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The Story of a Copied Knot

Some time ago (a little over six years in fact when this Issue of *The Braider* was being written) we received from a braider an excellent computer colour print-out of his scanned picture of a quirt handle made by him which contained the knot which we will discuss in this article. The braider told us that he had copied the braid from work by Luis B. Ortega and consequently we thought that his copied knot in all its aspects was supposed to resemble the knot on the braidwork he copied it from. Only after some letter exchange did we learn however that he had only seen this **type of knot** on quirts in the catalogue *California Vaquero Traditions* depicting work by Luis B. Ortega and did we receive the important information about the value of the parameter B^* (the number of nests) of his copied knot as well as of the way in which he braided it. Since this catalogue is only of size 219×146 mm., the photographs in it are very small and consequently the braidwork shows far to little detail for it to be properly decipherable. Hence the braider was limited to copying the **shape** and **the general Herringbone Pineapple braid-pattern** of the knot in the photographs concerned. Since there are here important lessons to be learned, we shall follow more or less the sequence of comments we made in our letter exchange.

Thus initially we received the computer colour print-out of his scanned picture of the knot on the quirt handle he made (see Fig. 963), but not a single detail of the value used for the parameter B^* of this knot, nor of the way in which he braided the knot.

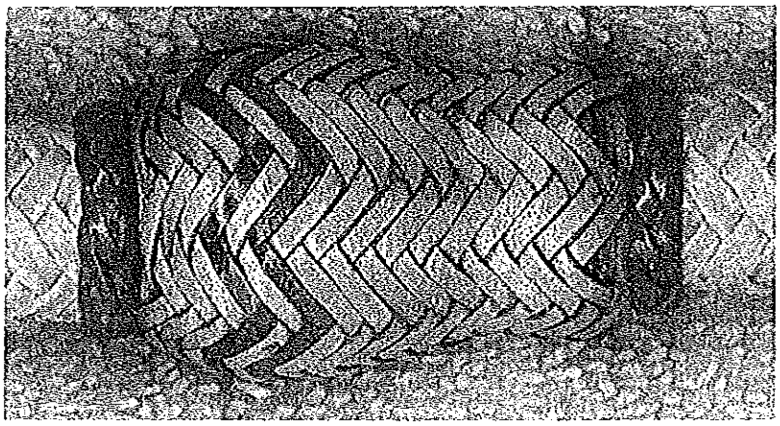


Fig. 963 — The copied knot on the quirt handle.

Thus from this picture in Fig. 963 we had to guess the value of B^*. Since it could have been 5 or 6 and since $B^* = 5$ gives not only a better pattern (a better star-pattern, especially when interbraiding is being used as in our case with the coloured strings), but is more versatile by being **odd**†, we took B^* to be 5. Next we have to deduce from the picture in Fig. 963 whether or not the Herringbone Pineapple Knot foundation could be a **Perfect** Herringbone Pineapple Knot foundation.

† When g.c.d.$(P, B^*) = 1$ the Herringbone Pineapple Knot foundation requires one essential string and is a Perfect Herringbone Pineapple Knot only when made with one string. In high class work one can expect to find such a foundation. Since for a Perfect Herringbone Pineapple Knot with $A =$ **odd** (as in our case with $A = 3$) $x =$ **even** (see *The Braider*, Issue No. 28, pg. 644), hence $P_{total} = P = 2A + x - 2 =$ **even**, it follows that with $B^* =$ **even** a Perfect Herringbone Pineapple Knot is not possible.

A Herringbone Pineapple Knot has rows of \ coding-sets alternating with rows of / coding-sets. Each coding-set consists of A consecutive identical single codings along the same helix. Let there be r_h coding-sets in a row of / coding-sets and let there be l_h coding-sets in a row of \ coding-sets. When $l_h = r_h$, the Herringbone Pineapple Knot is either a Standard Herringbone Pineapple Knot or a Semi-Standard Herringbone Pineapple Knot (with $y = A$). When $l_h = r_h - 1$, the Herringbone Pineapple Knot is a Perfect Herringbone Pineapple Knot or a Semi-Perfect Herringbone Pineapple Knot with $y = A - 1$. When $l_h = r_h + 1$, the Herringbone Pineapple Knot is a Perfect Herringbone Pineapple Knot or a Semi-Perfect Herringbone Pineapple Knot with $y = A + 1$. For any of these six types of Herringbone Pineapple Knots we have:

$$P_{total} = A + (l_h + r_h),$$

$$x = P_{total} + 2 - 2A = (l_h + r_h) + 2 - A,$$

$$k = \left|\frac{x - y - 2}{2}\right|_A = |l_h|_A = |r_h|_A \quad \text{when } l_h = r_h, \text{ hence } y = A,$$

$$k = \left|\frac{x - y - 2}{2}\right|_A = |l_h + 1|_A = |r_h|_A \quad \text{when } l_h = r_h - 1, \text{ hence } y = A - 1,$$

$$k = \left|\frac{x - y - 2}{2}\right|_A = |l_h - 1|_A = |r_h|_A \quad \text{when } l_h = r_h + 1, \text{ hence } y = A + 1,$$

For the Standard and Semi-Standard Herringbone Pineapple Knots we have in addition:

$|l_h|_A = |r_h|_A =$ number of components with $P_c = 3 + \frac{2(l_h) - 2|l_h|_A}{A} = 3 + \frac{2(r_h) - 2|r_h|_A}{A}$ each. For these components: $l_i + r_i = k + 1$.

$A - |l_h|_A = A - |r_h|_A =$ number of components with $P_c = 1 + \frac{2(l_h) - 2|l_h|_A}{A} = 1 + \frac{2(r_h) - 2|r_h|_A}{A}$ each. For these components: $l_i + r_i = k + 1 + A$.

The foundation Herringbone Pineapple Knot of the knot in Fig. 963 has either

1. $A = 3$, $l_h = 13$, $r_h = 14$, or
2. $A = 3$, $l_h = 14$, $r_h = 14$.

For case 1. we see that the foundation knot is a Perfect or a Semi-Perfect Herringbone Pineapple Knot with $P_{total} = P = A + (l_h + r_h) = 3 + (13 + 14) = 30$, $x = (l_h + r_h) + 2 - A = (13 + 14) + 2 - 3 = 26$, $k = |l_h + 1|_A = |r_h|_A = |13 + 1|_3 = |14|_3 = 2$. Since g.c.d.$(P, B^*) =$ g.c.d.$(30, 5) = 5$, we require five essential strings for this Semi-Perfect Herringbone Pineapple Knot.

The grid-diagrams of this knot and its foundation knot would therefore be as depicted in Fig. 964. Note that **in the overall braid** the bights in each nest of the foundation knot are nicely aligned at the left bight-edge and that the left-hand bights of the two interbraided components are also nicely aligned with the left-hand bights of the foundation knot. **In the overall braid**, the bights in each nest on the right-hand bight-edge of the foundation knot are not nicely aligned, but the practical braider would not be able to notice that of course (in the foundation knot itself, the bights in each left-hand nest **and** in each right-hand nest are nicely lined up).

The foundation knot is a Semi-Perfect Herringbone Pineapple Knot, hence not a type of knot well known to most braiders. It requires five essential strings which, apart from anything else, is **not** a good proposition for high quality braidwork. Furthermore, each of the **five** sub-components of the foundation knot has a string-run which is not an obvious result from (practical) experimentation. It is thus most unlikely that the grid-diagram in Fig. 964 resembles the knot made by Luis B. Ortega.

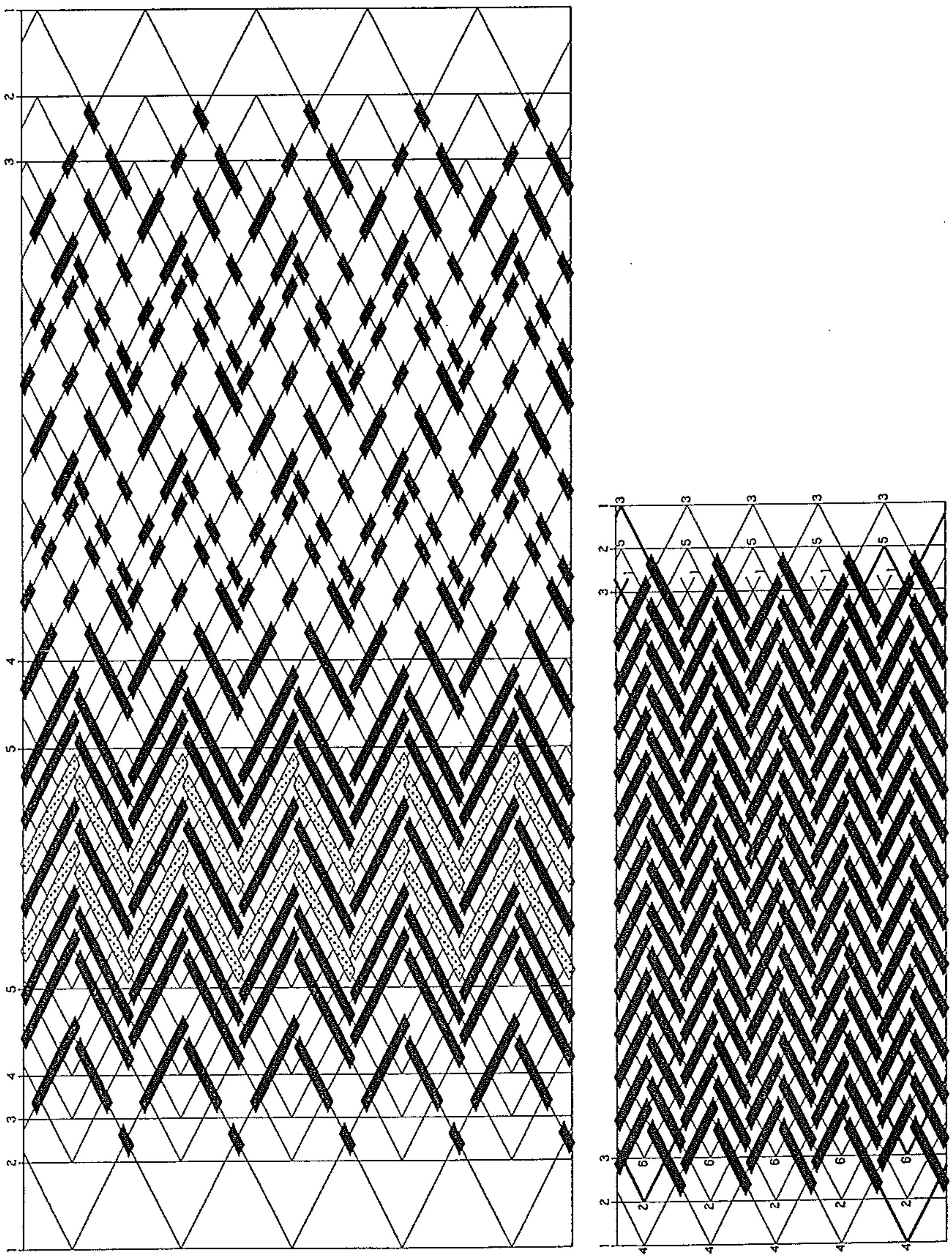


Fig. 964 — $A = 3$, $B^* = 5$, $l_h = 13$, $r_h = 14$, $x = 26$, $k = 2$, $y = A - 1 = 2$.

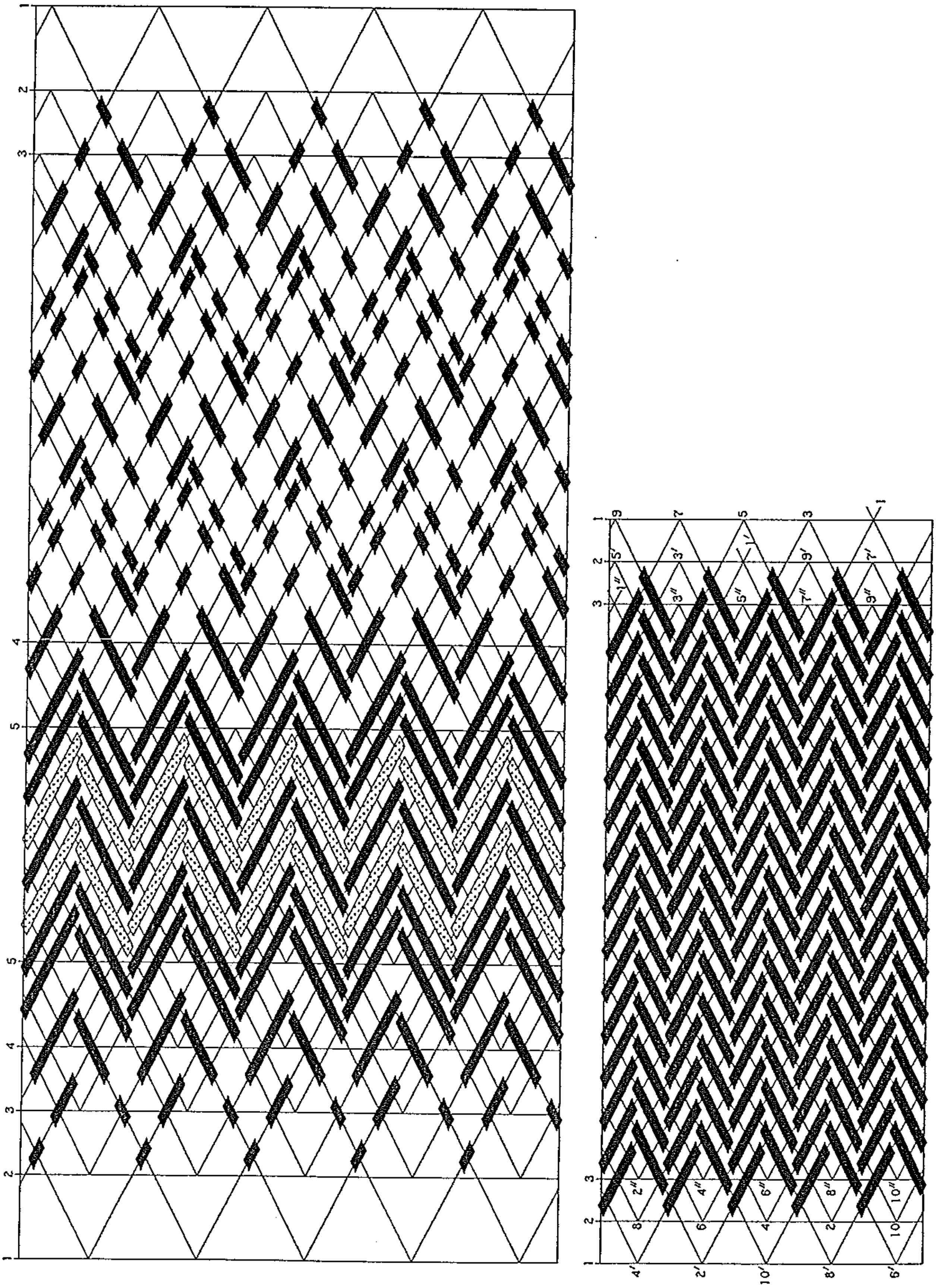


Fig. 965 — $A = 3$, $B^* = 5$, $l_h = r_h = 14$, $x = 27$, $k = 2$, $y = A = 3$.

For case **2.** we see that the foundation knot is a Standard or a Semi-Standard Herringbone Pineapple Knot with $P_{total} = A + (l_h + r_h) = 3 + (14 + 14) = 31$, $x = (l_h + r_h) + 2 - A = (14 + 14) + 2 - 3 = 27$ and $k = |l_h|_A = |r_h|_A = |14|_3 = 2$. This foundation knot has two sets of components:

One set with $|l_h|_A = |r_h|_A = |14|_3 = 2$ components, with each component having $P_c = 3 + \frac{2(l_h)-2|l_h|_A}{A} = 3 + \frac{2(r_h)-2|r_h|_A}{A} = 3 + \frac{2\times 14-2|14|_3}{3} = 11 = P_{c_1}$, and one set with $A - |l_h|_A = A - |r_h|_A = 3 - |14|_3 = 1$ component which has $P_c = 1 + \frac{2(l_h)-2|l_h|_A}{A} = 1 + \frac{2(r_h)-2|r_h|_A}{A} = 1 + \frac{2\times 14-2|14|_3}{3} = 9 = P_{c_2}$.

Since g.c.d.$(P_{c_1}, B^*) =$ g.c.d.$(11, 5) = 1$, and g.c.d.$(P_{c_2}, B^*) =$ g.c.d.$(9, 5) = 1$, the foundation knot is a Standard Herringbone Pineapple Knot and hence it requires three essential strings (three components with no sub-components).

The grid-diagrams of this knot and its foundation knot would therefore be as depicted in Fig. 965. Note that **in the overall braid** the bights in each nest of the foundation knot are **not** nicely aligned at the left bight-edge and that the left-hand bights of the two interbraided components are also **not** nicely aligned with any of the left-hand bights of the foundation knot. **In the overall braid**, the bights in each nest on the right-hand bight-edge of the foundation knot are not nicely aligned, but the practical braider would again not be able to notice that of course (in the foundation knot itself, the bights in each left-hand nest **and** in each right-hand nest are nicely aligned).

