (45° - 38.66°) = 6.34°$, hence a small helix angle which can very easily be disguised. The lower-right grid-diagram in Fig. 864 indicates a succession of the following two braiding sequences for this Round Bihelix Braid:
(1). Take string 1 around the back from left to right, then from right to left along the front: $u - 2o - u$.
(2). Take string 2 around the back from right to left, then from left to right along the front: $2u - o - 2u$.

In Fig. 865 is depicted a 9-string [2, 7] Round Bihelix Braid in which the colour of the two left-helix strings differs from the colour of the seven right-helix strings. When this Round Bihelix Braid has been braided properly, the colour-pattern will have a left-helix angle of $(45° - arctan\frac{2}{7}) = (45° - 15.95°) = 29.05°$. The lower-right grid-diagram in Fig. 865 indicates a succession of the following two braiding sequences for this Round Bihelix Braid:
(1). Take string 1 around the back from left to right, then from right to left along the front: $u - o$.
(2). Take string 2 around the back from right to left, then from left to right along the front: $2u - o - 2u - o - u$.

In Fig. 866 is depicted a 12-string [2, 10] Round Bihelix Braid in which the colour of the strings alternates as shown in the grid-diagrams. When this Round Bihelix Braid has been braided properly, the left-helix angle of the braid $((45° - arctan\frac{2}{10}) = (45° - 11.31°) = 33.69°)$ will appear as a VVV colour-pattern with a right-helix angle of $90° - 33.69° = 56.31°$. The lower-right grid-diagram in Fig. 866 indicates a succession of the following two braiding sequences for this Round Bihelix Braid:
(1). Take string 1 around the back from left to right, then from right to left along the front: $2u$.
(2). Take string 2 around the back from right to left, then from left to right along the front: $2u - 2o - 2u - 2o - 2u$.

In Fig. 867 is depicted a 12-string [3, 9] Round Bihelix Braid. When this Round Bihelix Braid has been braided properly, the left-helix angle of the braid $((45° - arctan\frac{3}{9}) = (45° - 18.43°) = 26.57°)$ will appear as a colour pattern with a left-helix angle of $90° - 26.57° = 63.43°$. The lower-right grid-diagram in Fig. 866 indicates a succession of the following two braiding sequences for this Round Bihelix Braid:
(1). Take string 1 around the back from left to right, then from right to left along the front: $2u - o$.
(2). Take string 2 around the back from right to left, then from left to right along the front: $u - 2o - u - 2o - u - 2o$.

