THE BRAIDER

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CONTENTS

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for
the braiding artisan

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Solution to the Question in Issue No. 37

Question on pg. 878.

Since the string-run of an $a \times b \times c$ Rectangular Right Prismatic Braid is equivalent to the string-run of a $b \times a \times c$ Rectangular Right Prismatic Braid with the same respective values a, b and c, we can restrict the requested proof to the string-run of an $a \times b \times c$ Rectangular Right Prismatic Braid in which $a < b$. The number of regular nested bights in each nest of bights is a, and there are $b - a$ crossing-points on each of the two bight-edges. When a Rectangular Right Prismatic Braid with a string-run containing a component whose string-run runs from a bight on one of the two bight-edges to a bight on the other bight-edge and then on to the initial bight, closing in that way the string-run of that component, must consist of more than two components, hence must require more than two essential strings. The case associated with the smallest c-value with such a string-run is depicted by the left-hand diagram in Fig. 704, and the case associated with the largest c-value with such a string-run is depicted by the right-hand diagram in Fig. 704.

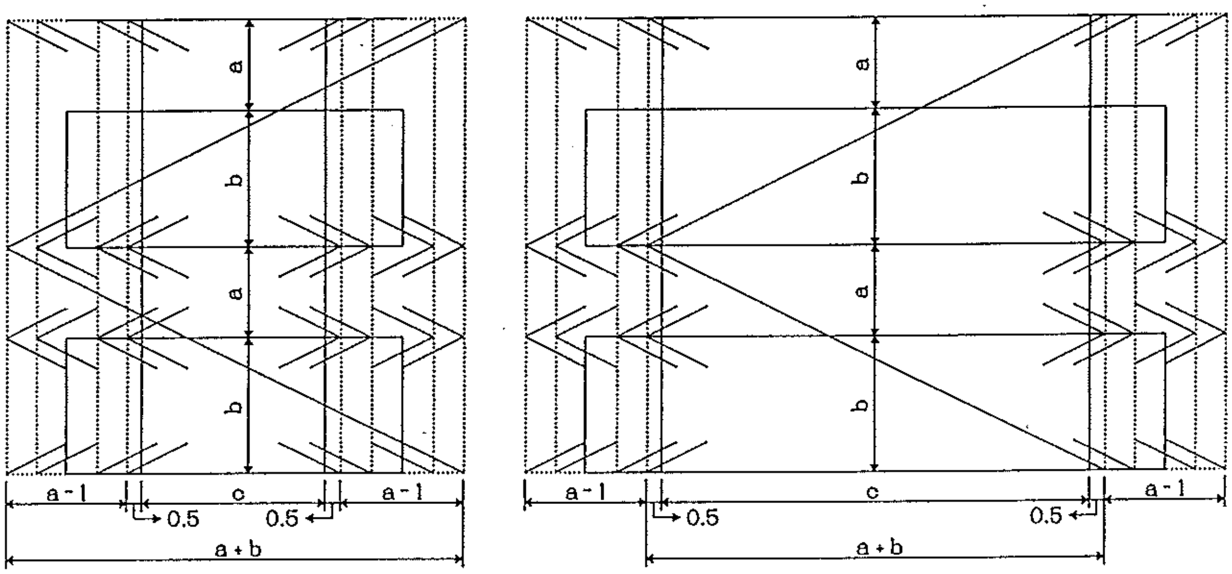


Fig. 704 — The two string-run diagrams associated with the proof.

In the left-hand diagram we see that $2a - 2 + 1 + c = a + b$, hence $c = b - a + 1$. Thus in general for any $a \times b \times c$ Rectangular Right Prismatic Braid we obtain $c = |a - b| + 1$.

In the right-hand diagram we see that $c + 1 = a + b$, hence $c = a + b - 1$.

Consequently for $|a - b| + 1 \leq c \leq a + b - 1$ an $a \times b \times c$ Rectangular Right Prismatic Braid requires more than two essential strings.

THE BRAIDER'S NOTEBOOK

In some previous issues of *The Braider* we have touched on problems concerning braid-classification attempts by some people. Such attempts can originate from a complete misunderstanding of what braids are about with the result that a **class of (braid) construction-methods** is taken to be a **class of braids**. This happened in a publication entitled '**Grant Weaves**', published in July 1995 by Pieter van de Griend.

Since **Murphy's Law**, also known as *Sod's Law*, played the upperhand in that publication, and since the weaves dealt with do **not** form a class of braids, we shall call them **Murphy Weaves**. The diagrams presented in that publication are typical braid **construction-method diagrams**, and such diagrams are often unable to tell us much about the **braidform(s)**. To investigate **braidforms** it is essential to employ grid-diagrams, and hence only grid-diagrams will be able to assist us in the classification of **braids**. It is important to stress that in general there is no connection between **braid classes** and **(braid) construction-method classes**.

We should therefor clearly keep in mind the following fundamental braiding law:

•♡• Braids of a similar string-run (structure) may be constructed by a similar construction-method, however, braids which may be constructed by a similar construction-method are not necessarily of a similar string-run (structure). Braids should therefore be classified according to their string-run (structure) and not to their construction-method as otherwise more or less unrelated braids will end up in the same braid-class.

Apart from erroneously regarding a set of braids created by a certain construction-method as a class of braids, the publication referred to above contains furthermore a fairly large number of erroneous statements and conclusions, some of them due to disregarding the most basic rule in braid investigations, namely that **flat string** only should be used.

The set of braids with which the above referred to publication tries to deal is characterised by the repetitive application of the following set of two construction sequences:

> We start with a set of n parallel strings, where n is a positive integer ≥ 2. These n strings are braided in the following manner:
>
> - Take the left-most of the n parallel strings **under** u strings towards the right. Take it up from among the strings, reverse direction to take it **over** o strings back to the left. While reversing the direction, the string should be given a full turn (right-hand screw moving down) in order for the front facing face to remain the front facing face.
> - Take the right-most of the n parallel strings **under** u strings towards the left. Take it up from among the strings, reverse direction to take it **over** o strings back to the right. While reversing the direction, the string should be given a full turn (left-hand screw moving down) in order for the front facing face to remain the front facing face.

Let's describe this braiding-method by the notation: $(n,\ u/o)$. Note that for consistency the *full-turn* movements in the definition above are also executed when $u = 0$ and when $o = 0$.

Murphy's braid construction-method falls under the 'standard' method for braiding **round braids**; it is, however, executed in a somewhat disguised way which in turn tends to mislead the braider. For this reason alone, this braid construction-method, although quite often used in the braiding literature, cannot be considered to be a good one and hence should not really be used at all.