Not only does the foundation knot require **three** essential strings **and** not only is it a Standard Herringbone Pineapple Knot, a type of knot well-known to most braiders, but each sub-component is a typical pattern-braiders under-over coded Regular Knot; hence the foundation knot is a pattern-braiders type of Standard Herringbone Pinapple Knot, consequently even more well-known to most braiders (sub-components between R_1 and L_2, and respectively between R_2 and L_1 each with $p = 11$ parts and $b = 5$ bights, and the sub-component between R_3 and L_3 with $p = 9$ parts and $b = 5$ bights; hence $p = nb \pm 1$). It is thus very likely that the knot in Fig. 963 is represented by the grid-diagram in Fig. 965. Since it is preferable to use the minimum number of essential strings in the overall knot, interbraiding this knot as indicated by the grid-diagram in Fig. 966 is to be preferred.

Let's now return to Fig. 964. We have seen that $x = 26$ in the foundation knot depicted in Fig. 964. By decreasing $x = 26$ slightly to $x = 25$, we obtain the interbraided knot with its foundation knot in Fig. 967 ($l_h + r_h = x + A - 2 = 25 + 3 - 2 = 26$, hence $l_h = r_h = 13$; consequently $k = \left|\frac{x-y-2}{2}\right|_A = \left|\frac{25-3-2}{2}\right|_3 = 1$). The foundation knot is a pattern-braiders type of Standard Herringbone Pineapple Knot (its sub-component between R_1 and L_1 has $p = 11$ parts and $b = 5$ bights, while its sub-components between R_2 and L_3, and respectively between R_3 and L_2 have each $p = 9$ parts and $b = 5$ bights; hence $p = nb \pm 1$).

By increasing $x = 26$ slightly to $x = 27$, we obtain the interbraided knot with its foundation knot in Fig. 968 ($l_h + r_h = x + A - 2 = 27 + 3 - 2 = 28$, hence $l_h = r_h = 14$; consequently $k = \left|\frac{x-y-2}{2}\right|_A = \left|\frac{27-3-2}{2}\right|_3 = 2$). The foundation knot is a pattern-braiders type of Standard Herringbone Pineapple Knot (its sub-components between R_1 and L_2, and respectively between R_2 and L_1 have each $p = 11$ parts and $b = 5$ bights, while its sub-component between R_3 and L_3 has $p = 9$ parts and $b = 5$ bights; hence $p = nb \pm 1$). Note that the foundation knot in Fig. 965 and Fig. 968 are identical, but their position in the overall interbraided knots are reversed.

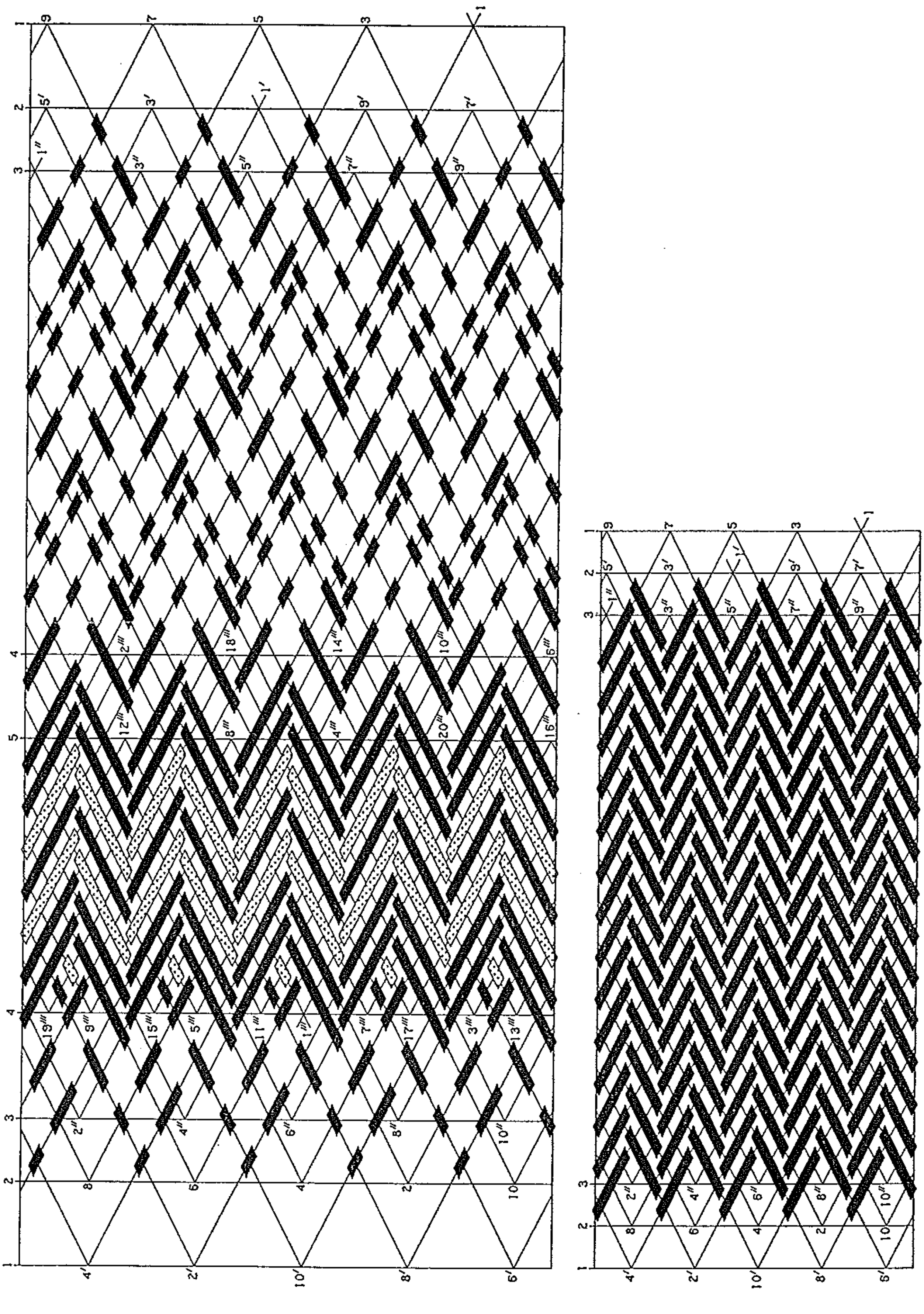


Fig. 966 — See text on pg. 1221.

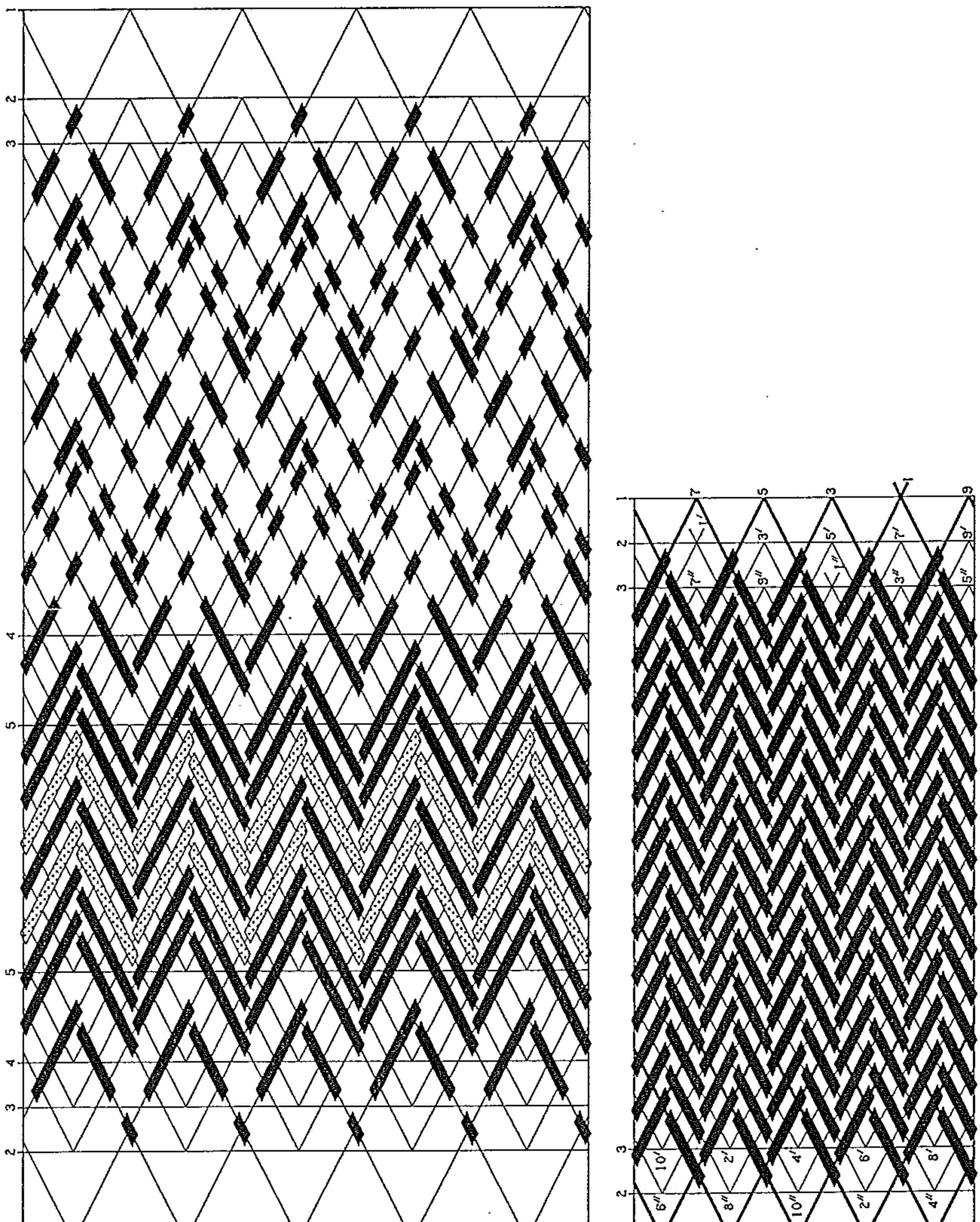


Fig. 967 — $A = 3$, $B^* = 5$, $l_h = r_h = 13$, $x = 25$, $k = 1$, $y = A = 3$.

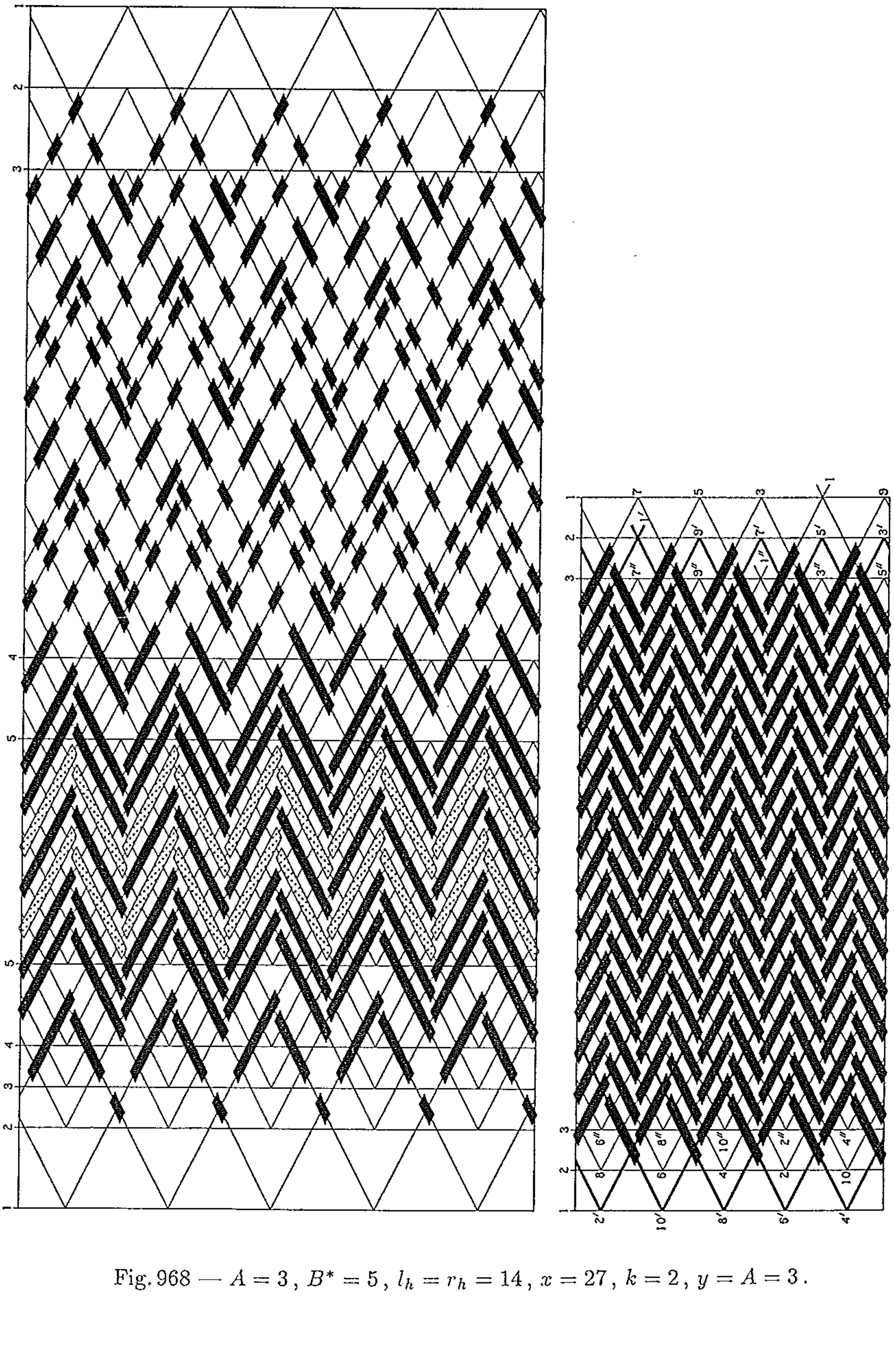


Fig. 968 — $A = 3$, $B^* = 5$, $l_h = r_h = 14$, $x = 27$, $k = 2$, $y = A = 3$.

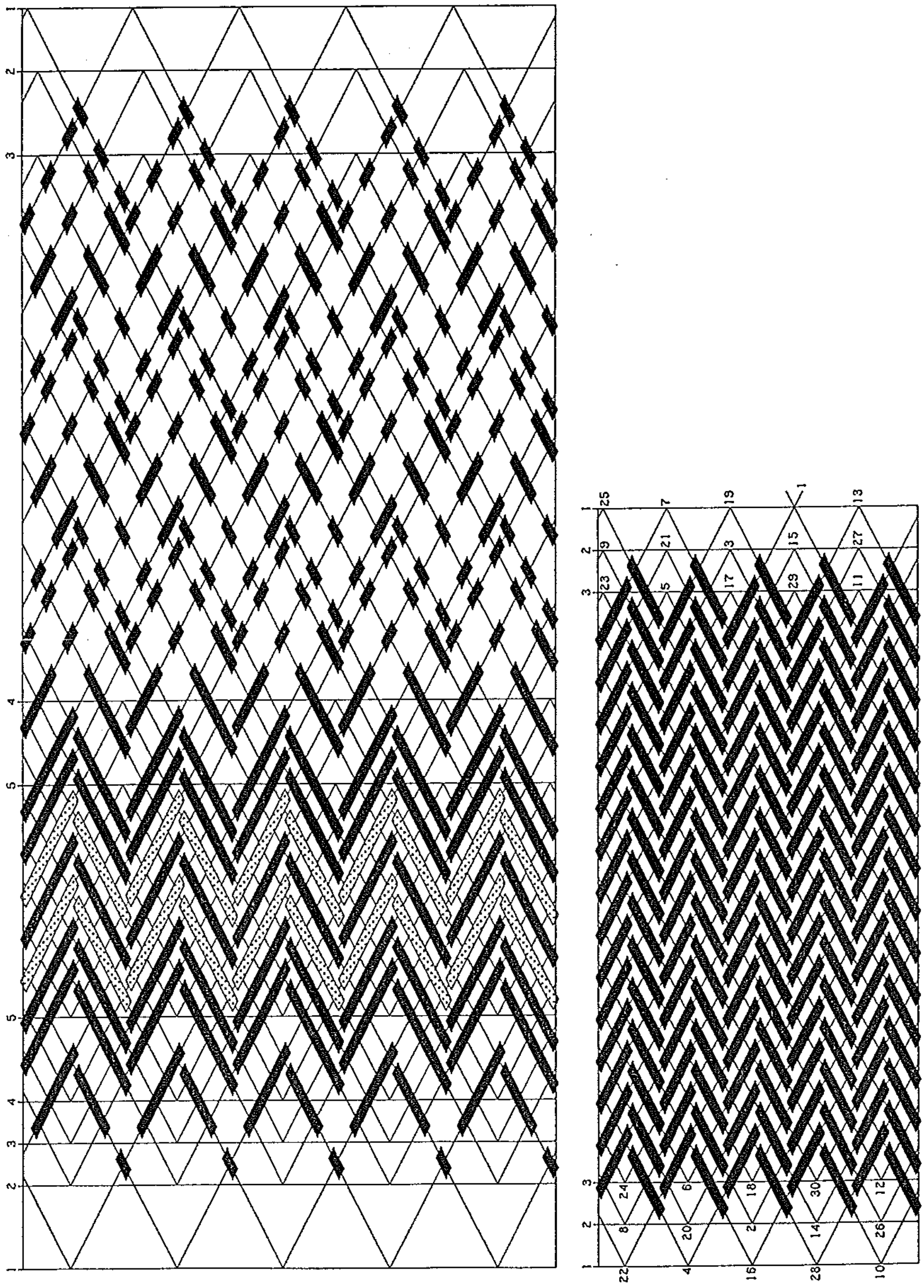


Fig. 969 — $A = 3$, $B^* = 5$, $l_h = 14$, $r_h = 15$, $x = 28$, $k = 3$, $y = A - 1 = 2$.