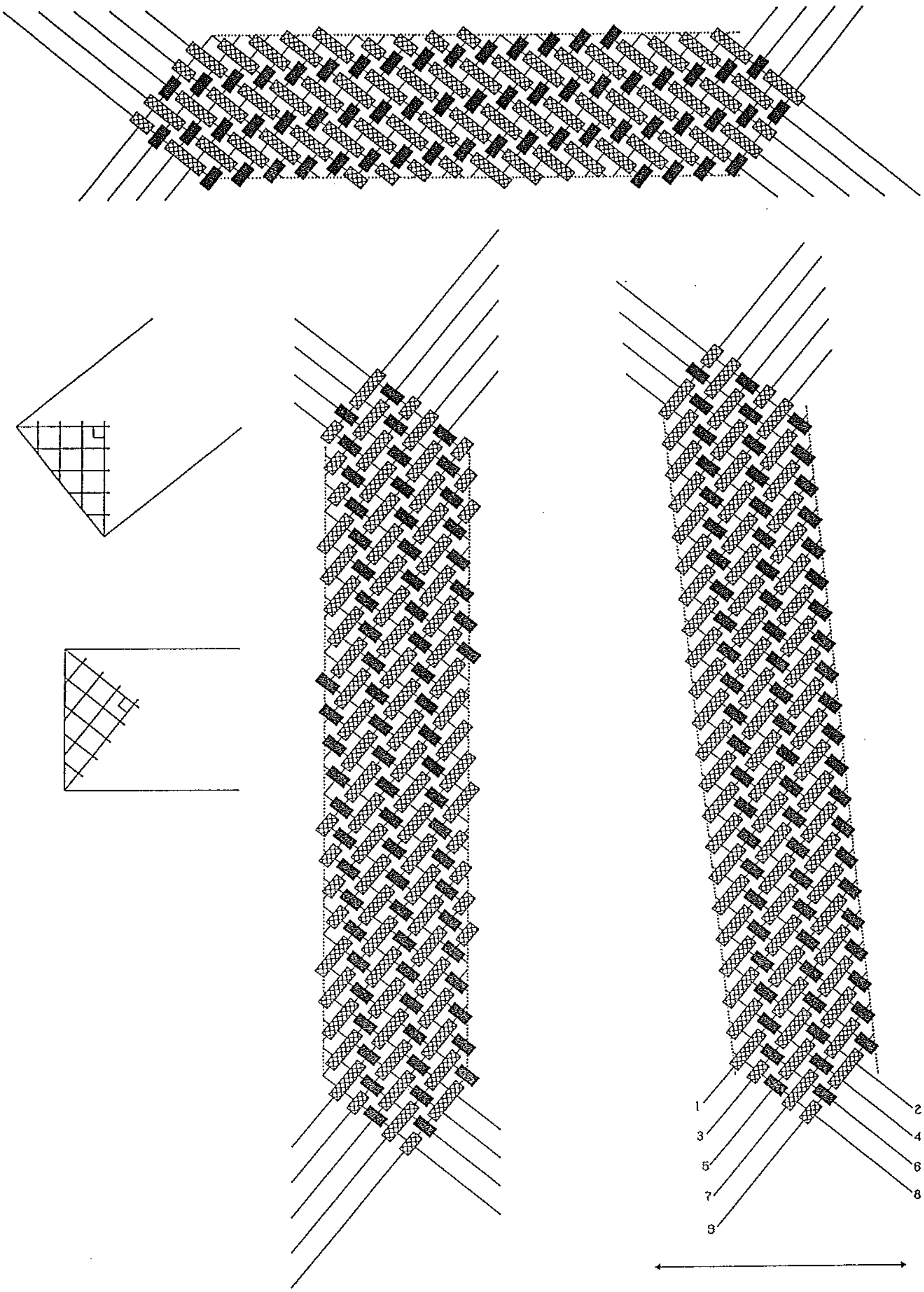


Fig. 864 — A 9-string [4, 5] Round Bihelix Braid.