Round braids are braids in the form of a cylinder without ends, or to put it technically a little more precise: it are braids in the form of a cylinder which has one end at minus infinity and the other end at plus infinity (Euclidian geometry), where the cylindrical braid is formed by two sets of strings: one set describes a right-hand helix while the other set desribes a left-hand helix. In the most elementary case, each set contains an equal number of strings; this are the normally encountered round braids we see. In the next case the numbers of strings in the two sets differ by 1. Let's limit ourselves to these two simple cases, and for convenience sake let's call the first case: **round braids with an even number of strings**, and the second case: **round braids with an odd number of strings.**

The 'standard' method for laying down the string-run sequence in round braids with an even number of strings is depicted in Fig. 705 by the left-most string-run diagram for an 8-string round braid.

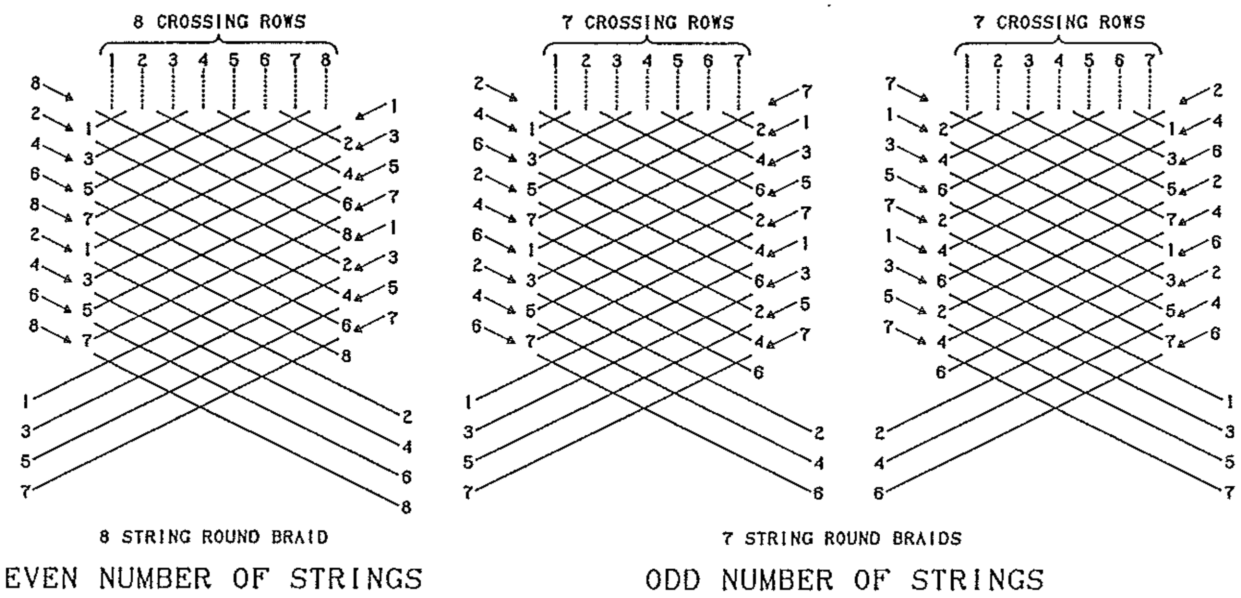


Fig. 705 — The 'standard' method for laying down the string-run in round braids.

The diagram clearly depicts the four strings which describe a right-hand helix (the strings 1, 3, 5, 7) and the four strings which describe a left-hand helix (the strings 2, 4, 6, 8). The free-ends of the strings which describe a right-hand helix point to the lower left, and the free-ends of the strings which describe a left-hand helix point to the lower right. The procedure for laying down the consecutive numbered strings is as follows:

- Take the free-end of string 1 and run it, from left to right, along the **back** of the braid; then, after giving it a full turn (right helix down), lay it down from upper-right to lower-left along the **front** of the braid, hence crossing the strings 2, 4, 6, 8 in sequence.
- Take the free-end of string 2 and run it, from right to left, along the **back** of the braid; then, after giving it a full turn (left helix down), lay it down from upper-left to lower-right along the **front** of the braid, hence crossing the strings 3, 5, 7, 1 in sequence.
- Take the free-end of string 3 and run it, from left to right, along the **back** of the braid; then, after giving it a full turn (right helix down), lay it down from upper-right to lower-left along the **front** of the braid, hence crossing the strings 4, 6, 8, 2 in sequence.
- Take the free-end of string 4 and run it, from right to left, along the **back** of the braid; then, after giving it a full turn (left helix down), lay it down from upper-left to lower-right along the **front** of the braid, hence crossing the strings 5, 7, 1, 3 in sequence.
- Take the free-end of string 5 and run it, from left to right, along the **back** of the braid; then, after giving it a full turn (right helix down), lay it down from upper-right to

lower-left along the **front** of the braid, hence crossing the strings 6, 8, 2, 4 in sequence.
- Take the free-end of string 6 and run it, from right to left, along the **back** of the braid; then, after giving it a full turn (left helix down), lay it down from upper-left to lower-right along the **front** of the braid, hence crossing the strings 7, 1, 3, 5 in sequence.
- Take the free-end of string 7 and run it, from left to right, along the **back** of the braid; then, after giving it a full turn (right helix down), lay it down from upper-right to lower-left along the **front** of the braid, hence crossing the strings 8, 2, 4, 6 in sequence.
- Take the free-end of string 8 and run it, from right to left, along the **back** of the braid; then, after giving it a full turn (left helix down), lay it down from upper-left to lower-right along the **front** of the braid, hence crossing the strings 1, 3, 5, 7 in sequence.
- Repeat the above eight steps as often as required in order to obtain the desired length of cylindrical braid.

In round braids with an odd number of strings, the set of strings with the greater number may either describe right-hand or left-hand helixes. The respective 'standard' method for laying down the string-runs is similar to the one above, and is depicted in Fig. 705 for a 7-string round braid.

It will be expedient to have a closer look at what goes on in round braids which have a set of right-hand helixes and a set of left-hand helixes†. It is obvious that the right-hand helixes cannot be separated from each other, and of course neither can the left-hand helixes (this will also readily be seen from Fig. 706). It will also be obvious that a right-hand helix can only be separated from the set of left-hand helixes when it is not intertwined with any of them. It therefore follows that a round braid can only be separated into two distinct parts when **none** of the right-hand helixes is intertwined with a left-hand helix, and consequently no left-hand helix is intertwined with a right-hand helix. The geometry of the round braid provides for two types of distinct separation. One type wherein the set of right-hand helixes can be totally separated from the set of left-hand helixes (**separable splitting**), and the other type wherein the one set of helixes encloses the other set of helixes (**enclosed splitting**).