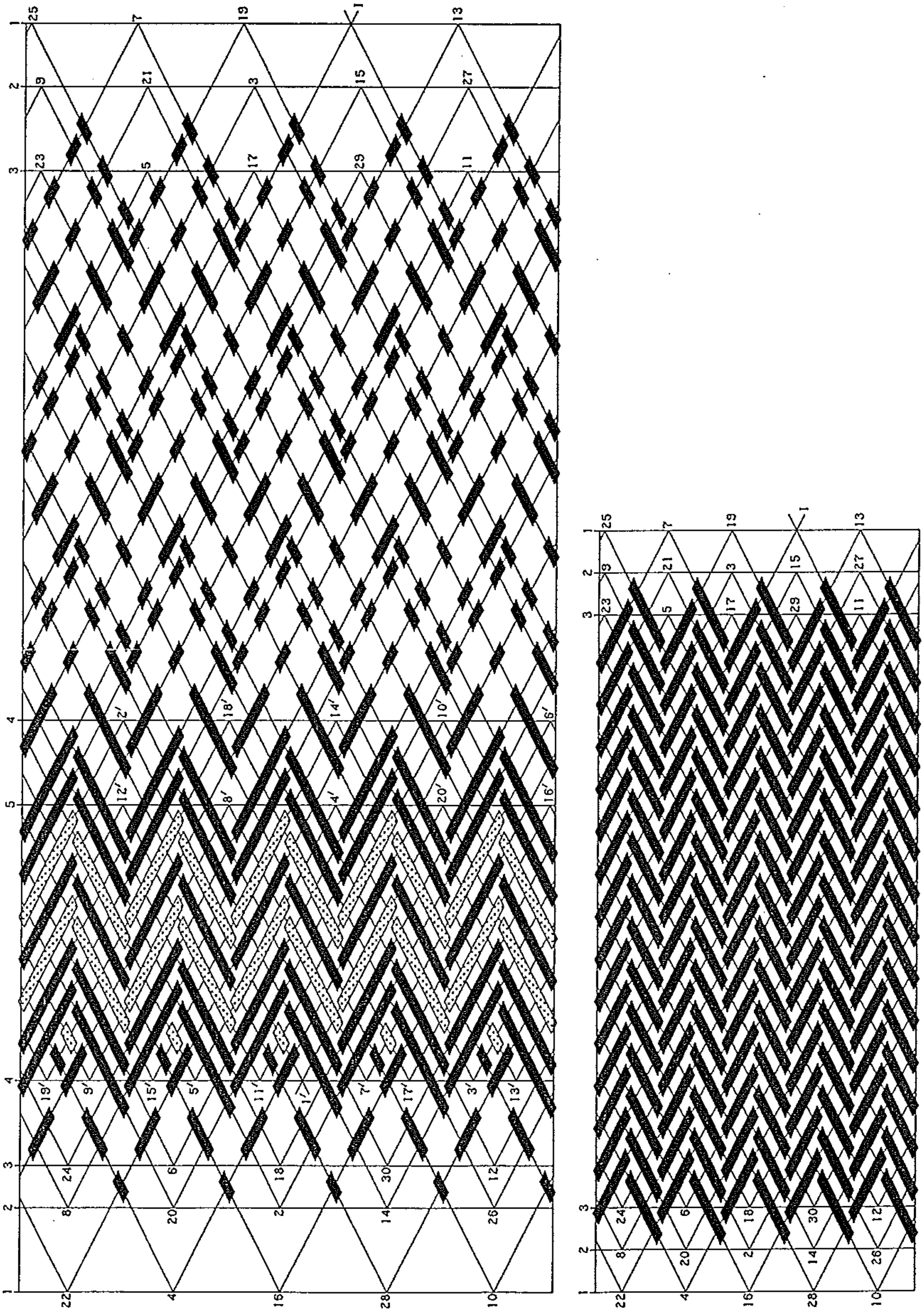


Fig. 970 — See text on pg. 1227.

Let's increase x a little more to $x = 28$. Then the foundation knot becomes a Perfect Herringbone Pineapple Knot, hence requires only one essential string. Its grid-diagram and the grid-diagram of its associated interbraided knot are depicted in Fig. 969 ($l_h + r_h = x + A - 2 = 28 + 3 - 2 = 29$, hence $l_h = 14$, $r_h = 15$; consequently $k = \left|\frac{x-y-2}{2}\right|_A = \left|\frac{28-2-2}{2}\right|_3 = 3$). This interbraided knot, which requires a total of **three** essential strings is in practice to be preferred (**three** essential strings in Fig. 969 against **five** essential strings in Fig. 965), however, we can reduce the number of essential strings even further to **two** by braiding the interbraid as shown in Fig. 970. Obviously the interbraided knot in Fig. 970 should preferably be used in practice (**two** essential strings in Fig. 970 against **four** essential strings in Fig. 966).

Let's get back to the naming of these knots in the set [Fig. 964, Fig. 967, Fig. 968, Fig. 969, Fig. 970] and in the set [Fig. 965, Fig. 966]. In the first set the visible interbraid is aligned within the foundation knot, while in the second set the visible interbraid is not aligned within the foundation knot. In the first set we have the sub-sets [Fig. 967, Fig. 968], [Fig. 969, Fig. 970] and [Fig. 964]. In the sub-set [Fig. 967, Fig. 968], the foundation knot is a Standard Herringbone Pineapple Knot. In the sub-set [Fig. 969, Fig. 970], the foundation knot is a Perfect Herringbone Pineapple Knot. In the sub-set [Fig. 964], the foundation knot is a Semi-Perfect Herringbone Pineapple Knot. In the second set [Fig. 965, Fig. 966], the foundation knot is a Standard Herringbone Pineapple Knot. Furthermore, the interbraid itself in [Fig. 966, Fig. 970] differs from the one in [Fig. 964, Fig. 967, Fig. 968, Fig. 969, Fig. 970]. Although the braids in the two sets [Fig. 964, Fig. 967, Fig. 968, Fig. 969, Fig. 970] and [Fig. 965, Fig. 966] look superficially alike, they are however not alike; the only thing they have in common is their shape.

This interbraiding of the foundation knots has the aim to offset to a greater or lesser extent the increase in the helix-angle of the strings over the swell. If the effective circumference of the surface under the braid is C_s, the effective strand-width is w, the angle α is 90° minus the helix-angle, the number of bights is b, then $C_s = nz = \frac{nw}{\sin\alpha} = \frac{bw}{\sin\alpha}$, hence $n = b = \frac{C_s \cdot \sin\alpha}{w}$ (see Fig. 971).

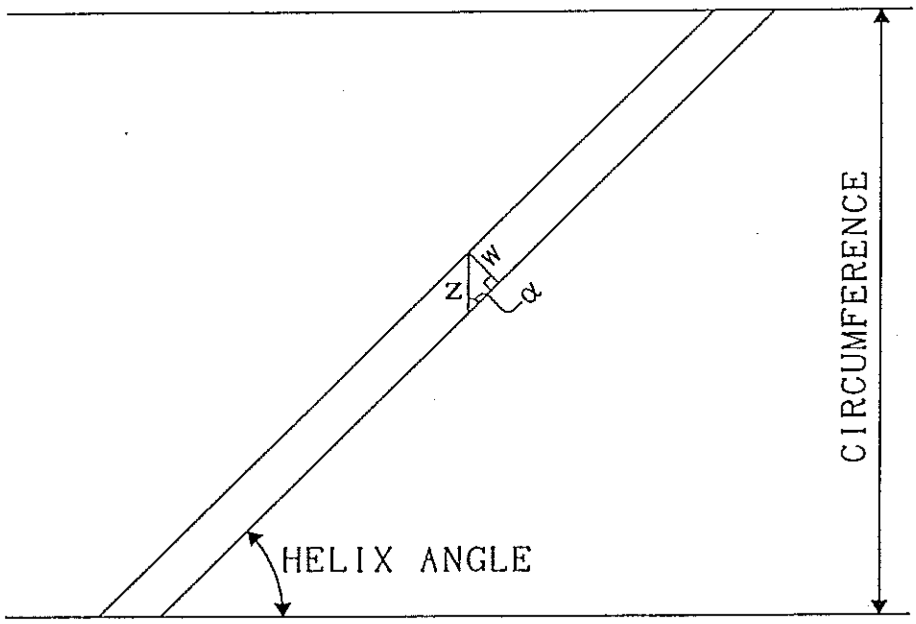


Fig. 971 — Circumference, strand-width and helix-angle.

Thus when C_s increases, α decreases when w and $n = b$ do not change, or when limiting the decrease in α (hence limiting the increase in the helix-angle), $n = b$ must increase when w does not change. This increase in n (n represents the number of left-helix strands which is equal to the number of right-helix strands) does not have to be with strands of a different colour, although for ornamental reasons this is often the case. The actual string-run of such an interbraided strand or strands does in general not follow exactly the path indicated in the grid-diagram, but good interbraiding will not show that. Hence how such interbraiding is done is unimportant as long as it is aesthetically compatible with the pattern of the braid of the foundation knot (see for example Fig. 965, Fig. 966, Fig. 967).

Eventually the braider informed us that he had used six strings and had laid them all down in alternating left and right helix stages. In other words $B^* = 6$ and the braiding was done by using the parallel braiding method†. Since in the foundation knot with $A = 3$, $l_h = 13$, $r_h = 14$, $B^* = 6$, hence $P_{total} = P = 30$ we require six essential strings, his choice of foundation knot was very easy to braid by means of the parallel braiding method, but was at the same time a knot which should not be used on high quality work (it is a type of knot one can expect to find on mass-produced braidwork or braidwork produced by a novice). In better quality braidwork we would expect to find a foundation knot with either $l_h = 15$, $r_h = 14$ or $l_h = 14$, $r_h = 15$ or $l_h = 13$, $r_h = 12$ or $l_h = 12$, $r_h = 13$. In each of these cases the foundation knot is a Semi-Perfect Herringbone Pineapple Knot which requires only two essential strings! We can, of course, still braid those foundation knots with six strings instead of two, but that would clearly indicate that the braider does not know what can be done with only a little more effort while obtaining a much higher quality in artistic braiding sense let alone craftsmanship. Hence let's show in an example what should and what should not be done for obtaining high quality braidwork.

Let $l_h = 15$ and $r_h = 14$. Let $A = 3$ and $B^* = 6$. We thus have:

$$l_h = r_h + 1 \quad \longrightarrow y = A + 1,$$
$$x = l_h + r_h + 2 - A = 15 + 14 + 2 - 3 = 28,$$
$$P_{total} = P = l_h + r_h + A = 15 + 14 + 3 = 32,$$
$$\text{g.c.d.}(P, B^*) = \text{g.c.d.}(32, 6) = 2 \quad \longrightarrow \text{hence 2 essential strings required},$$
$$k = |l_h - 1|_A = |r_h|_A = |14|_3 = 2.$$

For the conventional first-return string-run see upper-left diagram in Fig. 972. Place the Standing Ends of the two essential strings on right-hand side with the Standing

† Let there be m strings in the string-set which generate the left-helix and the right-helix string-run half-cycles; then the braid consists of $2n$ sets each of m string-run half-cycles ($2nm = 2AB^* = 2B$). The m string-run half-cycles in a string-run half-cycle set have all the same orientation but do not necessarily have the same bight-boundaries. In the parallel braiding method, each of the m strings completes its string-run half-cycle in the j^{th} string-run half-cycle set before starting with the string-run half-cycles of the $(j+1)^{th}$ string-run half-cycle set. Any string of the string-set can be replaced by a different colour string for the whole or part of its string-length. In the most commonly used parallel braiding method, the Standing Ends of the m strings are placed at the same bight-boundary and are regularly spaced over the total number of bights) In high class braidwork we should not use an excessive number of strings and hence multi-string core covering braids with m greater than the number of essential strings should only be used when the string-length of the essential strings is getting too long.

End half-cycle running from lower-right to upper-left; draw first-return string-run in accordance (see upper-right diagram in Fig. 972).

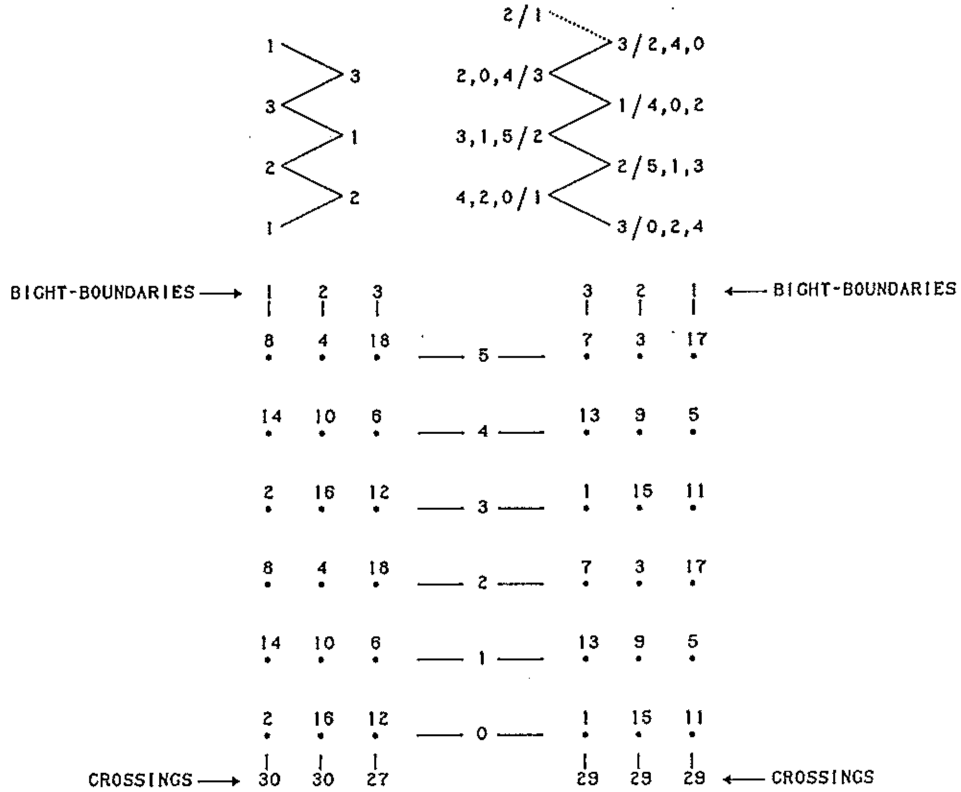


Fig. 972 — First-return string-run of one string and half-cycle pattern for $m = 2$.

Add to this first-return string-run diagram for one essential string the nest-index numbers; the nest at the beginning of the first half-cycle receives the nest-index number $I^*_R = I^*_1 = 0$, and the nest at the end of the first half-cycle receives the nest-index number $I^*_L = I^*_{1'} = 0$. The nest at the beginning of the second half-cycle is the nest at the end of the first half-cycle and the nest at the end of the second half-cycle receives the nest-index number $I^*_R = I^*_2 = |I^*_1 + \Delta I^*_1|_{B^*}$. The nest at the beginning of the third half-cycle is the nest at the end of the second half-cycle and the nest at the end of the third half-cycle receives the nest-index number $I^*_L = I^*_{2'} = |I^*_{1'} + \Delta I^*_{1'}|_{B^*}$. The nest at the beginning of the fourth half-cycle is the nest at the end of the third half-cycle and the nest at the end of the fourth half-cycle receives the nest-index number $I^*_R = I^*_3 = |I^*_2 + \Delta I^*_2|_{B^*}$. The nest at the beginning of the fifth half-cycle is the nest at the end of the fourth half-cycle and the nest at the end of the fifth half-cycle receives the nest-index number $I^*_L = I^*_{3'} = |I^*_{2'} + \Delta I^*_{2'}|_{B^*}$. And so on. Hence:

Half-cycle 1 begins at right bight-boundary $r_1 = 3$ and nest-index number $I^*_R = I^*_1 = 0$. It ends at left bight-boundary $l_1 = 1$ and nest-index number $I^*_L = I^*_{1'} = 0$.

Half-cycle 2 begins at left bight-boundary $l_1 = 1$ and nest-index number $I^*_l = I^*_{1'} = 0$. It ends at right bight-boundary $r_2 = 2$ and nest-index number $I^*_R = I^*_2 = \cdots$.

Half-cycle 3 begins at right bight-boundary $r_2 = 2$ and nest-index number $I^*_R = I^*_2 = \cdots$. It ends at left bight-boundary $l_2 = 2$ and nest-index number $I^*_L = I^*_{2'} = \cdots$.

Half-cycle 4 begins at left bight-boundary $l_2 = 2$ and nest-index number $I^*_l = I^*_{2'} = \cdots$. It ends at right bight-boundary $r_3 = 1$ and nest-index number $I^*_R = I^*_3 = \cdots$.

Half-cycle 5 begins at right bight-boundary $r_3 = 1$ and nest-index number $I_R^* = I_3^* = \cdots$. It ends at left bight-boundary $l_3 = 3$ and nest-index number $I_L^* = I_{3'}^* = \cdots$.

Half-cycle 6 begins at left bight-boundary $l_3 = 3$ and nest-index number $I_l^* = I_{3'}^* = \cdots$. It ends at right bight-boundary $r_4 = r_1 = 3$ and nest-index number $I_R^* = I_4^* = \cdots$.