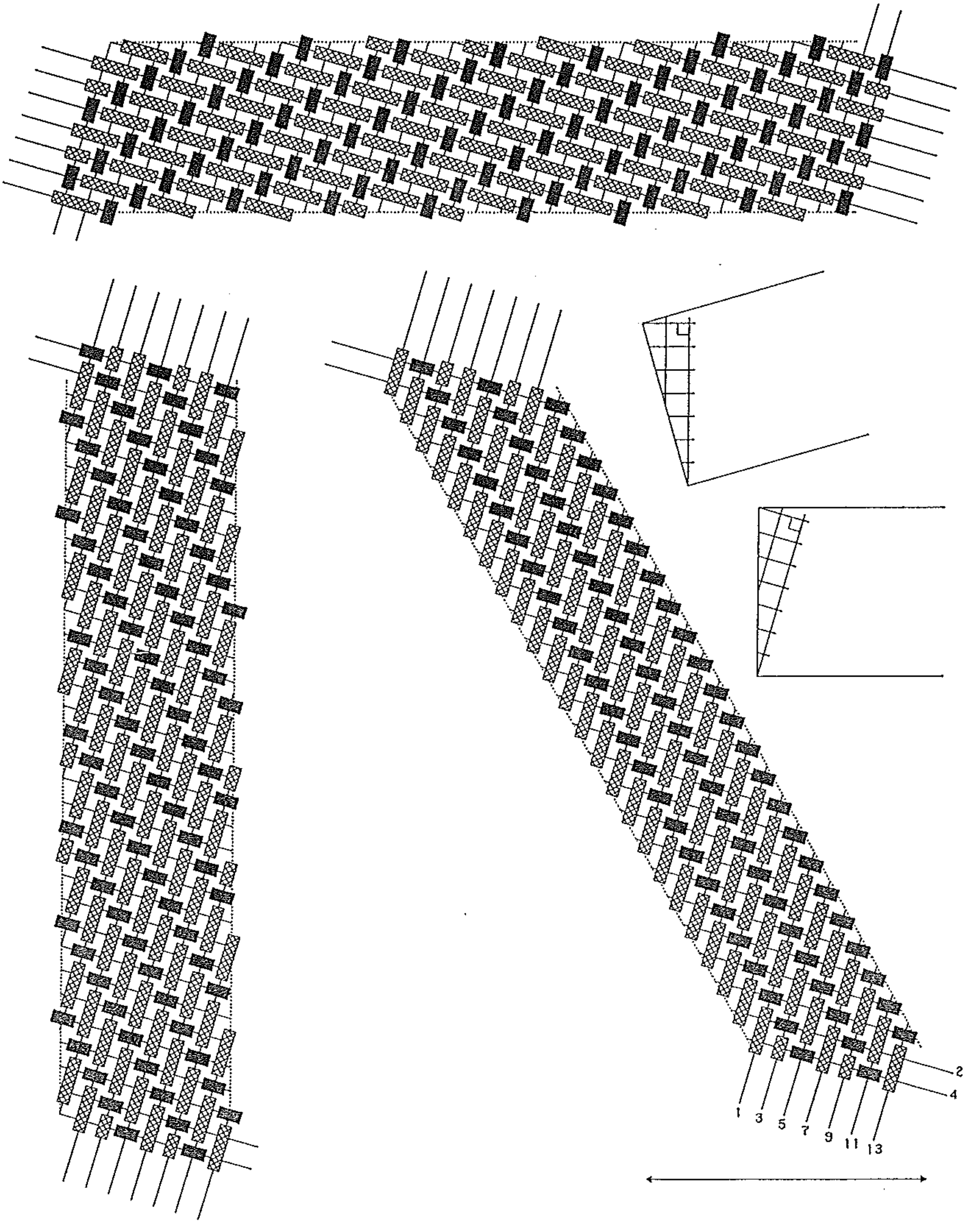


Fig. 865 — A 9-string [2, 7] Round Bihelix Braid.

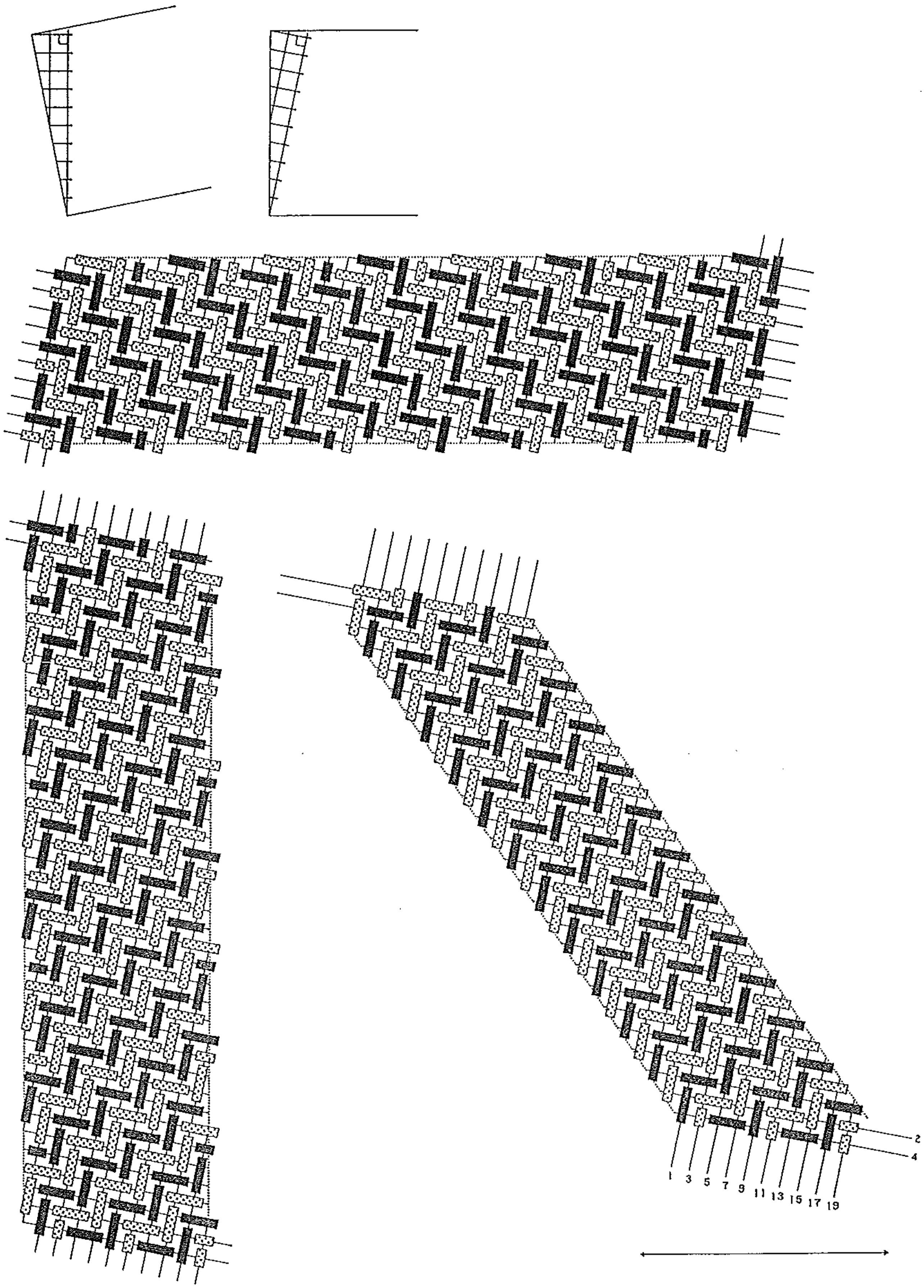


Fig. 866 — A 12-string [2, 10] Round Bihelix Braid.