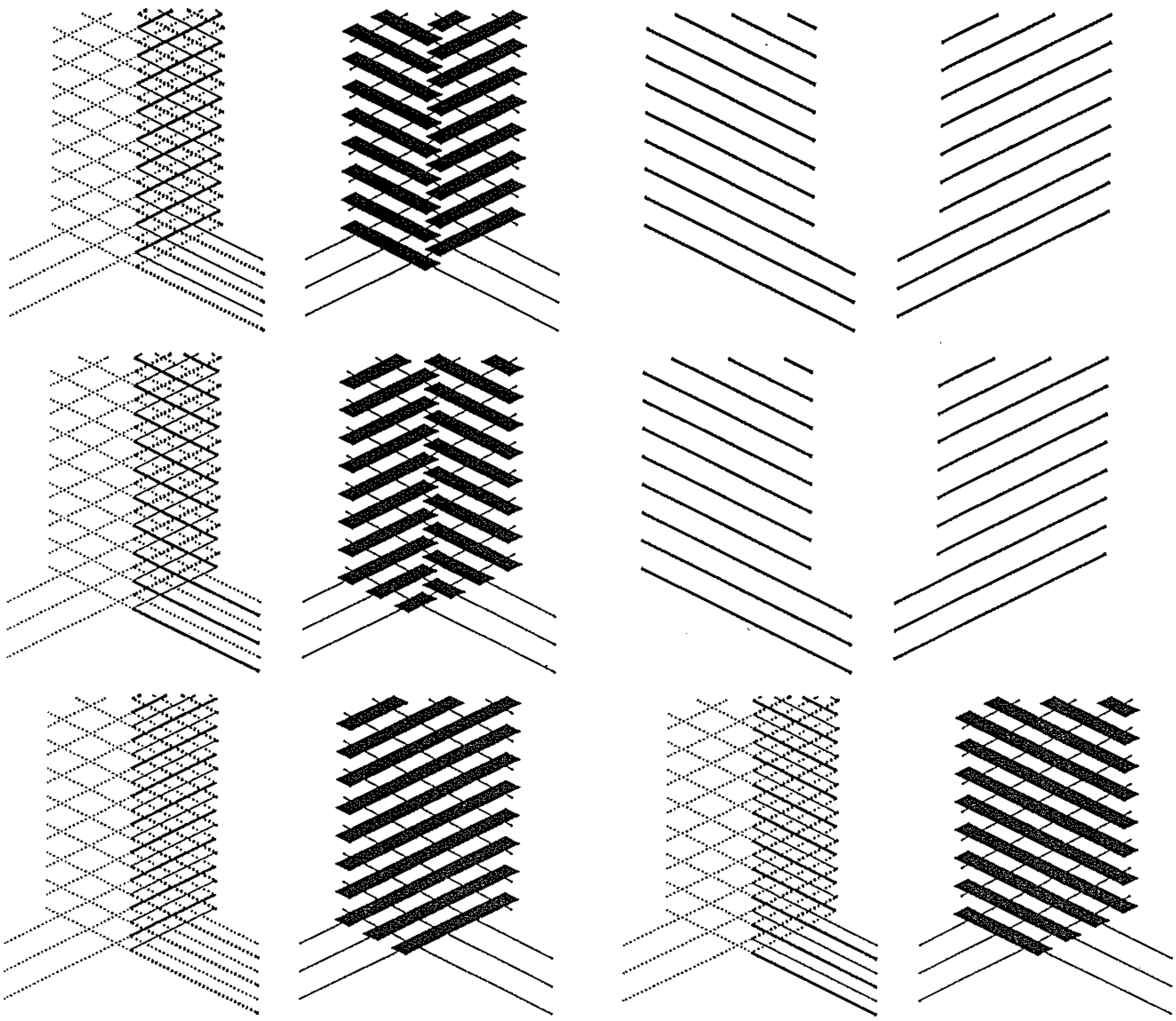
From the 'general' string-run diagrams it will readily be seen that in order for each string to describe a helix on the cylindrial surface, its free-end must after having past along the back of the braid cross on the front of the braid all the strings of the opposing set. Hence in round braids with an even number of strings‡ ($2x$ strings), the free-end of each string must at the time of its placement cross the x strings of the opposing set on the front of the braid. It will readily be seen that if the superimposed coding on these string-runs is such that for all the strings in both sets these x crossings are of an **identical** nature (hence for all the strings laid down from upper-right to lower-left as well as for the strings laid down from upper-left to lower-right either x *over*-crossings or x *under*-crossings), the braid will split into two distinct parts which can be separated totally as explained above. In fact, this necessary and sufficient condition for the coding,

† A round braid in which the string-run consists solely out of either right-hand helixes or left-hand helixes is called an **embrionic round braid**. Embrionic round braids and embrionic cylindrical braids are some of the most elementary braidforms, and are hence of paramount importance to physical braids. It is, for example, with the treatment of these by the Topological Knot Theory that this theory is of little or no relevance to physical braids.

‡ As before defined with respect to the numbers of right- and left-hand helixes.

in order for the round braid to be splittable into two distinct parts which are totally separable, is readily to be seen from the left-most diagrams in each of the first two rows of diagrams in Fig. 706. These diagrams show the projection of a round braid with such an even number of strings. Observe that the helixes indicated by the solid lines can be lifted off the helixes indicated by the dotted lines.

Also note that the coding in the gid-diagram second from left, central row of diagrams in Fig. 706, indicates the two totally separable parts. Hence the gid-diagram second from left, top row in Fig. 706, which depicts the upside down version of the previous refered to grid-diagram, also indicates the total separability of the round braid into two parts.