Half-cycle 7 begins at right bight-boundary $r_4 = r_1 = 3$ and nest-index number $I_R^* = I_4^* = \cdots$. It ends at left bight-boundary $l_4 = l_1 = 1$ and nest-index number $I_L^* = I_{4'}^* = \cdots$.

Half-cycle 8 begins at left bight-boundary $l_4 = l_1 = 1$ and nest-index number $I_l^* = I_{4'}^* = \cdots$. It ends at right bight-boundary $r_5 = r_2 = 2$ and nest-index number $I_R^* = I_5^* = \cdots$.

Half-cycle 9 begins at right bight-boundary $r_5 = r_2 = 2$ and nest-index number $I_R^* = I_5^* = \cdots$. It ends at left bight-boundary $l_5 = l_2 = 2$ and nest-index number $I_L^* = I_{5'}^* = \cdots$.

Half-cycle 10 begins at left bight-boundary $l_5 = l_2 = 2$ and nest-index number $I_l^* = I_{5'}^* = \cdots$. It ends at right bight-boundary $r_6 = r_3 = 1$ and nest-index number $I_R^* = I_6^* = \cdots$.

Half-cycle 11 begins at right bight-boundary $r_6 = r_3 = 1$ and nest-index number $I_R^* = I_6^* = \cdots$. It ends at left bight-boundary $l_6 = l_3 = 3$ and nest-index number $I_L^* = I_{6'}^* = \cdots$.

Half-cycle 12 begins at left bight-boundary $l_6 = l_3 = 3$ and nest-index number $I_l^* = I_{6'}^* = \cdots$. It ends at right bight-boundary $r_7 = r_1 = 3$ and nest-index number $I_R^* = I_7^* = \cdots$.

Half-cycle 13 begins at right bight-boundary $r_7 = r_1 = 3$ and nest-index number $I_R^* = I_7^* = \cdots$. It ends at left bight-boundary $l_7 = l_1 = 1$ and nest-index number $I_L^* = I_{7'}^* = \cdots$.

Half-cycle 14 begins at left bight-boundary $l_7 = l_1 = 1$ and nest-index number $I_l^* = I_{7'}^* = \cdots$. It ends at right bight-boundary $r_8 = r_2 = 2$ and nest-index number $I_R^* = I_8^* = \cdots$.

Half-cycle 15 begins at right bight-boundary $r_8 = r_2 = 2$ and nest-index number $I_R^* = I_8^* = \cdots$. It ends at left bight-boundary $l_8 = l_2 = 2$ and nest-index number $I_L^* = I_{8'}^* = \cdots$.

Half-cycle 16 begins at left bight-boundary $l_8 = l_2 = 2$ and nest-index number $I_l^* = I_{8'}^* = \cdots$. It ends at right bight-boundary $r_9 = r_3 = 1$ and nest-index number $I_R^* = I_9^* = \cdots$.

Half-cycle 17 begins at right bight-boundary $r_9 = r_3 = 1$ and nest-index number $I_R^* = I_9^* = \cdots$. It ends at left bight-boundary $l_9 = l_3 = 3$ and nest-index number $I_L^* = I_{9'}^* = \cdots$.

Half-cycle 18 begins at left bight-boundary $l_9 = l_3 = 3$ and nest-index number $I_l^* = I_{9'}^* = \cdots$. It ends at right bight-boundary $r_{10} = r_1 = 3$ (the beginning of half-cycle 1) and nest-index number $I_R^* = I_{10}^* = I_1^* = 0$.

The calculations for the entries $= \cdots$ are as follows:

$$I_1^* = 0\,,$$

$$I_{1'}^* = 0\,,$$

$$I_2^* = |I_1^* + \Delta I_1^*|_{B^*} = \left| I_1^* + \frac{|4A + x - (r_1 + r_2 + 2l_1)|_B}{A} \right|_{B^*} = \left| 0 + \frac{|40 - 7|_{18}}{3} \right|_6 = 5\,,$$

$$I^*_{2'} = |I^*_{1'} + \Delta I^*_{1'}|_{B^*} = \left| I^*_{1'} + \frac{|4A + x - (l_1 + l_2 + 2r_2)|_B}{A} \right|_{B^*} = \left| 0 + \frac{|40 - 7|_{18}}{3} \right|_6 = 5\,,$$

$$I^*_3 = |I^*_2 + \Delta I^*_2|_{B^*} = \left| I^*_2 + \frac{|4A + x - (r_2 + r_3 + 2l_2)|_B}{A} \right|_{B^*} = \left| 5 + \frac{|40 - 7|_{18}}{3} \right|_6 = 4\,,$$

$$I^*_{3'} = |I^*_{2'} + \Delta I^*_{2'}|_{B^*} = \left| I^*_{2'} + \frac{|4A + x - (l_2 + l_3 + 2r_3)|_B}{A} \right|_{B^*} = \left| 5 + \frac{|40 - 7|_{18}}{3} \right|_6 = 4\,,$$

$$I^*_4 = |I^*_3 + \Delta I^*_3|_{B^*} = \left| I^*_3 + \frac{|4A + x - (r_3 + r_4 + 2l_3)|_B}{A} \right|_{B^*} = \left| 4 + \frac{|40 - 10|_{18}}{3} \right|_6 = 2\,,$$

$$I^*_{4'} = |I^*_{3'} + \Delta I^*_{3'}|_{B^*} = \left| I^*_{3'} + \frac{|4A + x - (l_3 + l_4 + 2r_4)|_B}{A} \right|_{B^*} = \left| 4 + \frac{|40 - 10|_{18}}{3} \right|_6 = 2\,,$$

$$I^*_5 = |I^*_4 + \Delta I^*_4|_{B^*} = \left| I^*_4 + \frac{|4A + x - (r_4 + r_5 + 2l_4)|_B}{A} \right|_{B^*} = \left| 2 + \frac{|40 - 7|_{18}}{3} \right|_6 = 1\,,$$

$$I^*_{5'} = |I^*_{4'} + \Delta I^*_{4'}|_{B^*} = \left| I^*_{4'} + \frac{|4A + x - (l_4 + l_5 + 2r_5)|_B}{A} \right|_{B^*} = \left| 2 + \frac{|40 - 7|_{18}}{3} \right|_6 = 1\,,$$

$$I^*_6 = |I^*_5 + \Delta I^*_5|_{B^*} = \left| I^*_5 + \frac{|4A + x - (r_5 + r_6 + 2l_5)|_B}{A} \right|_{B^*} = \left| 1 + \frac{|40 - 7|_{18}}{3} \right|_6 = 0\,,$$

$$I^*_{6'} = |I^*_{5'} + \Delta I^*_{5'}|_{B^*} = \left| I^*_{5'} + \frac{|4A + x - (l_5 + l_6 + 2r_6)|_B}{A} \right|_{B^*} = \left| 1 + \frac{|40 - 7|_{18}}{3} \right|_6 = 0\,,$$

$$I^*_7 = |I^*_6 + \Delta I^*_6|_{B^*} = \left| I^*_6 + \frac{|4A + x - (r_6 + r_7 + 2l_6)|_B}{A} \right|_{B^*} = \left| 0 + \frac{|40 - 10|_{18}}{3} \right|_6 = 4\,,$$

$$I^*_{7'} = |I^*_{6'} + \Delta I^*_{6'}|_{B^*} = \left| I^*_{6'} + \frac{|4A + x - (l_6 + l_7 + 2r_7)|_B}{A} \right|_{B^*} = \left| 0 + \frac{|40 - 10|_{18}}{3} \right|_6 = 4\,,$$

$$I^*_8 = |I^*_7 + \Delta I^*_7|_{B^*} = \left| I^*_7 + \frac{|4A + x - (r_7 + r_8 + 2l_7)|_B}{A} \right|_{B^*} = \left| 4 + \frac{|40 - 7|_{18}}{3} \right|_6 = 3\,,$$

$$I^*_{8'} = |I^*_{7'} + \Delta I^*_{7'}|_{B^*} = \left| I^*_{7'} + \frac{|4A + x - (l_7 + l_8 + 2r_8)|_B}{A} \right|_{B^*} = \left| 4 + \frac{|40 - 7|_{18}}{3} \right|_6 = 3\,,$$

$$I^*_9 = |I^*_8 + \Delta I^*_8|_{B^*} = \left| I^*_8 + \frac{|4A + x - (r_8 + r_9 + 2l_8)|_B}{A} \right|_{B^*} = \left| 3 + \frac{|40 - 7|_{18}}{3} \right|_6 = 2\,,$$

$$I^*_{9'} = |I^*_{8'} + \Delta I^*_{8'}|_{B^*} = \left| I^*_{8'} + \frac{|4A + x - (l_8 + l_9 + 2r_9)|_B}{A} \right|_{B^*} = \left| 3 + \frac{|40 - 7|_{18}}{3} \right|_6 = 2\,,$$

$$I^*_{10} = I^*_0 = 0\,.$$

The I^*_R and I^*_L values have been entered on the first-return string-run diagram of one string at the upper-right in Fig. 972.

We can now assemble the half-cycle pattern (this and its use is fully discussed in *The Braider*, Issues No. 28 and No. 29; it is the diagram immediately below the first-return string-run diagrams in Fig. 972). The number of crossings on a half-cycle is calculated with the formula $2A+x-1-(r_i+l_i)$ for a half-cycle which runs from lower right bight-boundary r_i to upper left bight-boundary l_i. Similarly the number of crossings on a half-cycle which runs from lower left bight-boundary l_i to upper right bight-boundary r_i is calculated with the formula $2A + x - 1 - (l_i + r_i)$.

From the half-cycle pattern we derive the half-cycle tables in Fig. 973 (see the above mentioned issues of *The Braider*, however, in those issues we have limited ourselves to series braiding, which would in this case mean that we first complete the braiding of essential string No. 1, and after that we braid essential string No. 2; we would then call the first half-cycle of essential string No. 2 **half-cycle 19** (since the knot has 18 bights and hence 36 half-cycles in total) and keep numbering the following halfcycles of essential string No. 2 upwards).

L → R

2	16	12	14	10	6	8	4	18	2	16	12	14	10	6	8	4	18			
8	4	18	2	16	12	14	10	6	8	4	18	2	16	12	14	10	6			
14	10	6	8	4	18	2	16	12	14	10	6	8	4	18	2	16	12			
u	o	o	o	u	u	u	o	o	o	u	u	u	o	o	o	u	u	2	14	8
u	u	o	o	o	u	u	u	o	o	o	u	u	u	o	o	o	u	16	10	4
u	u	u	o	o	o	u	u	u	o	o	o	u	u	u	o	o	o	12	6	18

1 X +

R → L

11	15	X	5	9	13	17	3	7	11	15	X	5	9	13	17	3	7			
17	3	7	11	15	X	5	9	13	17	3	7	11	15	X	5	9	13			
5	9	13	17	3	7	11	15	X	5	9	13	17	3	7	11	15	X			
u	u	o	o	o	u	u	u	o	o	o	u	u	u	o	o	o	u	1	13	7
u	o	o	o	u	u	u	o	o	o	u	u	u	o	o	o	u	u	15	9	3
o	o	o	u	u	u	o	o	o	u	u	u	o	o	o	u	u	u	11	5	17

1 X +

Fig. 973 — Half-cycle tables for $m = 2$.

Since we have 2 essential strings which are parallel braided, we don't need the complete half-cycle tables (a half-cycle table consists of four compartments: an upper-left compartment, a lower-left compartment, an upper-right compartment and a lower-right compartment). A complete half-cycle table has:
in the upper-left compartment B^* rows and a number of columns equal to the maximum number of crossings on the half-cycles it is associated with,
in the lower-left compartment A rows and a number of columns equal to those in the upper-left compartment,
in the lower-right compartment a number of rows equal to those in the lower-left compartment and a number of columns equal to the number of rows in the upper-left compartment.
the upper-right compartment couples the rows in the upper-left compartment with the columns in the lower-right compartment.

Hence in our case, the complete half-cycle table for the odd-numbered half-cycles (from lower-right to upper-left) has in the upper-left compartment $B^* = 6$ rows and 29 columns, in the lower-left compartment $A = 3$ rows and 29 columns, in the lower-right compartment 3 rows and 6 columns; the complete half-cycle table for the even-numbered half-cycles (from lower-left to upper-right) has in the upper-left compartment $B^* = 6$ rows and 30 columns, in the lower-left compartment $A = 3$ rows and 30 columns, in the lower-right compartment 3 rows and 6 columns.

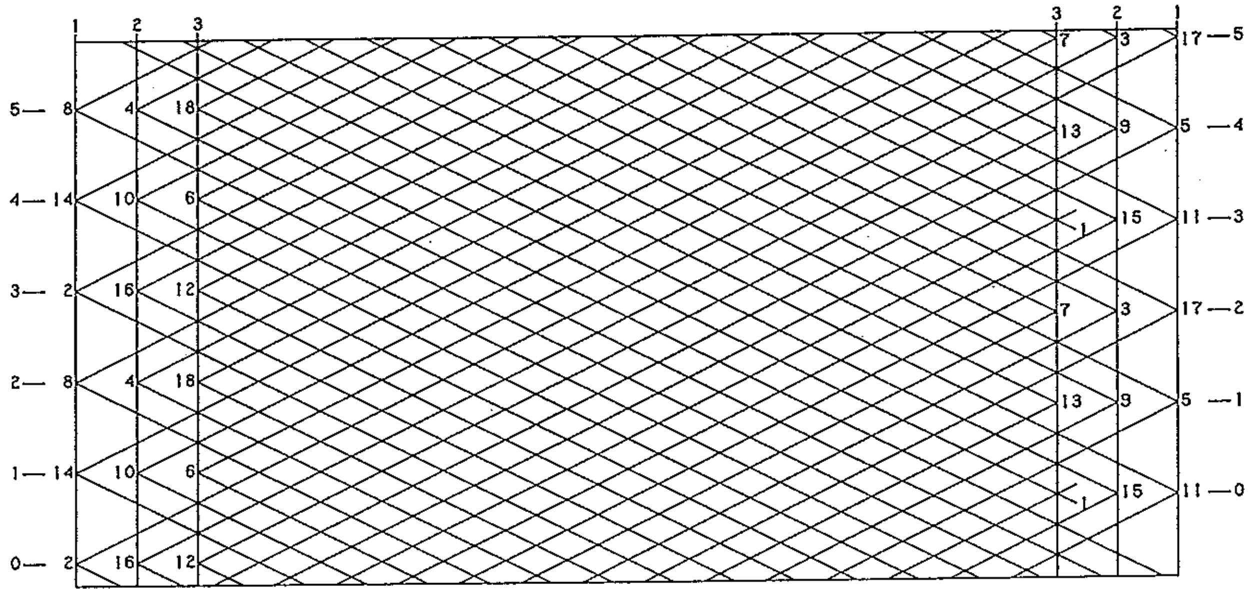
Say we have m strings in the string-set and we braid these by the parallel braiding method. Then in their half-cycle tables we only need:
in their upper-left compartments $\frac{B^*}{m}$ rows and $\frac{2B}{m}$ columns,
in their lower-left compartments A rows and $\frac{2B}{m}$ columns,
in their lower-right compartments A rows and $\frac{B^*}{m}$ columns.

Hence in our case for the parallel braiding of $m = 2$ strings, the half-cycle tables require in their upper-left compartments $\frac{B^*}{m} = \frac{6}{2} = 3$ rows and $\frac{2B}{m} = \frac{36}{2} = 18$ columns, in their lower-left compartments $A = 3$ rows and $\frac{2B}{m} = 18$ columns, and in their lower-right compartments $A = 3$ rows and $\frac{B^*}{m} = 3$ columns. To ensure that we obtain the correct number of crossings for half-cycles specified by a row in the lower-right compartment we repeat the crossing-sequence obtained from the lower-left compartment in that row so that we obtain this sequence the number of times indicated on the right of the table concerned and repeat the crossing-sequence obtained in the lower-left compartment in that row once again until the bold vertical line has been reached.