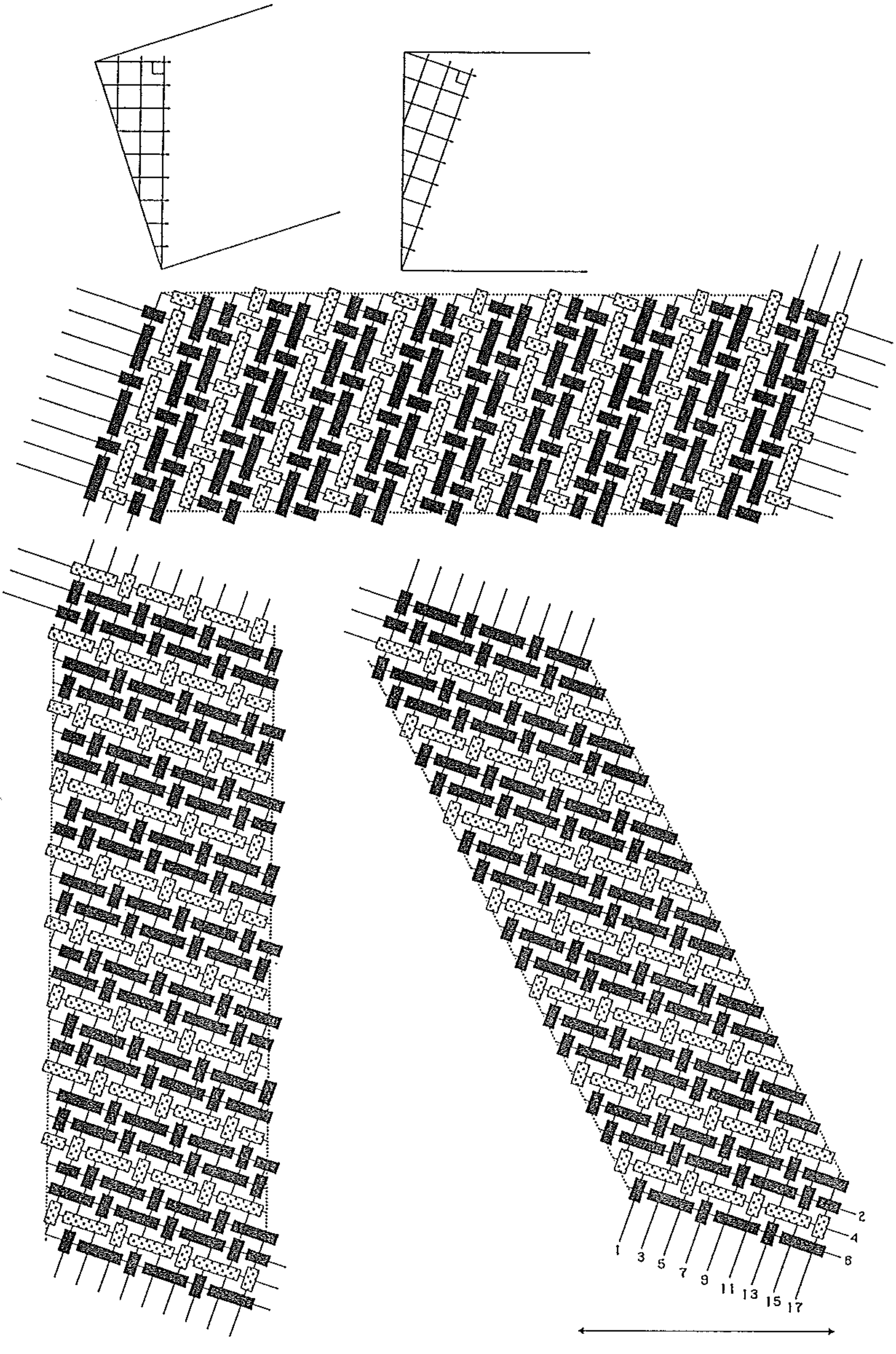


Fig. 867 — A 12-string [3, 9] Round Bihelix Braid.