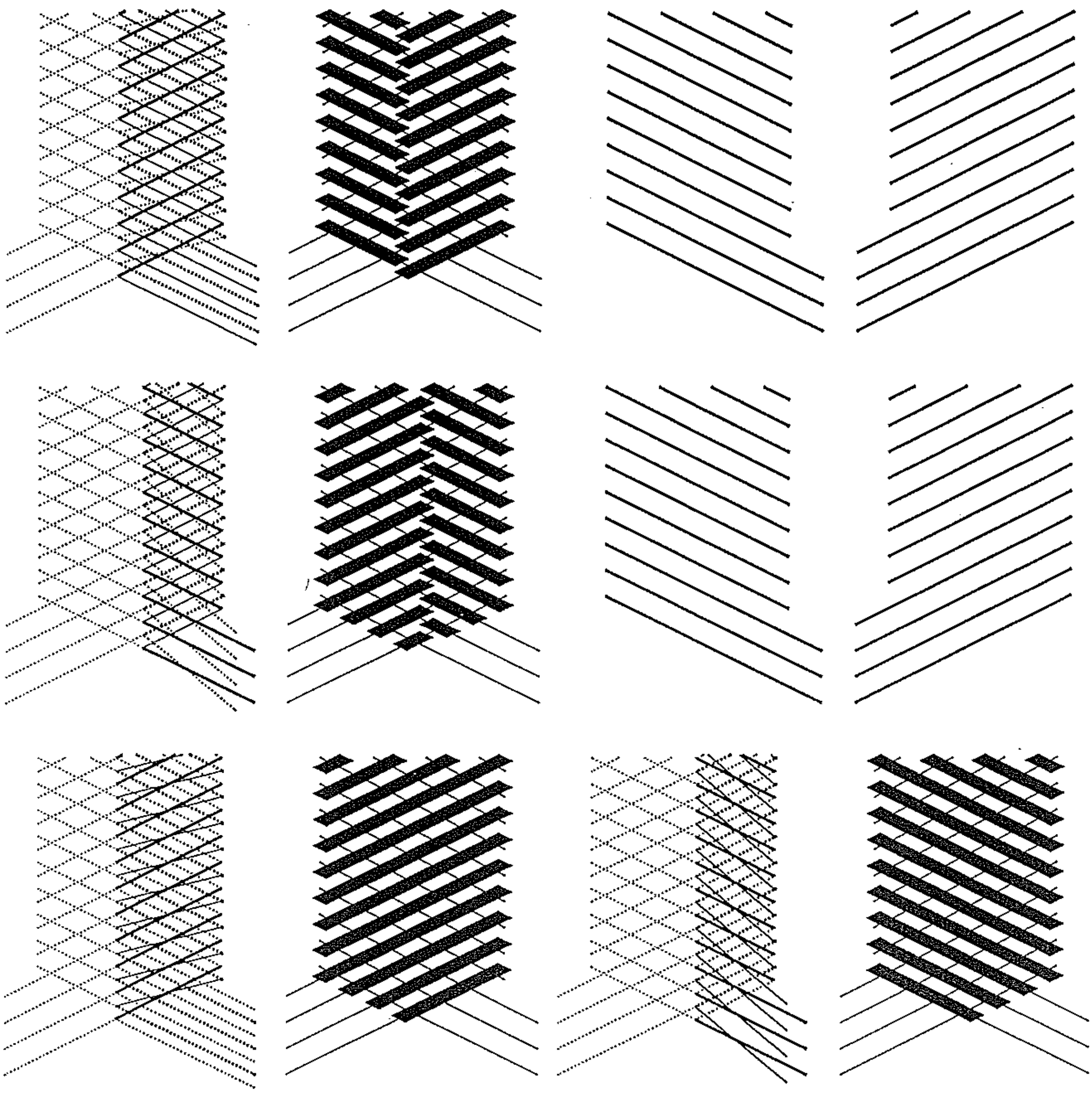
6 STRING ROUND BRAID

EVEN NUMBER OF STRINGS

THICK LINES ABOVE THIN LINES, AND SOLID LINES ABOVE DOTTED LINES OF SAME THICKNESS.

Fig. 706 — The necessary and sufficient coding requirements for splitting.

If the superimposed coding on these string-runs is such that for all the strings in one set these x crossings are of an **opposite** nature to the x crossings of the other set (hence for all the strings laid down from upper-right to lower-left x *over*-crossings while for all the strings laid down from upper-left to lower-right x *under*-crossings, or vice versa), the braid will also split into two distinct parts where the set with right-hand helixes encloses, but not intertwines, the set with left-hand helixes, or respectively vice versa (**enclosed splitting**). See Fig. 706, bottom row of diagrams.



7 STRING ROUND BRAID

ODD NUMBER OF STRINGS

THICK LINES ABOVE THIN LINES, AND SOLID LINES ABOVE DOTTED LINES OF SAME THICKNESS.

Fig. 707 — The necessary and sufficient coding requirements for splitting.

In Fig. 707 we have shown the diagrams which depict the corresponding splitting in round braids with an odd number of strings†

† As before defined with respect to the numbers of right- and left-hand helixes.

Say, that instead of the 'standard' braiding-method, we use Murphy's construction-method. Then our earlier described 'standard' braiding-method for round braids with an even number of strings is identical to $(2x,\ u/(u+1-x))$, where $(x-1) \leq u \leq (2x-1)$. Hence $o = u + 1 - x$, where $(x-1) \leq u \leq (2x-1)$. Hence when the superimposed coding is such that the braid splits into two parts (see above, and note that enclosed splitting is not possible under the the Murphy Weaves), then either $u = (x-1)$, hence $o = 0$ (central row of diagrams in Fig. 706), or $u = (2x-1)$, hence $o = x$ (top row of diagrams in Fig. 706). Note that we can't construct round braids with Murphy's construction-method which have an odd number of strings, since the two fundamental braiding steps in this method are identical with respect to the u's and o's, and hence in round braids the number of crossings which each string makes when being laid down from upper right to lower left or from upper left to lower right is equal to $(n-1-u+o)$.

It should be noted that the vertical lines through the crossing-points of the strings are rows, and that there are n rows in a round braid of n strings. When each of these rows has a constant coding, then we have a row-coded braid (when splittable into two totally separate parts, we obtain two embrionic round braids, each one without any crossing rows).

Before proceeding with the Murphy Weaves, let us first have a look at **regular flat braids** braided by the 'standard' method for round braids. After our earlier exposition of the 'standard' round braiding-method, we should not encounter any difficulties in reading the string-run diagrams in Fig. 708.

It will be needless to say that in practice nobody would contemplate braiding a regular flat braid in this manner, but as we shall see it is extensively used in Murphy's construction-method.

Note that in these diagrams the vertical lines through the crossing-points are columns and **not** rows! Also note that there are $(n-1)$ columns in a braid of n strings. When each of these columns has a constant coding, then we have a column-coded braid.

Since the two fundamental braiding steps in Murphy's construction-method are identical with respect to the u's and o's, we can't encounter with that method the "even number of strings" case, but we do encounter the "odd number of strings" case. Here for a braid with n strings we have:

$$n - 1 - u + o = \frac{n-1}{2}, \qquad \text{where } n = \text{odd}.$$

hence:

$$u - o = \frac{n-1}{2}.$$

Let's summarise what we have found out so far about the Murphy Weaves.