Hence from these half-cycle tables in Fig. 973 we read the following half-cycle braiding algorithms:

half-cycle 1 : $R_3 \longrightarrow L_1$: Free run.
half-cycle 2 : $L_1 \longrightarrow R_2$: $u \mid o \longrightarrow$
$u - o - u$.
half-cycle 3 : $R_2 \longrightarrow L_2$: $o \mid u \longrightarrow$
$o - u - o$.
half-cycle 4 : $L_2 \longrightarrow R_1$: $u\,u\,o \mid o \longrightarrow$
$2u - 2o - 2u - o$.
half-cycle 5 : $R_1 \longrightarrow L_3$: $o\,o\,u \mid u \longrightarrow$
$2o - 2u - 2o - u$.
half-cycle 6 : $L_3 \longrightarrow R_3$: $u\,o\,u \mid o\,u\,o \longrightarrow$
$u - o - u - o - u - o - u - o - u$.
half-cycle 7 : $R_3 \longrightarrow L_1$: $o\,u\,o \mid u\,o\,u \longrightarrow$
$o - u - o - u - o - u - o - u - o$.
half-cycle 8 : $L_1 \longrightarrow R_2$: $u\,u\,u\,o\,o \mid o\,o\,u \longrightarrow$
$3u - 4o - 4u - 2o$.
half-cycle 9 : $R_2 \longrightarrow L_2$: $o\,o\,u\,o\,u \mid u\,o\,u \longrightarrow$
$2o - u - o - 2u - o - u - 2o - u - o - u$.
half-cycle 10 : $L_2 \longrightarrow R_1$: $u\,u\,o\,u\,o\,o\,o \mid u\,o\,u \longrightarrow$
$2u - o - u - 3o - u - o - 3u - o - u - 3o$.
half-cycle 11 : $R_1 \longrightarrow L_3$: $o\,o\,u\,u\,o\,u\,u \mid o\,o\,u \longrightarrow$
$2o - 2u - o - 2u - 2o - u - 2o - 2u - o - 2u$.
half-cycle 12 : $L_3 \longrightarrow R_3$: $u\,u\,o\,o\,u\,u \mid o\,o\,u\,u\,o\,o \longrightarrow$
$2u - 2o - 2u - 2o - 2u - 2o - 2u - 2o - 2u$.
half-cycle 13 : $R_3 \longrightarrow L_1$: $u\,o\,o\,u\,u\,o\,o \mid u\,u\,o\,o\,u \longrightarrow$
$u - 2o - 2u - 2o - 2u - 2o - 2u - 2o - 2u - 2o$.
half-cycle 14 : $L_1 \longrightarrow R_2$: $u\,o\,o\,u\,u\,o\,o\,o\,u \mid u\,o\,o\,u\,u \longrightarrow$
$u - 2o - 2u - 3o - 2u - 2o - 3u - 2o - 2u - 3o - u$.
half-cycle 15 : $R_2 \longrightarrow L_2$: $u\,o\,o\,u\,u\,u\,o\,o\,u \mid u\,o\,o\,o\,u \longrightarrow$
$u - 2o - 3u - 2o - 2u - 3o - 2u - 2o - 3u - 2o - u$.
half-cycle 16 : $L_2 \longrightarrow R_1$: $u\,u\,o\,o\,o\,u\,u\,o\,o\,o\,u \mid u\,u\,o\,o\,u \longrightarrow$
$2u - 3o - 2u - 3o - 3u - 2o - 3u - 3o - 2u - 3o - u$.
half-cycle 17 : $R_1 \longrightarrow L_3$: $o\,o\,u\,u\,u\,o\,o\,o\,u\,u \mid o\,o\,o\,u\,u\,u \longrightarrow$
$2o - 3u - 3o - 2u - 3o - 3u - 2o - 3u - 3o - 2u$.
half-cycle 18 : $L_3 \longrightarrow R_3$: $u\,u\,u\,o\,o\,o\,u\,u\,u \mid o\,o\,o\,u\,u\,u\,o\,o\,o \longrightarrow$
$3u - 3o - 3u - 3o - 3u - 3o - 3u - 3o - 3u$.

These sequential braiding steps are shown on pp. 1234 - 1239.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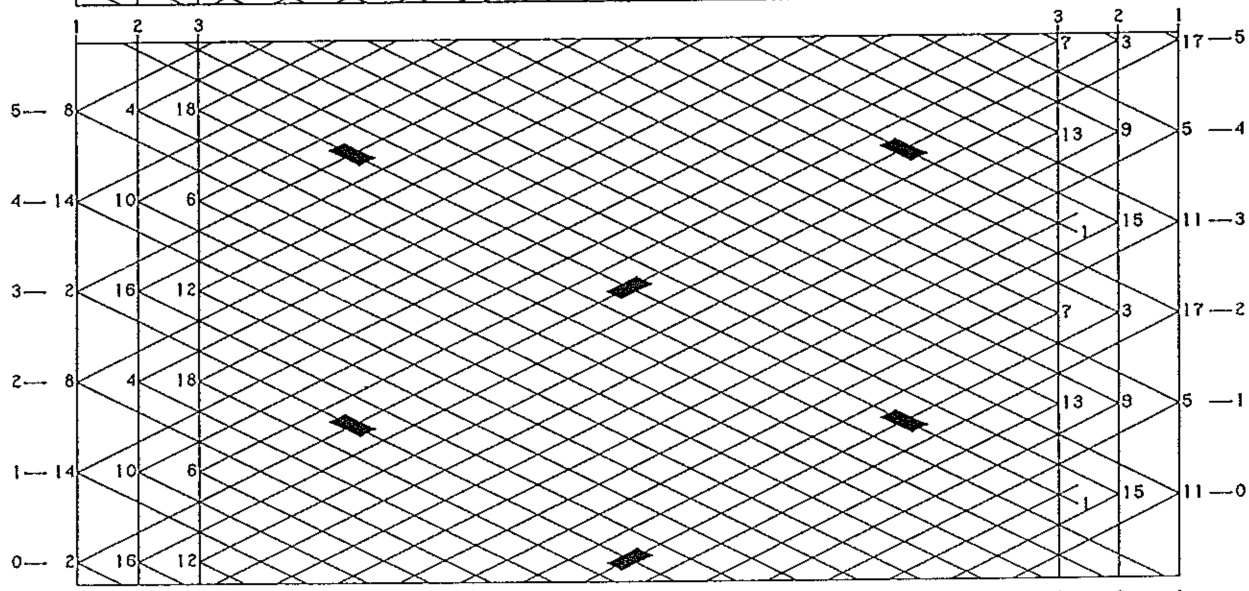
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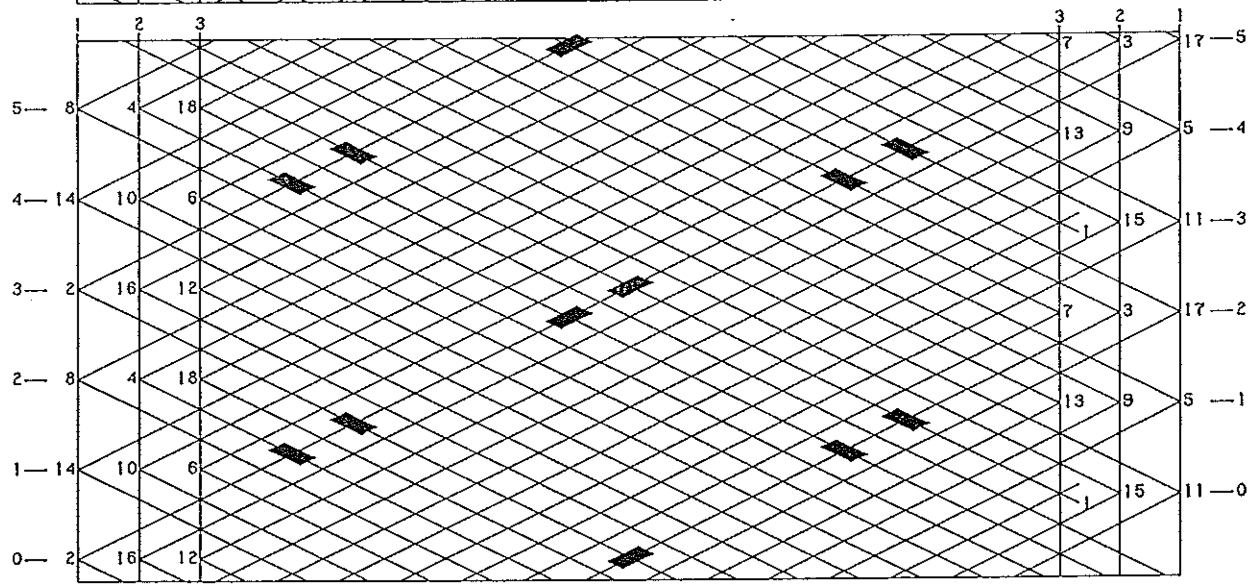
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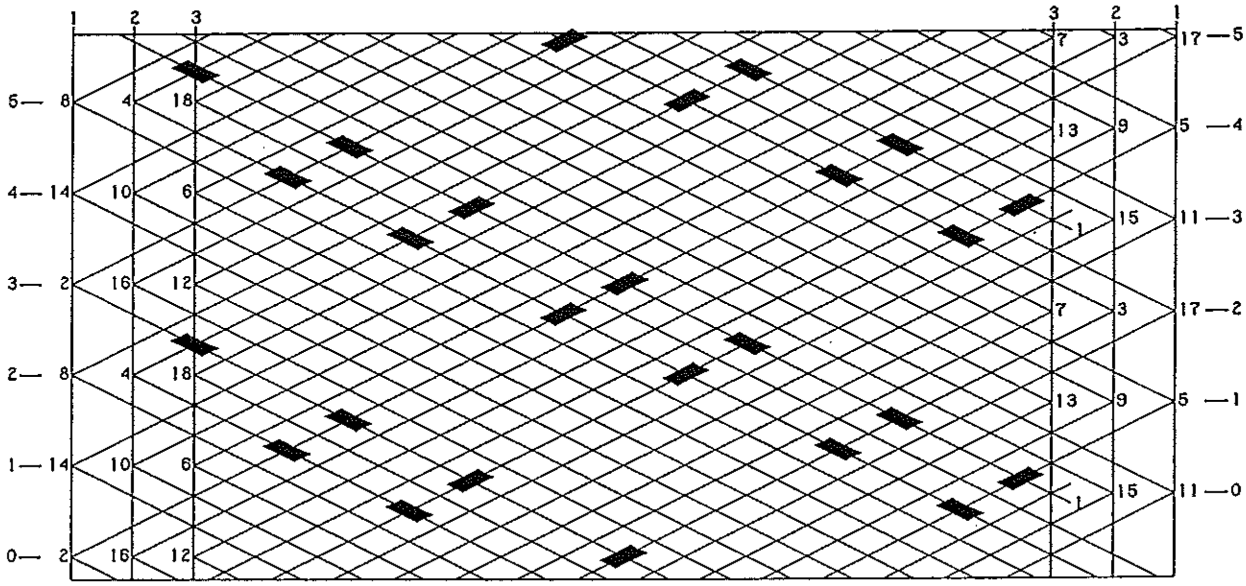

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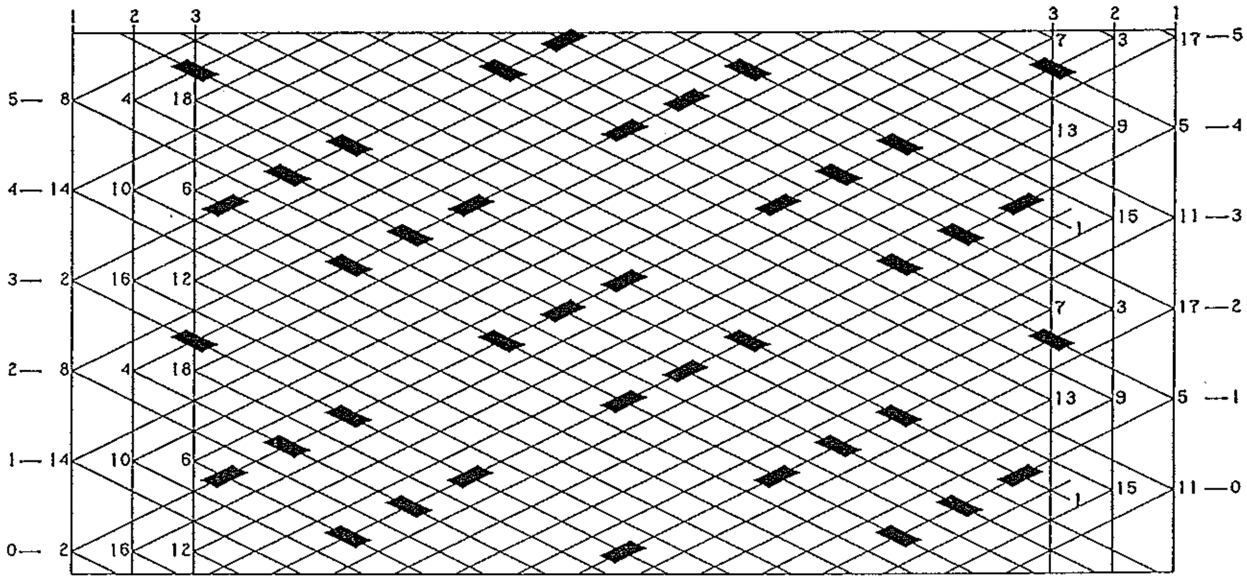

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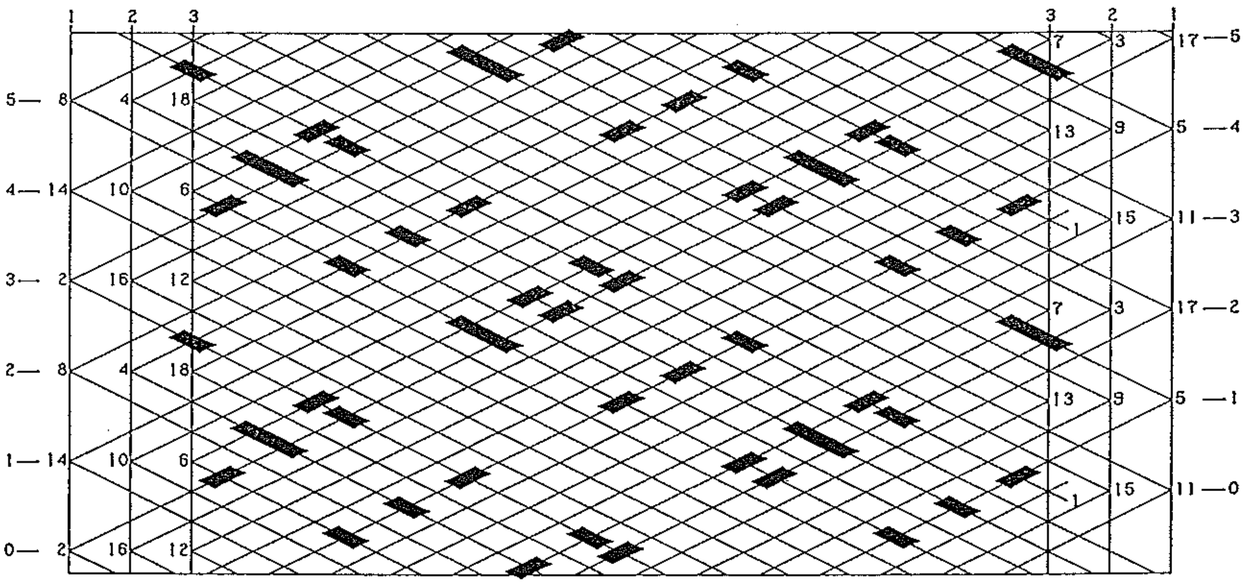

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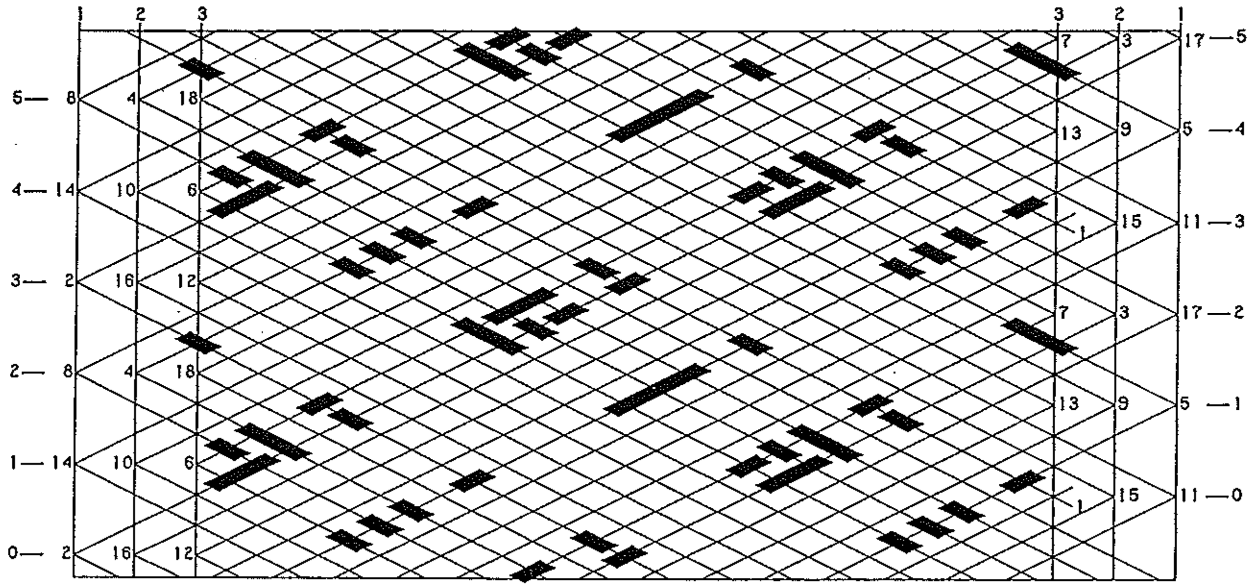
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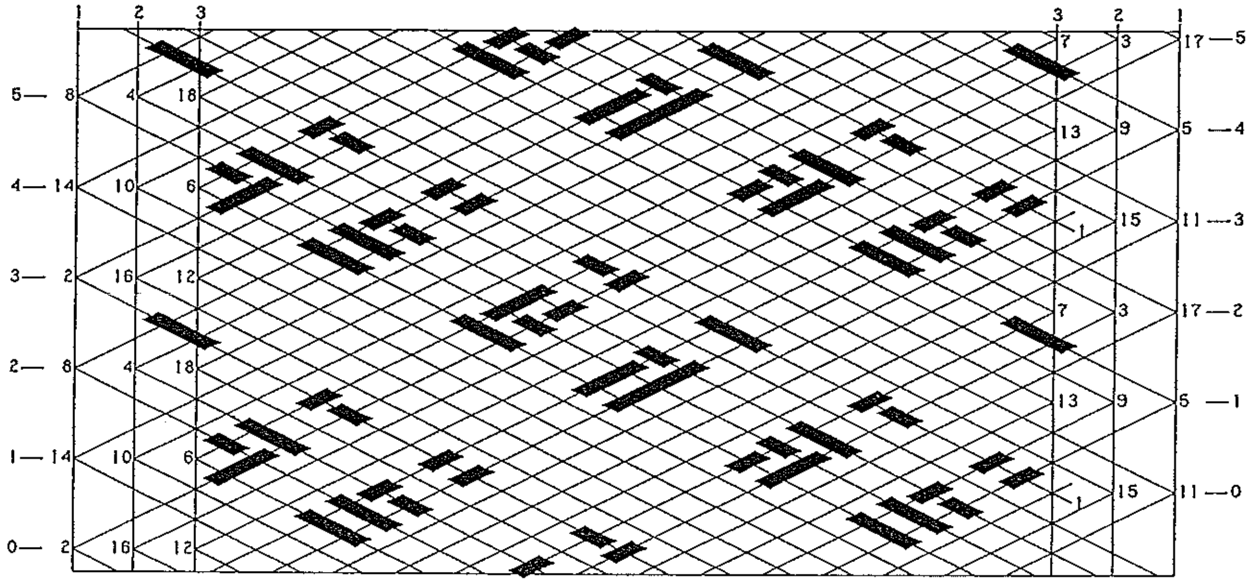
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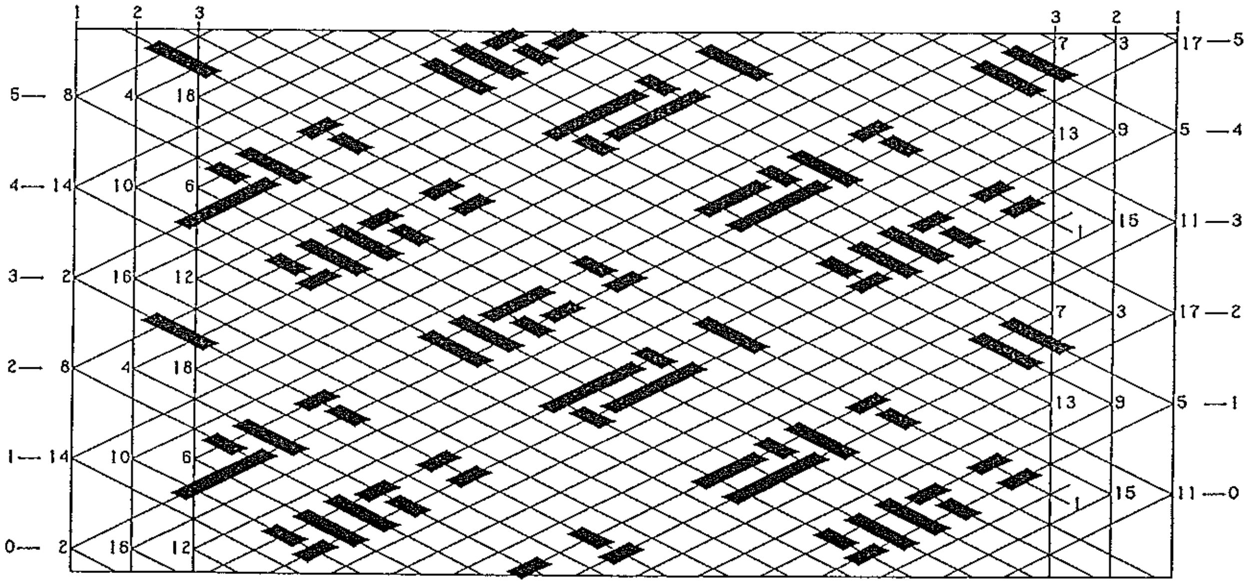
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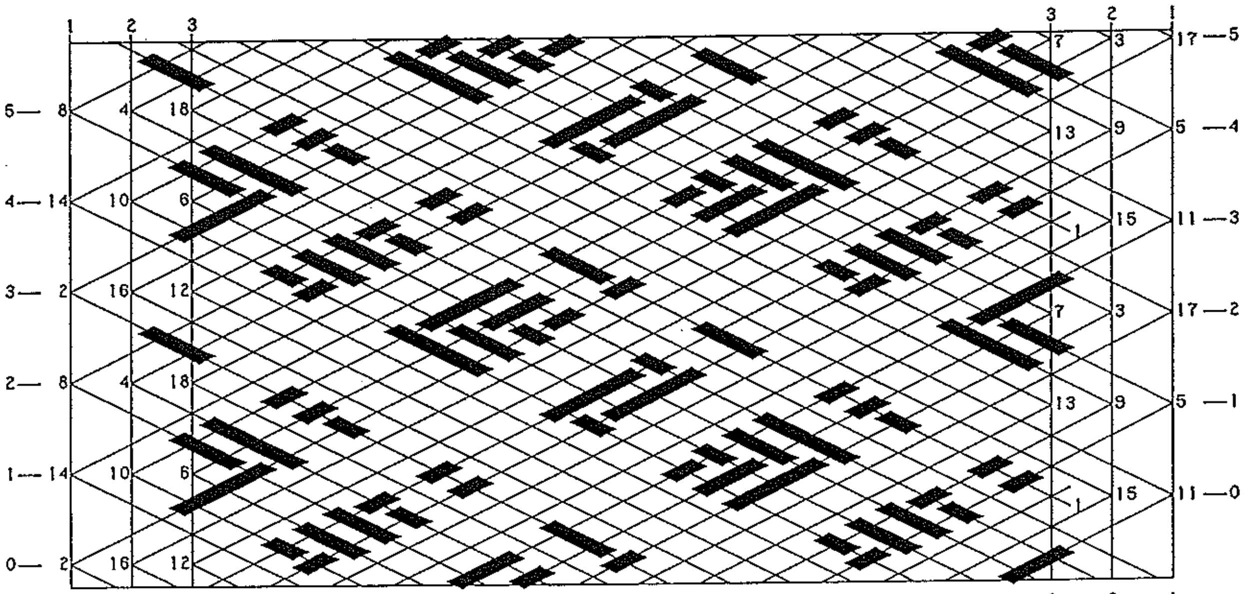
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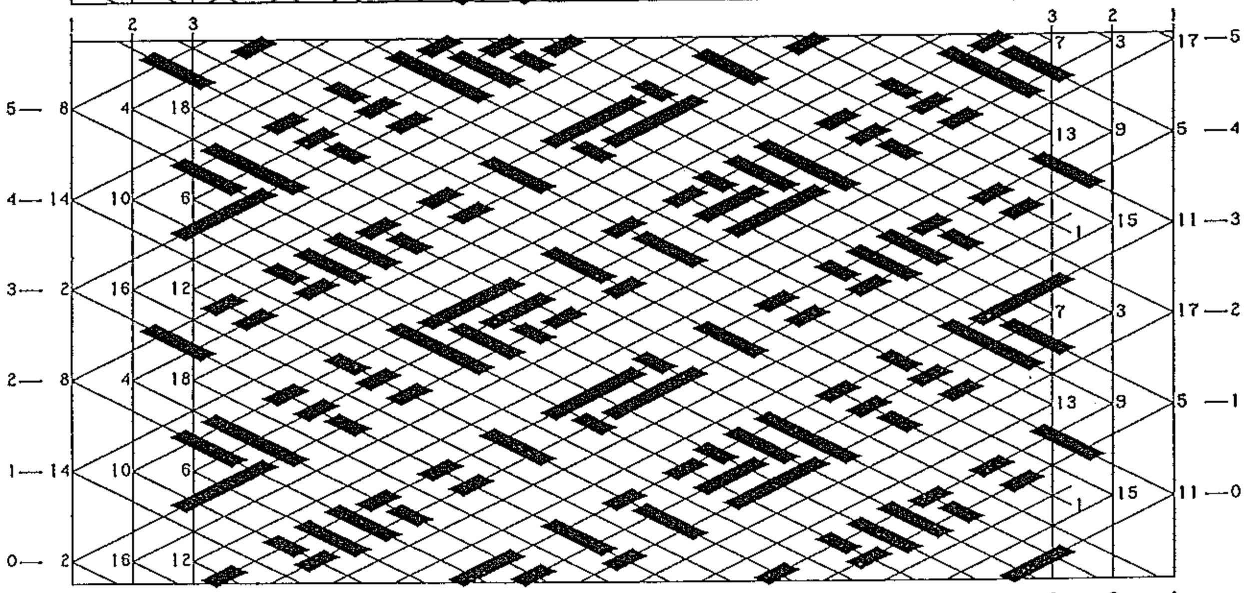
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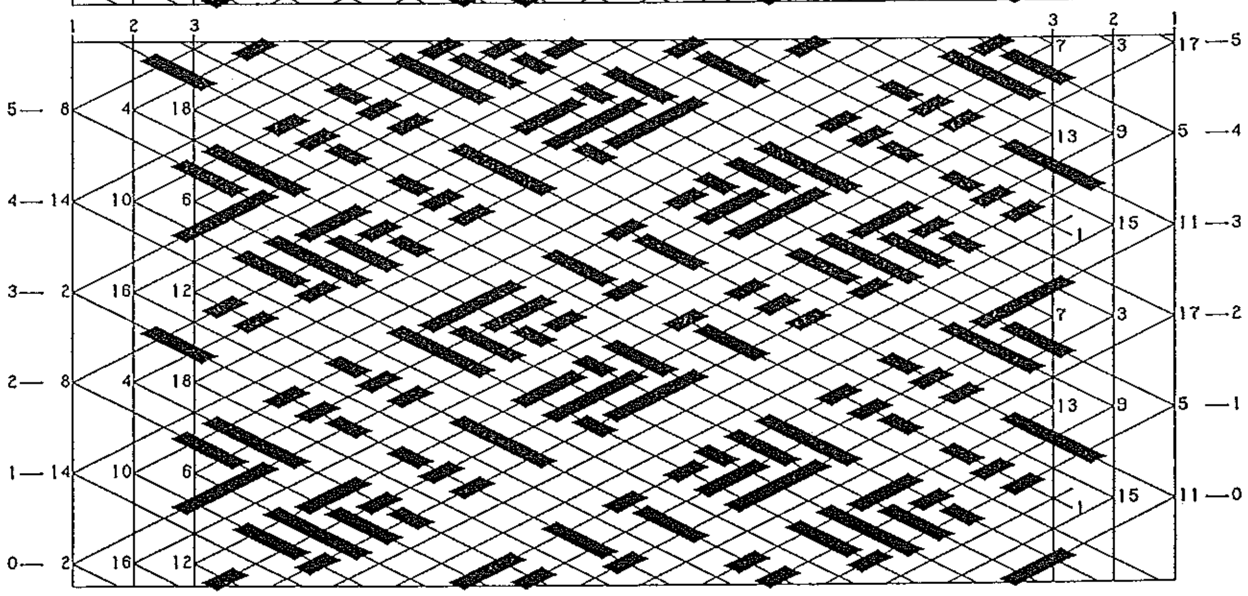
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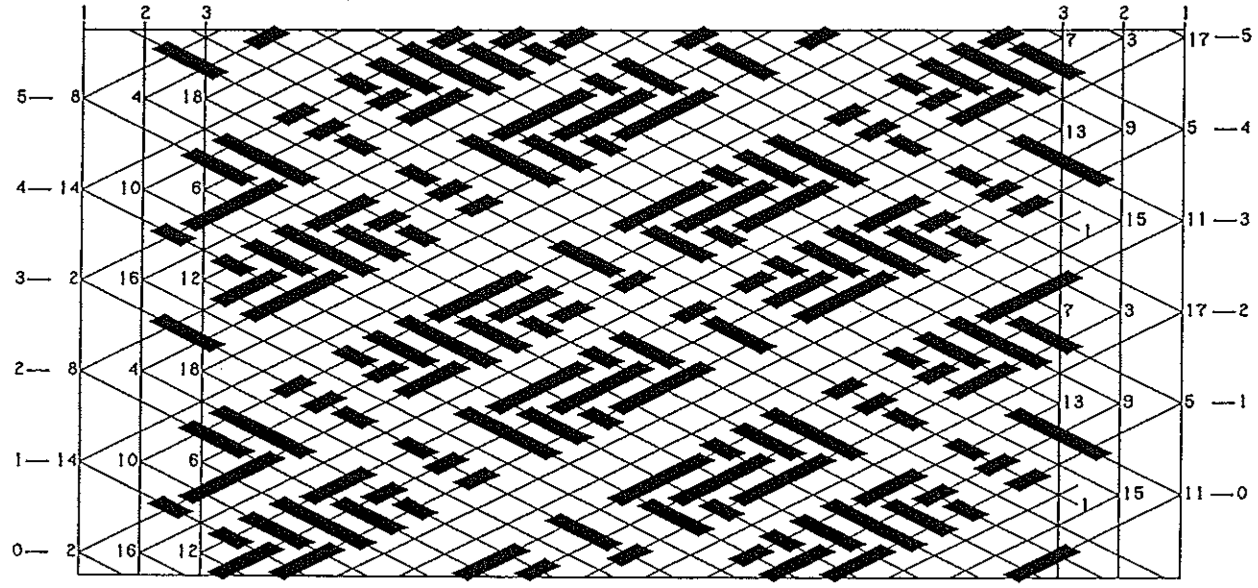
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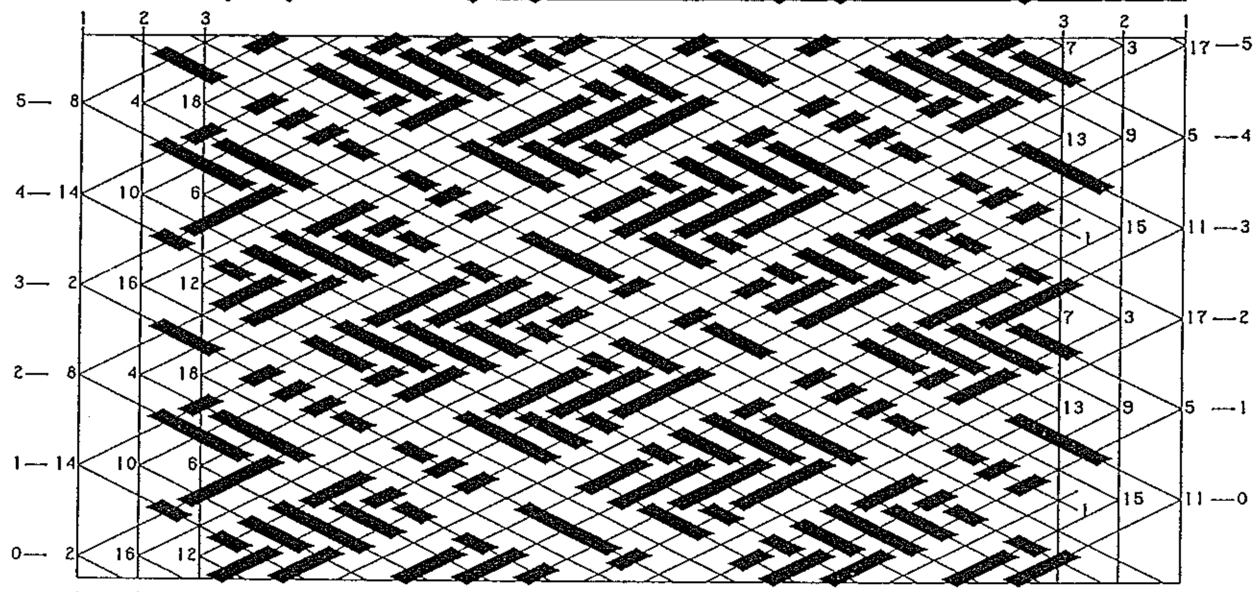
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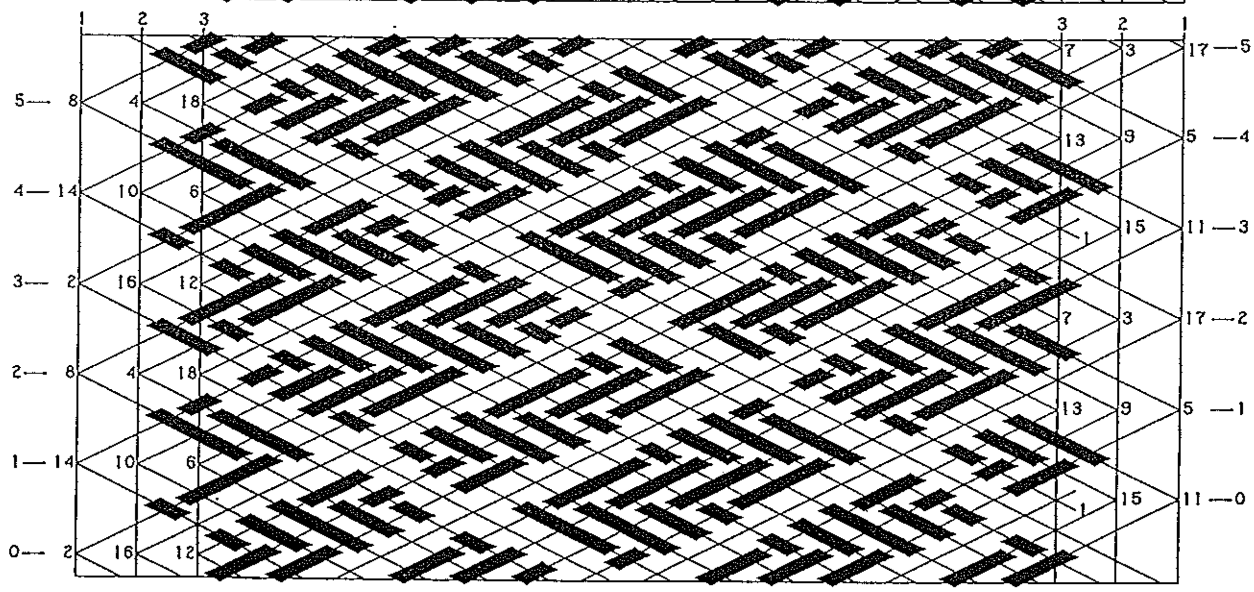
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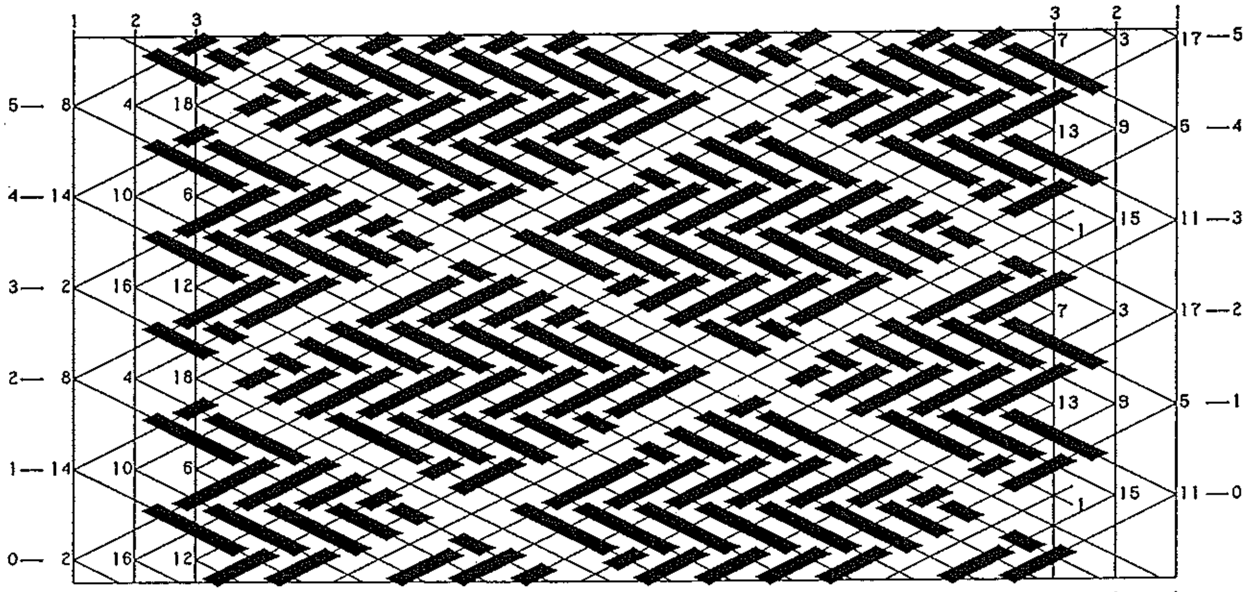
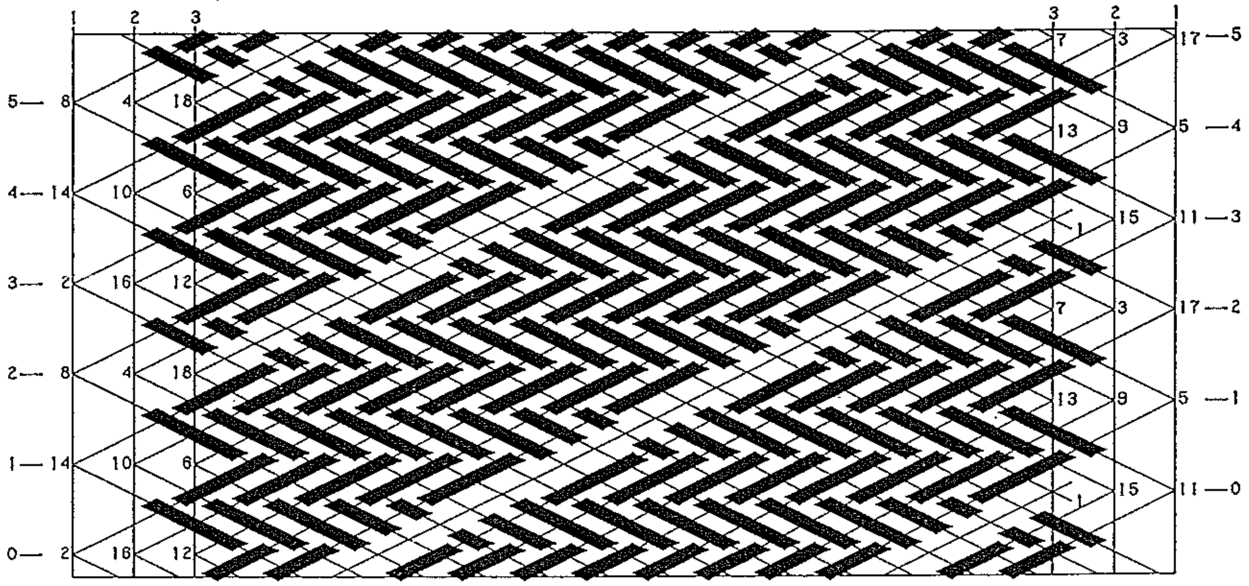
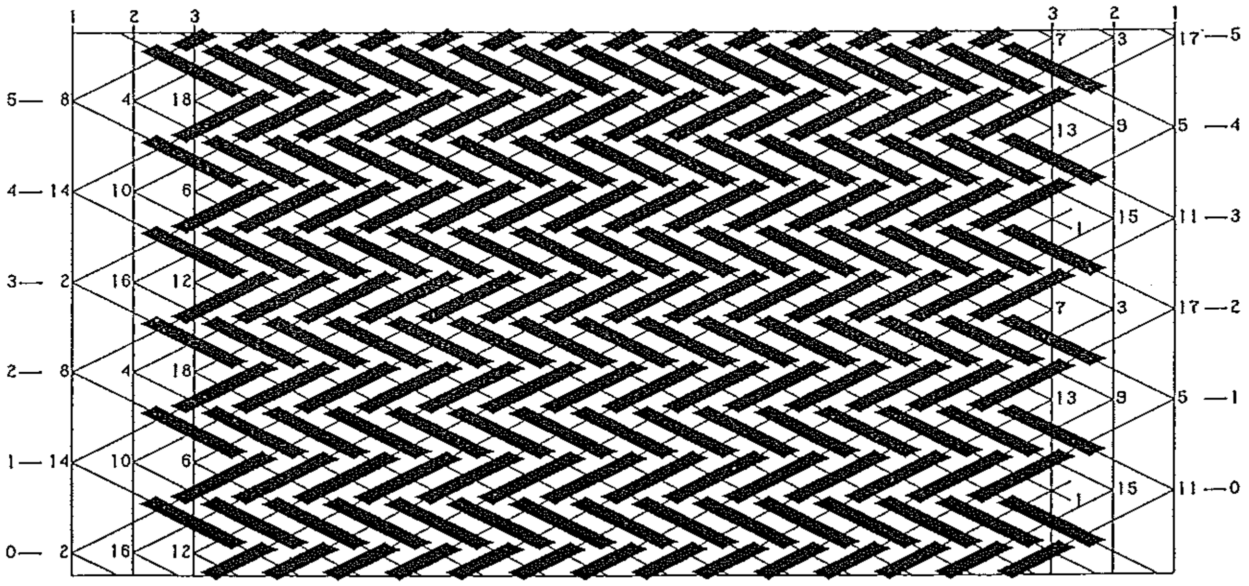