•♡• For an **odd** number of strings n there are no Murphy Weaves which are round braids in which all the strings participate in the actual weave of the braid.

•♡• For an **odd** number of strings n there are Murphy Weaves which are regular flat braids in which all the strings participate in the actual weave of the braid. For these braids $u - o = \frac{n-1}{2}$.

•♡• For an **even** number of strings n there are Murphy Weaves which are round braids in which all the strings participate in the actual weave of the braid. For these braids $u - o = \frac{n-2}{2}$. These Murphy Weaves will split into two totally separate parts when:

(i). $o = 0$, and hence $u = \dfrac{n-2}{2}$.

(ii). $o = \dfrac{n}{2}$, and hence $u = n - 1$.

•♡• For an **even** number of strings n there are no Murphy Weaves which are regular flat braids in which all the strings participate in the actual weave of the braid.

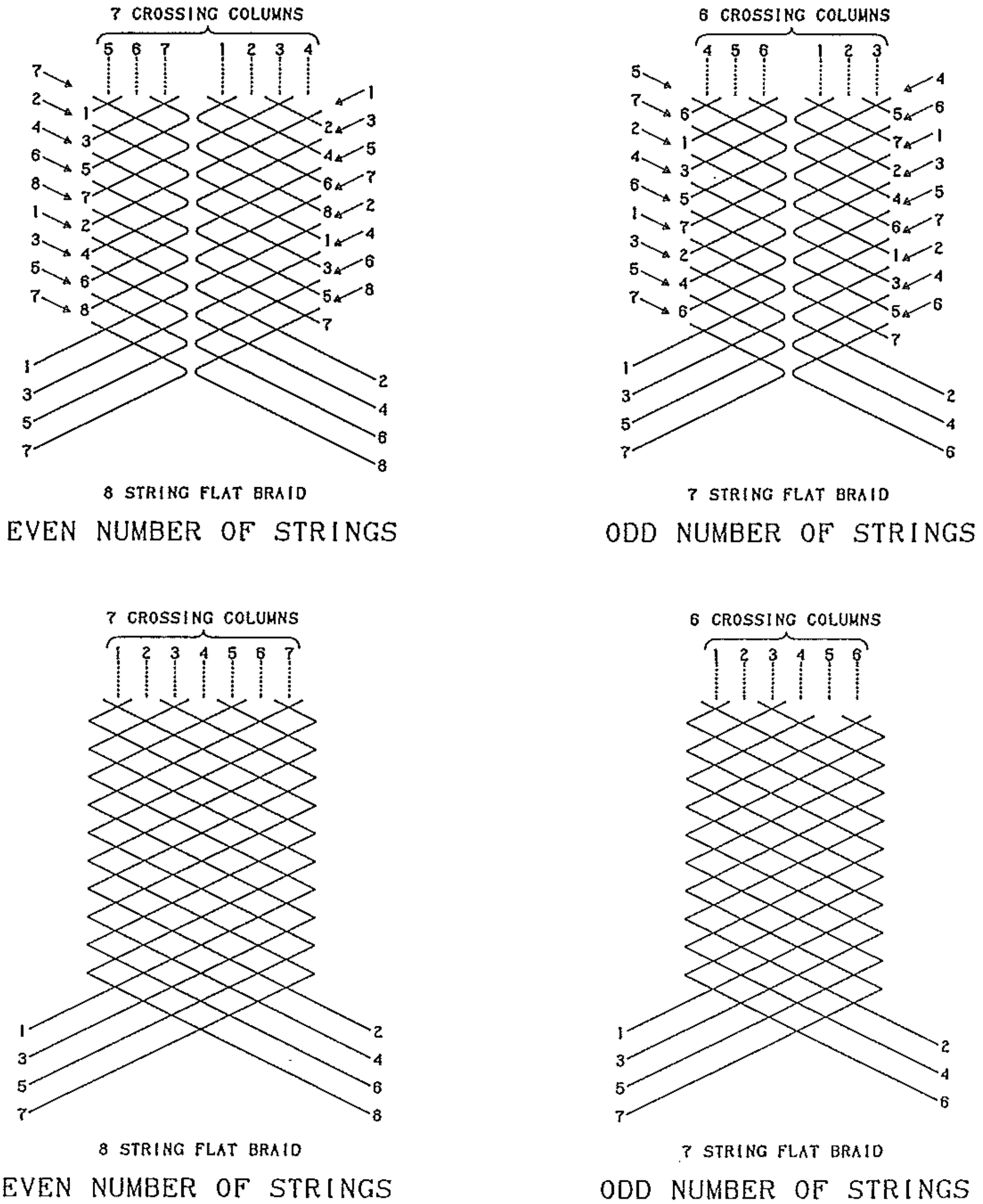


Fig. 708 — Two different braiding-methods for regular flat braids.

When a string makes fewer than $\dfrac{n-1}{2}$ crossing-points when laid down (on the front) in a Murphy Weave with an **odd** number of strings, we see from the right-hand string-run diagrams in Fig. 708 that this Murphy Weave contains a regular flat braid. In fact we see that if this number of crossings is y, then this regular flat braid contains $(2y+1)$ strings. Hence if the Murphy Weave contains a total of n strings, it follows that $(n-2y-1)$ strings (hence an *even* number of strings) do not take part in the actual weaving; it are **passive** strings which are totally free of the regular flat braid.

When a string makes fewer than $\frac{n}{2}$ crossing-points when laid down (on the front) in a Murphy Weave with an **even** number of strings, we see from the left-hand string-run diagrams in Fig. 708 that this Murphy Weave contains a regular flat braid. In fact we see that if this number of crossings is y, then this regular flat braid contains $(2y+1)$ strings. Hence if the Murphy Weave contains a total of n strings, it follows that $(n-2y-1)$ strings (hence an *odd* number of strings) do not take part in the actual weaving; it are **passive** strings which are totally free of the regular flat braid.

Since $y = (n-1-u+o)$, it follows that for such Murphy Weaves we have the conditons:

$$u - o > \frac{n-1}{2}, \quad \text{for } n = \text{odd}, \quad \textit{with}$$

$(2n-1-2u+2o)$ strings in regular flat braid; $(2u-2o+1-n)$ passive strings.

$$u - o > \frac{n-2}{2}, \quad \text{for } n = \text{even}, \quad \textit{with}$$

$(2n-1-2u+2o)$ strings in regular flat braid; $(2u-2o+1-n)$ passive strings.