Now let's say that instead of using the 2 essential strings, we use 6 strings (hence $m = 6$). The associated half-cycle tables will then have in their upper-left compartments $\frac{B^*}{m} = \frac{6}{6} = 1$ row and $\frac{2B}{m} = \frac{36}{6} = 6$ columns, in their lower-left compartments $A = 3$ rows and $\frac{2B}{m} = 6$ columns, and in their lower-right compartments $A = 3$ rows and $\frac{B^*}{m} = 1$ column. To ensure that we obtain the correct number of crossings for half-cycles specified by a row in the lower-right compartment we repeat the crossing-sequence obtained from the lower-left compartment in that row so that we obtain this sequence the number of times indicated on the right of the table concerned and repeat the crossing-sequence obtained in the lower-left compartment in that row once again until the bold vertical line has been reached.

The associated first-return string-run of a string and the half-cycle pattern of the six strings are depicted in Fig. 974.

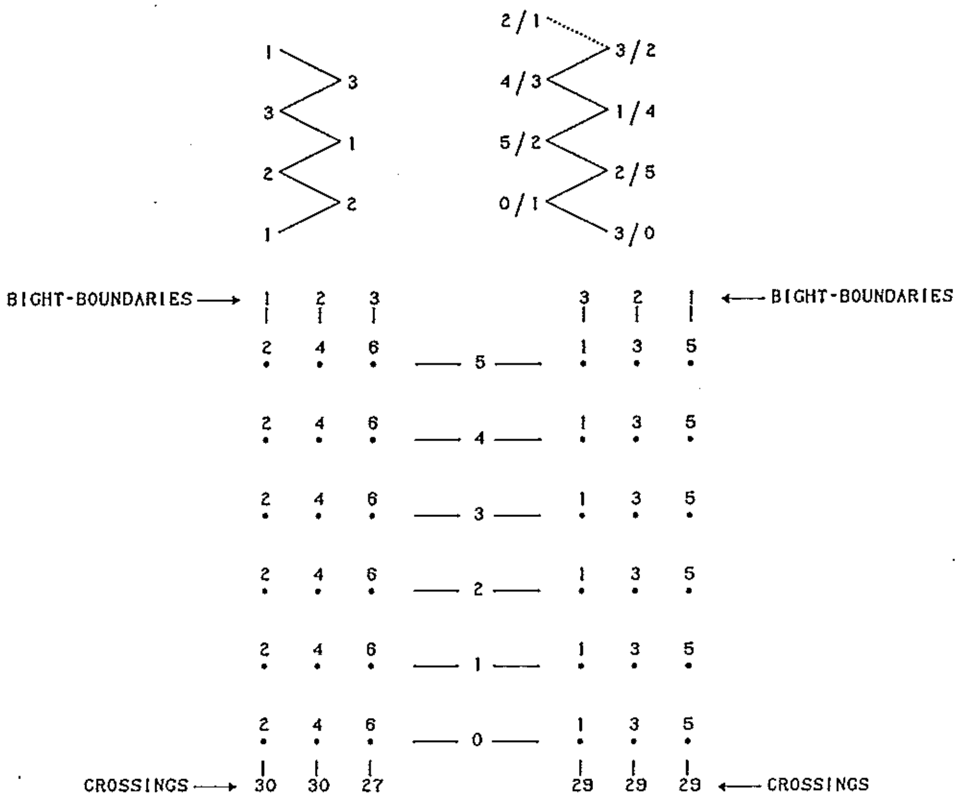


Fig. 974 — First-return string-run of one string and half-cycle pattern for $m = 6$.

From this half-cycle pattern in Fig. 974 we obtain the half-cycle tables in Fig. 975.

L → R

2	4	6	2	4	6	↰
u	o	o	o	u	u	2
u	u	o	o	o	u	4
u	u	u	o	o	o	6

4 X +

R → L

5	3	X	5	3	X	↰
u	u	o	o	o	u	1
u	o	o	o	u	u	3
o	o	o	u	u	u	5

4 X +

Fig. 975 — Half-cycle tables for $m = 6$.

Hence from the half-cycle tables in Fig. 975 we read the following half-cycle braiding algorithms for parallel braiding the six strings:

half-cycle 1 : $R_3 \longrightarrow L_1$: Free run.

half-cycle 2 : $L_1 \longrightarrow R_2$: $u\ o \mid \longrightarrow$

$u - o - u - o - u - o - u - o - u - o$.

half-cycle 3 : $R_2 \longrightarrow L_2$: $o\,u\,| \longrightarrow$
$o - u - o - u - o - u - o - u - o - u$.
half-cycle 4 : $L_2 \longrightarrow R_1$: $u\,u\,o\,o\,| \longrightarrow$
$2u - 2o - 2u - 2o - 2u - 2o - 2u - 2o - 2u - 2o$.
half-cycle 5 : $R_1 \longrightarrow L_3$: $o\,o\,u\,u\,| \longrightarrow$
$2o - 2u - 2o - 2u - 2o - 2u - 2o - 2u - 2o - 2u$.
half-cycle 6 : $L_3 \longrightarrow R_3$: $u\,u\,u\,|\,o\,o\,o \longrightarrow$
$3u - 3o - 3u - 3o - 3u - 3o - 3u - 3o - 3u$.

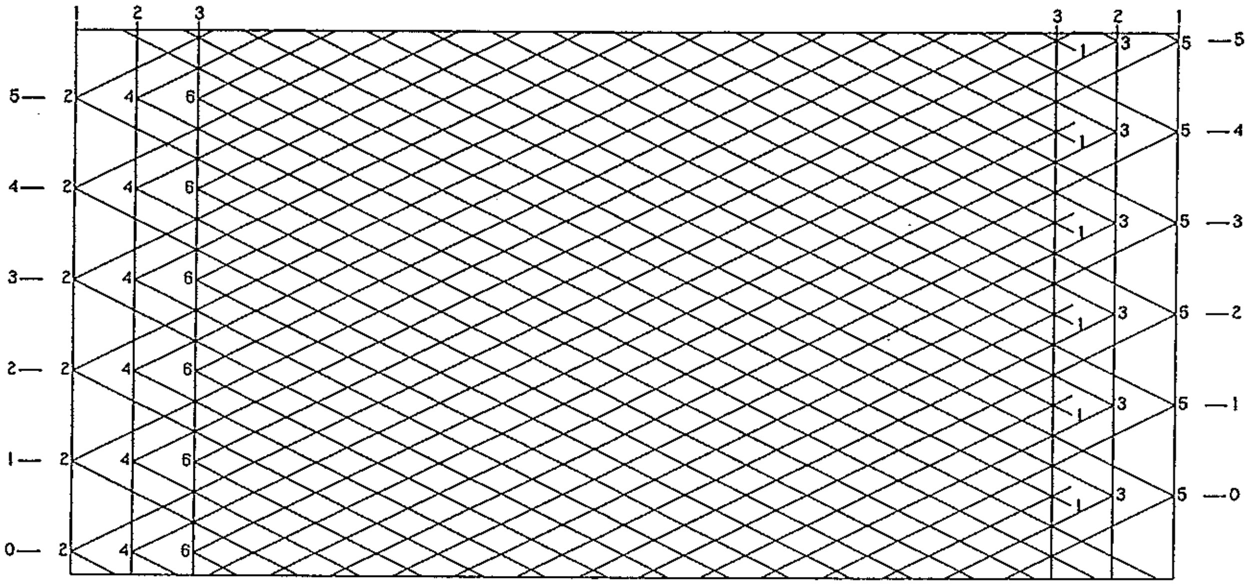
These sequential braiding steps are shown on pp. 1242 - 1243.

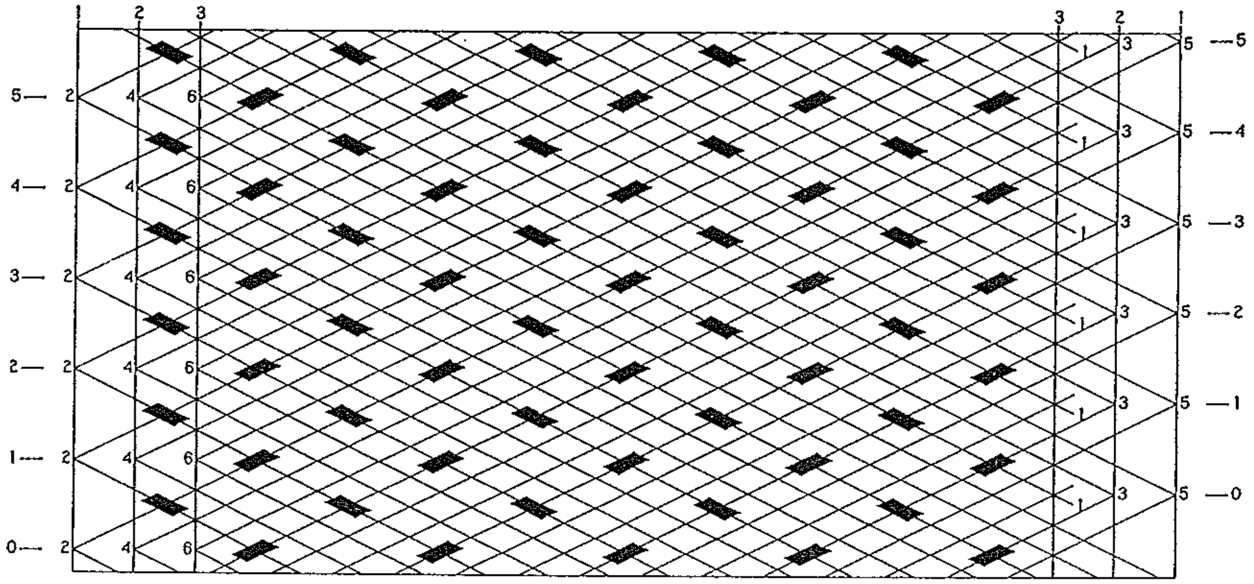
Compare these two construction procedures — both are simple parallel braiding methods, but the method with $m = 2$ requires **four** string-ends to be worked away, while the method with $m = 6$ requires **twelve** string-ends to be worked away, hence 3× as many!!! Of course, the $m = 6$ approach is faster but the craftsmanship is much poorer!!! In fact, the $m = 6$ approach is the approach of novice braiders or mass-producers. Unfortunately most braiders belong to their ranks while most customers wouldn't be able to tell the difference between the knot whose foundation knot is produced with $m = 2$ and the knot whose foundation knot is produced with $m = 6$. But — quality leads to better prices and a better reputation in the commercial and especially in the collectors world (a Rolls Royce can demand a better price than a Toyota; sure, some are quite satisfied in producing Toyotas, and many are quite happy to purchase them, but those with plenty of lolly certainly go for the Rolls Royces, not the Toyotas). We have shown how the novice gets caught out by the type of work he produces, while a faker, who knows what braiding is about, would surely have taken say $l_h = 14$, $r_h = 15$ or $l_h = 15$, $r_h = 14$ and use $m = 6$). Mind you a buyer who knows his beans and does the few simple mental calculations required, can readily discover whether or not it might be a fake and obviously will look for any telltales in that direction, and such telltales are extremely difficult, if not impossible to hide completely.