The round braids in Fig. 709 contain passive strings. We see that in order to fulfil Murphy Weave conditions, the number of passive strings must be **odd** when the total number of strings is **odd**, and the number of passive strings must be **even** when the total number of strings is **even**. The round braid itself must always have an even number of strings.

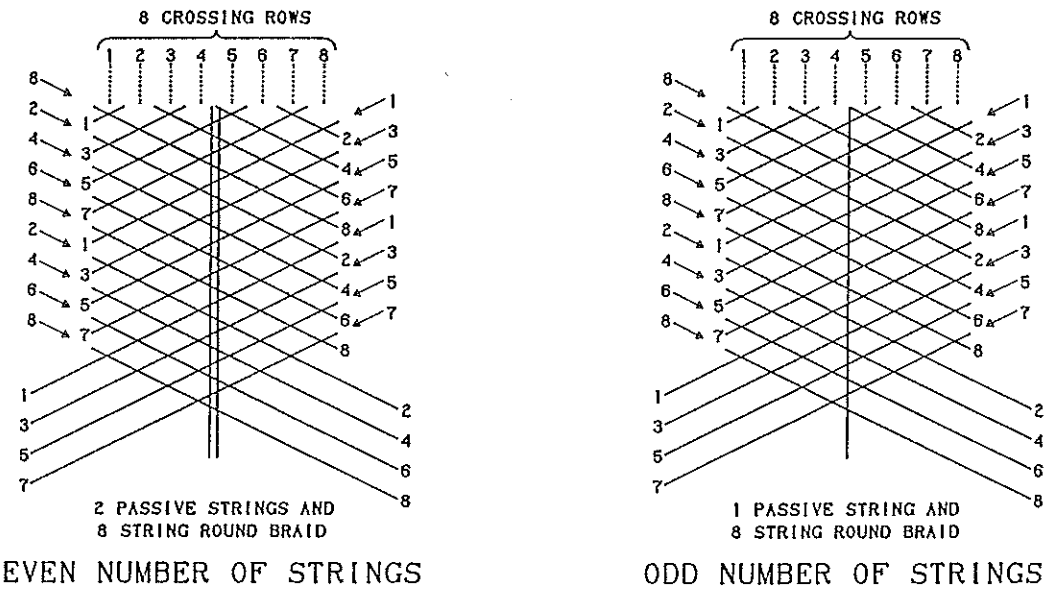


Fig. 709 — Round braids with passive strings.

When a string makes more than $\frac{n-1}{2}$ crossing-points when laid down (on the front) in a Murphy Weave with an **odd** number of strings, we see from the right-hand string-run diagram in Fig. 709 that this Murphy Weave contains a round braid with passive strings. In fact we see that if this number of crossings is y, then the number of passive strings is equal to $(2y-n)$, while the round braid itself consists of $2(n-y)$ strings.

When a string makes more than $\frac{n}{2}$ crossing-points when laid down (on the front) in a Murphy Weave with an **even** number of strings, we see from the left-hand string-run diagram in Fig. 709 that this Murphy Weave contains a round braid with passive strings. In fact we see that if this number of crossings is y, then the number of passive strings is equal to $(2y - n)$, while the round braid itself consists of $2(n - y)$ strings.

Since $y = (n - 1 - u + o)$, it follows that for such Murphy Weaves we have the conditons:

$$u - o < \frac{n-1}{2}, \quad \text{for } n = \text{odd}, \quad \textit{with}$$

$$2(u - o + 1) \text{ strings in round braid;} \quad (n - 2 - 2u + 2o) \text{ passive strings.}$$

$$u - o < \frac{n-2}{2}, \quad \text{for } n = \text{even}, \quad \textit{with}$$

$$2(u - o + 1) \text{ strings in round braid;} \quad (n - 2 - 2u + 2o) \text{ passive strings.}$$

Let's now investigate how these passive strings are positioned in these Murphy Weaves, hence how they are associated with the round braids. From Fig. 709 we observe that the passive strings are the last strings which are crossed when a string is being laid down from upper-right to lower left as well as when a string is being laid down from upper-left to lower-right. The seven different arrangement to be considered are schematically depicted in Fig. 710.

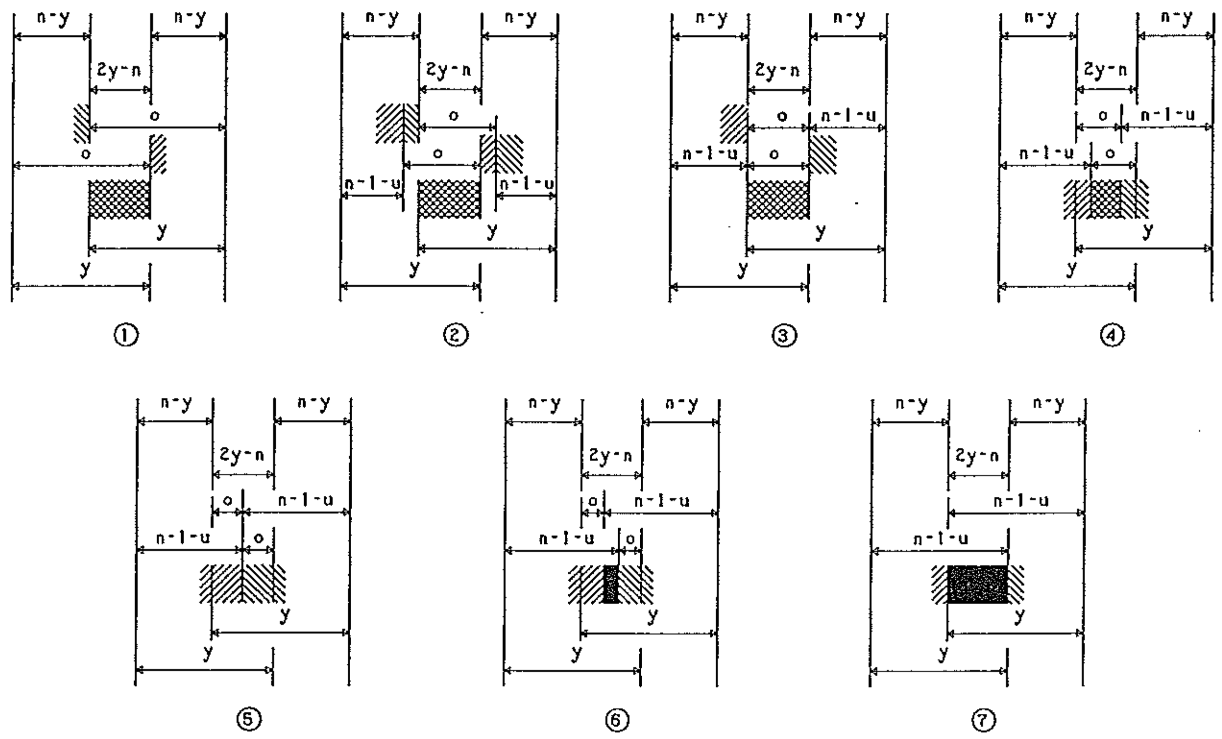


Fig. 710 — The arrangements of the passive strings.

(1). Diagram ① depicts the case where all the passive strings $(2y - n)$ are fully encircled by the round braid. When the passive strings are extracted, the round braid splits into two totally separated parts; each part being an embrionic round braid, one with a right-hand helix and the other with a left-hand helix. With the previously obtained relationships and those derived from diagram ① we obtain:

$$u - o < \frac{n-1}{2} \quad \text{for} \quad n = \text{odd},$$
$$u - o < \frac{n-2}{2} \quad \text{for} \quad n = \text{even},$$
$$u = n - 1 \quad \text{and} \quad o > \frac{n}{2},$$
$$\text{number of passive strings} = 2o - n,$$
$$\text{number of strings in each embrionic round braid} = n - o.$$

(2). Diagram ②depicts the case where all the passive strings $(2y-n)$ are fully encircled by the round braid. When the passive strings are extracted, the round braid does not split into two parts. With the previously obtained relationships and those derived from diagram ②we obtain:

$$u - o < \frac{n-1}{2} \quad \text{for} \quad n = \text{odd},$$
$$u - o < \frac{n-2}{2} \quad \text{for} \quad n = \text{even},$$
$$2u - o > n - 2 \quad \text{and} \quad u < n - 1,$$
$$\text{number of passive strings} = n - 2 - 2u + 2o,$$
$$\text{number of strings in round braid} = 2(u + 1 - o).$$

(3). Diagram ③depicts the case where all the passive strings $(2y-n)$ are fully encircled by the round braid. When the passive strings are extracted, the round braid splits into two totally separated parts; each part being an embrionic round braid, one with a right-hand helix and the other with a left-hand helix. With the previously obtained relationships and those derived from diagram ③we obtain:

$$u - o < \frac{n-1}{2} \quad \text{for} \quad n = \text{odd},$$
$$u - o < \frac{n-2}{2} \quad \text{for} \quad n = \text{even},$$
$$2u - o = n - 2,$$
$$\text{number of passive strings} = n - 2 - 2u + 2o,$$
$$\text{number of strings in each embrionic round braid} = u + 1 - o.$$

(4). Diagram ④ depicts the case where only some of the passive strings are fully encircled by the round braid; they form the central set of passive strings. The rest of the passive strings are divided into two sets with equal numbers; the left-hand set is only encircled by the set of right-hand helixes, while the right-hand set is only encircled by the left-hand helixes. The round braid splits into two totally separated parts (which are embrionic round braids, one with a right-hand helix and the other with a left-hand helix) when the central set of passive strings is extracted. Each part encircles its set of passive strings. With the previously obtained relationships and those derived from diagram ④we obtain:

$$u - o < \frac{n-1}{2} \quad \text{for} \quad n = \text{odd},$$
$$u - o < \frac{n-2}{2} \quad \text{for} \quad n = \text{even},$$
$$2u - o < n - 2 \quad \text{and} \quad u > \frac{n-2}{2},$$
$$\text{number of passive strings in central set} = 2u + 2 - n,$$
$$\text{number of passive strings in each embrionic braid} = n - 2 - 2u + o,$$
$$\text{number of strings in each embrionic round braid} = u + 1 - o.$$

(5). Diagram ⑤ depicts the case where the passive strings are divided into two sets with equal numbers; the left-hand set is only encircled by the set of right-hand helixes, while the right-hand set is only encircled by the left-hand helixes. The round braid splits into two totally separated parts (which are embrionic round braids, one with a right-hand helix and the other with a left-hand helix) each of which encircles its set of passive strings.

Note that this case can only exist when n is even.

With the previously obtained relationships and those derived from diagram ⑤ we obtain:

$$u - o < \frac{n-2}{2} \quad \text{for} \quad n = \text{even},$$
$$u = \frac{n-2}{2},$$
$$\text{number of passive strings in each embrionic braid} = \frac{n - 2 - 2u + 2o}{2},$$
$$\text{number of strings in each embrionic round braid} = u + 1 - o.$$

(6). Diagram ⑥ depicts the case where some of the passive strings fall outside the round braid; they form the central set of passive strings. The rest of the passive strings are divided into two sets with equal numbers; the left-hand set is only encircled by the set of right-hand helixes, while the right-hand set is only encircled by the left-hand helixes. The round braid splits into two totally separated parts (which are embrionic round braids, one with a right-hand helix and the other with a left-hand helix). Each embrionic round braid encircles its set of passive strings. With the previously obtained relationships and those derived from diagram ⑥ we obtain:

$$u - o < \frac{n-1}{2} \quad \text{for} \quad n = \text{odd},$$
$$u - o < \frac{n-2}{2} \quad \text{for} \quad n = \text{even},$$
$$u < \frac{n-2}{2} \quad \text{and} \quad o > 0,$$
$$\text{number of passive strings in central set} = n - 2 - 2u,$$
$$\text{number of passive strings in each embrionic braid} = o,$$
$$\text{number of strings in each embrionic round braid} = u + 1 - o.$$

(7). Diagram ⑦ depicts the case where all the passive strings fall outside the round braid. The round braid splits into two totally separated parts (which are embrionic round braids, one with a right-hand helix and the other with a left-hand helix). With the previously obtained relationships and those derived from diagram ⑦ we obtain:

$$u - o < \frac{n-1}{2} \quad \text{for} \quad n = \text{odd},$$

$$u - o < \frac{n-2}{2} \quad \text{for} \quad n = \text{even},$$

$$o = 0,$$

$$\text{number of free passive strings} = n - 2 - 2u,$$

$$\text{number of strings in each embrionic round braid} = u + 1.$$

In the following two Examples, the Murphy Weaves with 6 strings and 7 strings are discussed respectively by using the above derived relationships. Although grid-diagrams with zero values for u and o are not depicted in the respective Figs. 711 and 712A & 712B, they are of course just as important as the others.

Example 1: $n = 6$.

(A). No passive strings; $u - o = \frac{n-2}{2} = \frac{6-2}{2} = 2$. Hence Murphy Weave is a round braid without passive strings.