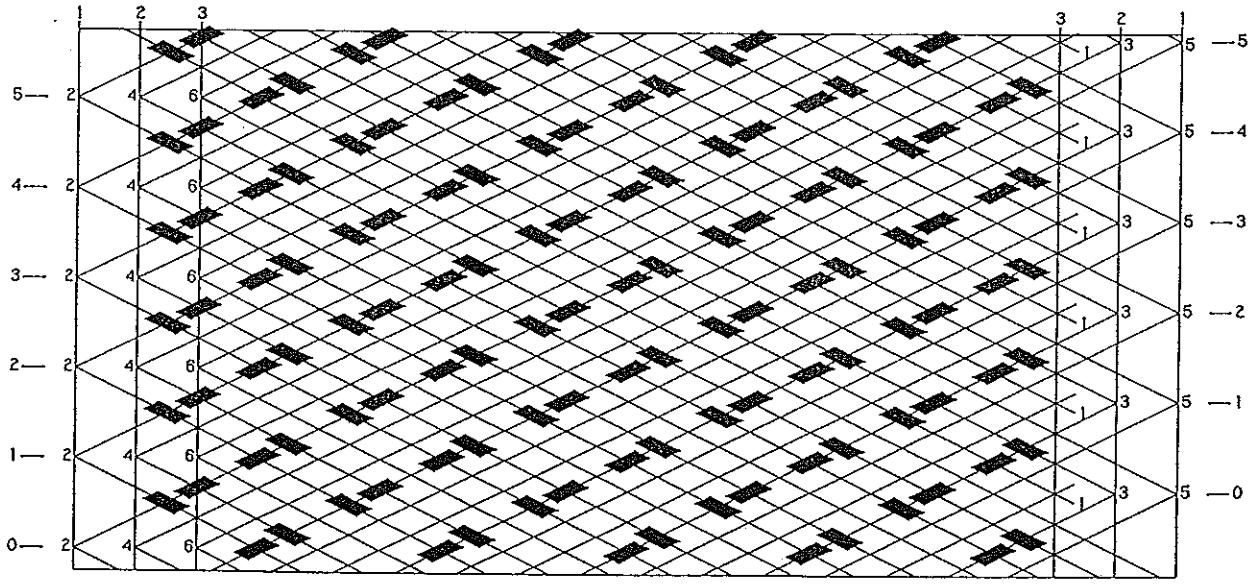
The braider who did send us the computer colour print-out of his scanned picture of the knot he braided on his quirt handle was apparently not aware of what he really was doing since he was under the impression that when he would join in his foundation knot the string-ends of the six strings, he would obtain the string-run of a Perfect Herringbone Pineapple Knot. We know that this is impossible for any Herringbone Pineapple Knot with $A =$ **odd** and $B^* =$ **even** .† Only after some letter exchange did he draw the grid-diagram of his foundation knot and discovered his erroneous assumption. A craftsman braider would make sure that he knows what he is producing and hence would not make unfounded assumptions — a simple grid-diagram made by hand on a piece of isometric graph-paper (wich shouldn't take more than 10 minutes at most) would immediately have shown what was going on. It is furthermore not only for the craftsman braider, but also for the buyer of high quality braidwork important to know the role which the l_h and r_h values play, and consequently it is important that they are able to perform a few simple mental calculations.

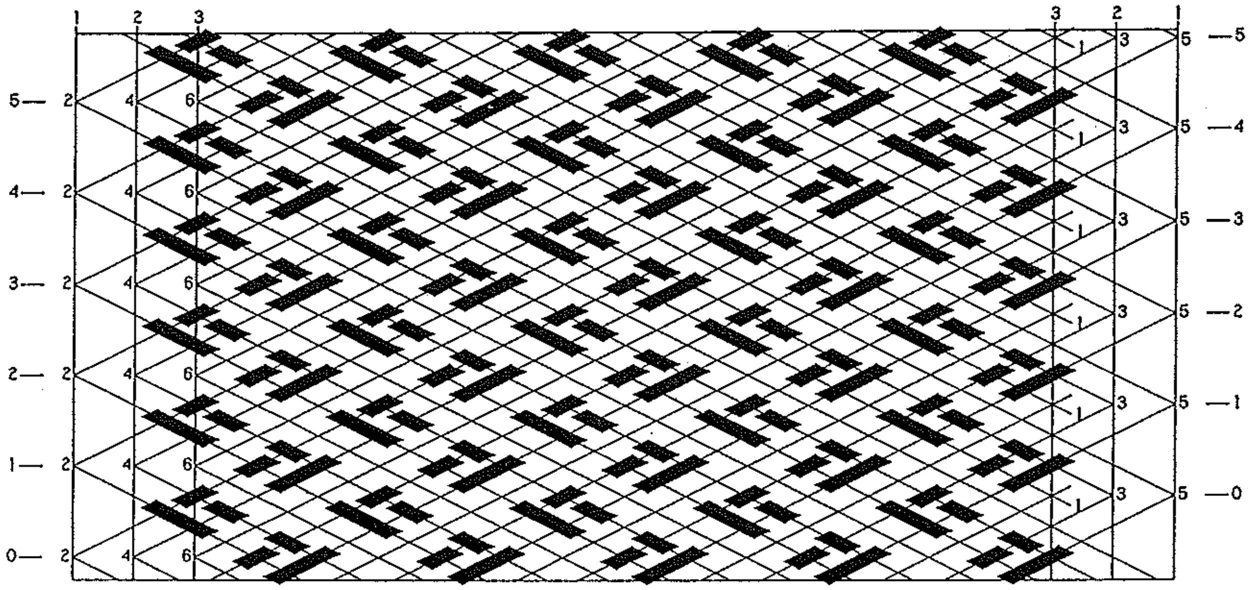
† See footnote on pg. 1217. Another way to prove this would be as follows:

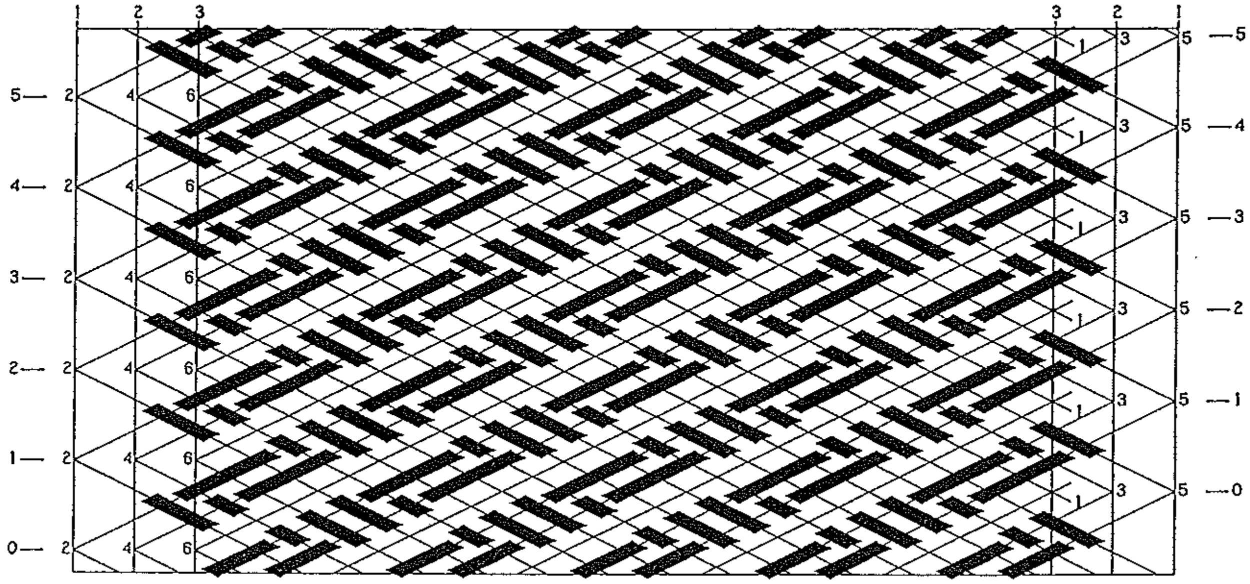
A Standard or a Semi-Standard Herringbone Pineapple Knot will always require more than one string. For a Perfect or a Semi-Perfect Herringbone Pineapple Knot $l_h + r_h =$ **odd**, hence $P_{total} = P = A + l_h + r_h =$ **even** for $A =$ **odd**. Consequently g.c.d. $(P, B^*) \neq 1$ for $B^* =$ **even** and hence we cannot possibly have a Perfect Herringbone Pineapple Knot when $A =$ **odd** and $B^* =$ **even** .

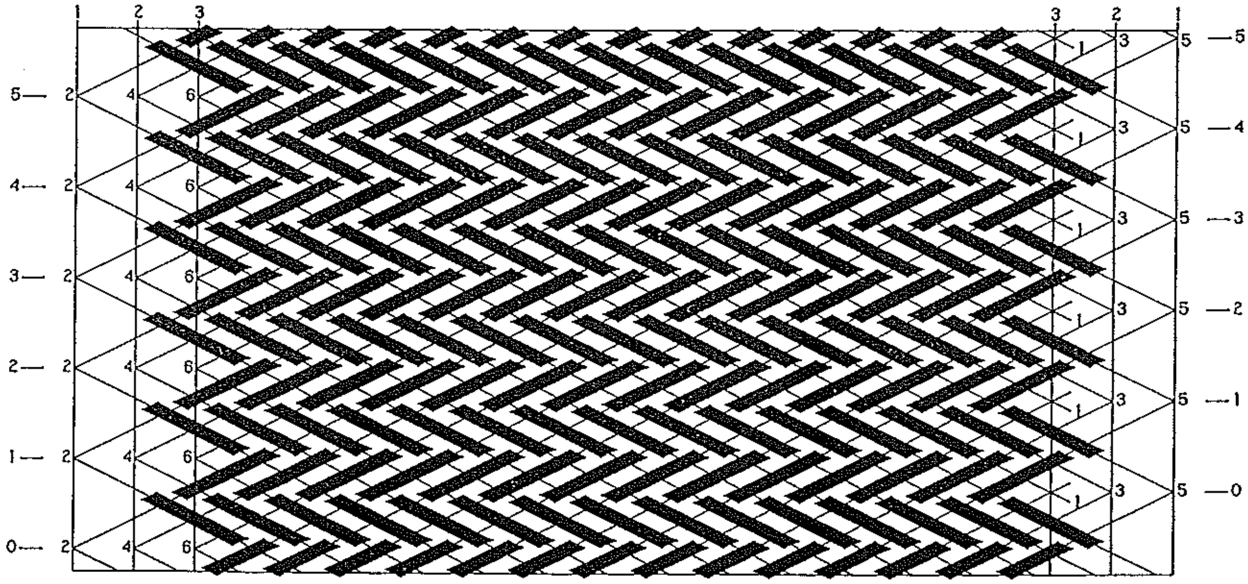

1 2 3
3 2 1
5— 2 4 6
4— 2 4 6
3— 2 4 6
2— 2 4 6
1— 2 4 6
0— 2 4 6
1 3 5 —5
1 3 5 —4
1 3 5 —3
1 3 5 —2
1 3 5 —1
1 3 5 —0


1 2 3
3 2 1
5— 2 4 6
4— 2 4 6
3— 2 4 6
2— 2 4 6
1— 2 4 6
0— 2 4 6
1 3 5 —5
1 3 5 —4
1 3 5 —3
1 3 5 —2
1 3 5 —1
1 3 5 —0


1 2 3
3 2 1
5— 2 4 6
4— 2 4 6
3— 2 4 6
2— 2 4 6
1— 2 4 6
0— 2 4 6
1 3 5 —5
1 3 5 —4
1 3 5 —3
1 3 5 —2
1 3 5 —1
1 3 5 —0







A Sliding Lanyard Knot

The lanyard is made from a six-string $\rightarrow 2u - o \,|\, 2o - u \leftarrow$ round braid†. One end of the round braid goes over into a knot through which the other end of the round braid can slide in order to provide an adjustment for the necklace loop of the lanyard.

After forming the necklace loop in the six-string round braid, place its Sliding Knot end on top of the other end and finish the Sliding Knot end as indicated in the sequential diagrams of Fig. 976.

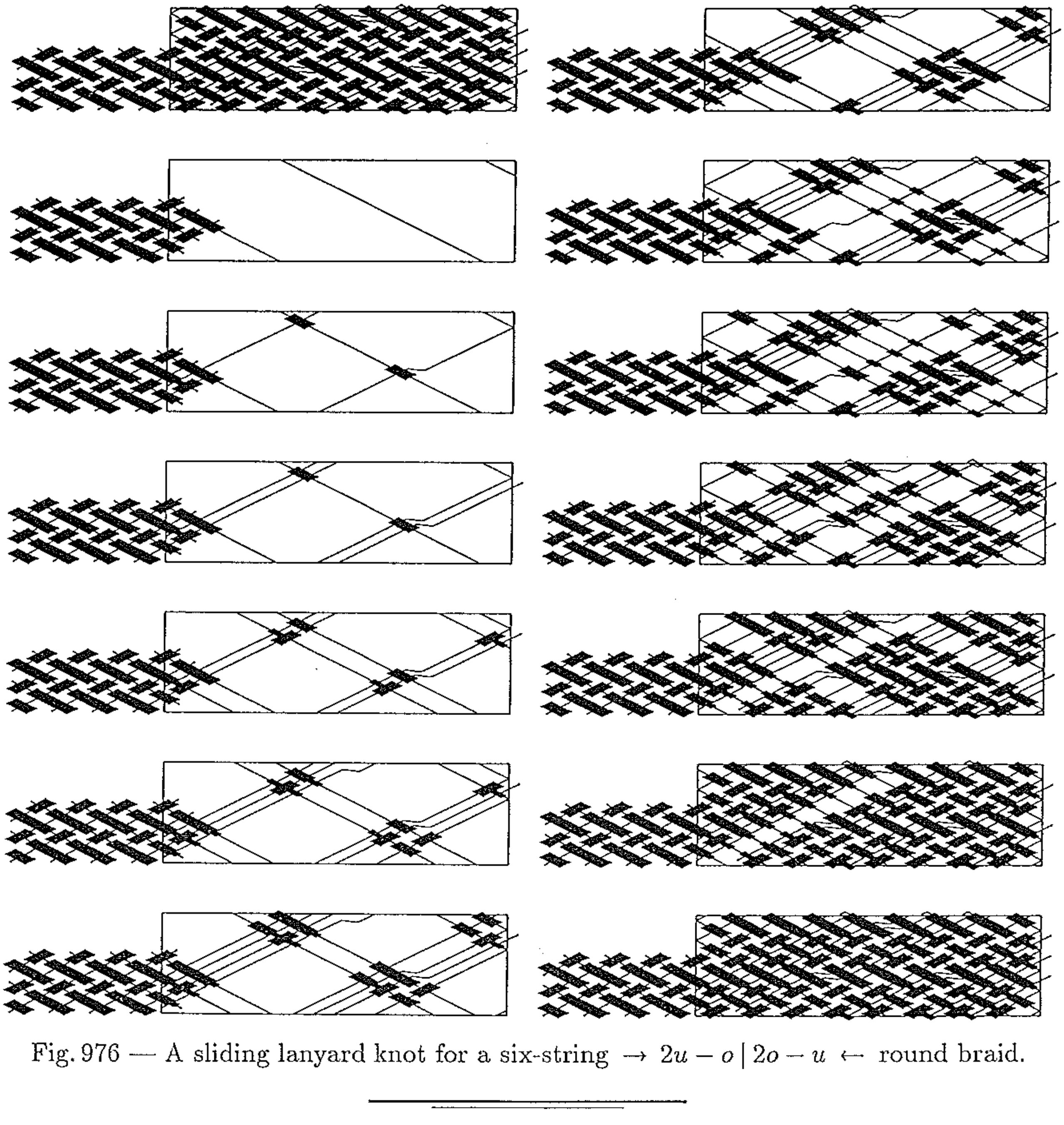


Fig. 976 — A sliding lanyard knot for a six-string $\rightarrow 2u - o \,|\, 2o - u \leftarrow$ round braid.

† Refer to *The Braider*, Issue No. 7, pp. 146 - 153.