(i). $u = 5$, hence $o = 3$; (6, 5/3).

Since in this case $u = n - 1$, the braid will split into two totally separate parts. One is an embrionic round braid with a right-hand helix and 3 strings. The other is an embrionic round braid with a left-hand helix and 3 strings.

(ii). $u = 4$, hence $o = 2$; (6, 4/2).

The round braid will not split into parts.

(iii). $u = 3$, hence $o = 1$; (6, 3/1).

The round braid will not split into parts. It can readily be seen from the grid-diagrams that (6, 3/1) is identical to (6, 4/2).

(iv). $u = 2$, hence $o = 0$; (6, 2/0).

Since in this case $o = 0$, the braid will split into two totally separate parts. One is an embrionic round braid with a right-hand helix and 3 strings. The other is an embrionic round braid with a left-hand helix and 3 strings.

(B). Passive strings; $u - o > \frac{n-2}{2}$. Hence $u - o > 2$. Murphy Weave consists of a regular flat braid and passive strings.

(i). $u = 5$, hence $o < 3$.

(6, 5/0). Number of passive strings is equal to $2u - 2o + 1 - n = 5$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 1$, hence it becomes after all also a passive string. Thus in the end no braid is formed at all, consequently all strings are passive.

(6, 5/1). Number of passive strings is equal to $2u - 2o + 1 - n = 3$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 3$.

(6, 5/2). Number of passive strings is equal to $2u - 2o + 1 - n = 1$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 5$.

(ii). $u = 4$, hence $o < 2$.

(6, 4/0). Number of passive strings is equal to $2u - 2o + 1 - n = 3$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 3$. This regular flat braid is the regular flat braid in (6, 5/1) upside down.

(6, 4/1). Number of passive strings is equal to $2u - 2o + 1 - n = 1$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 5$.

(iii). $u = 3$, hence $o < 1$.

(6, 3/0). Number of passive strings is equal to $2u - 2o + 1 - n = 1$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 5$. This regular flat braid is the regular flat braid in (6, 5/2) upside down.

(C). Passive strings; $u - o < \frac{n-2}{2}$, hence $u - o < 2$. Murphy Weave consists of a round braid and passive strings.

Note that the condition $u - o < 2$, hence $o > u - 2$, applies to all the cases below, and only occasionally has it been stated again in a particular case.

(1). $u = n - 1 = 5$; $o > \frac{n}{2}$, hence $o > 3$.

All passive strings fully encircled by round braid; round braid splits into two totally separated embrionic round braids when the passive strings are extracted.

(6, 5/4). Number of passive strings is equal to $2o - n = 2$. Number of strings in each embrionic round braid is equal to $n - o = 2$.

(6, 5/5). Number of passive strings is equal to $2o - n = 4$. Number of strings in each embrionic round braid is equal to $n - o = 1$.

(2). $2u - o > n - 2$; and $u < n - 1$. Hence $u - 2 < o < 2u - 4$; $u < 5$.

All passive strings fully encircled by round braid; round braid does not split into two parts when the passive strings are extracted.

(i). $u = 4$, hence $2 < o < 4$.

(6, 4/3). Number of passive strings is equal to $n - 2 - 2u + 2o = 2$. Number of strings in round braid is equal to $2(u + 1 - o) = 4$.

(ii). $u = 3$, hence $1 < o < 2$. No solutions for o.

(iii). $u = 2$, hence $0 < o < 0$. No solutions for o.

(3). $2u - o = n - 2$, hence $o = 2u - 4$. $u - 2 < o$.

All passive strings fully encircled by round braid; round braid splits into two totally separated embrionic round braids when the passive strings are extracted.

(i). $u = 4$, hence $o = 4$.

(6, 4/4). Number of passive strings is equal to $n - 2 - 2u + 2o = 4$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 1$.

(ii). $u = 3$, hence $o = 2$.

(6, 3/2). Number of passive strings is equal to $n - 2 - 2u + 2o = 2$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 2$.

(iii). $u = 2$. No solutions for o.

(4). $2u - o < n - 2$; and $u > \frac{n-2}{2}$. Hence $o > 2u - 4$. $u > 2$.

Only some of the passive strings are fully encircled by the round braid; they form the central set of passive strings. The rest of the passive strings are divided into two sets with equal numbers; the left-hand set is only encircled by the right-hand helixes, while the right-hand set is only encircled by the left-hand helixes. The round braid splits into two totally separate embrionic round braids when the cental set of passive strings is extracted. Each embrionic round braid encircles its set of passive strings.

(i). $u = 4$. No solutions for o.

(ii). $u = 3$. Then $o > 2$.

(6, 3/3). Number of passive strings in central set is equal to $2u+2-n = 2$. Number of passive strings encircled by each embrionic round braid is equal to $n-2-2u+o = 1$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 1$.

(5). $u = \frac{n-2}{2}$. Hence $u = 2$. $o > u - 2$, hence $o > 0$.

Passive strings are divided into two sets of equal numbers. The round braid splits into two totally separate embrionic round braids, each of which encircles its set of passive strings.

(6, 2/1). Number of passive strings encircled by each embrionic round braid is equal to $\frac{n-2-2u+2o}{2} = 1$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 2$.

(6, 2/2). Number of passive strings encircled by each embrionic round braid is equal to $\frac{n-2-2u+2o}{2} = 2$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 1$.

(6). $u < \frac{n-2}{2}$, hence $u < 2$. $o > 0$.

Some of the passive strings fall outside the round braid; they form the central set. The rest of the passive strings are divided into two equal sets; the left-hand set is only encircled by the set of right-hand helixes, while the right-hand set is only encircled by the left-hand helixes. The round braid splits up into two totally separated embrionic round braids, each of which encircles its set of passive strings.

$u = 1$. $o = 1$.

(6, 1/1). Number of passive strings in central set is equal to $n-2-2u = 2$. Number of passive strings encircled by each embrionic round braid is equal to $o = 1$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 1$.

(7). $o = 0$. $u < 2 + o$, hence $u < 2$.

All passive strings fall outside the round braid. The round braid splits up into two separated embrionic round braids, one with a right-hand helix and the other with a left-hand helix.

(i). $u = o$.

(6, 0/0). Number of free passive strings is equal to $n - 2 - 2u = 4$. Number of strings in each embrionic round braid is equal to $u+1 = 1$. The left-most string receives a right-hand helix, and the right-most string receives a left-hand helix.

(ii). $u = 1$.

(6, 1/0). Number of free passive strings is equal to $n - 2 - 2u = 2$. Number of strings in each embrionic round braid is equal to $u + 1 = 2$.

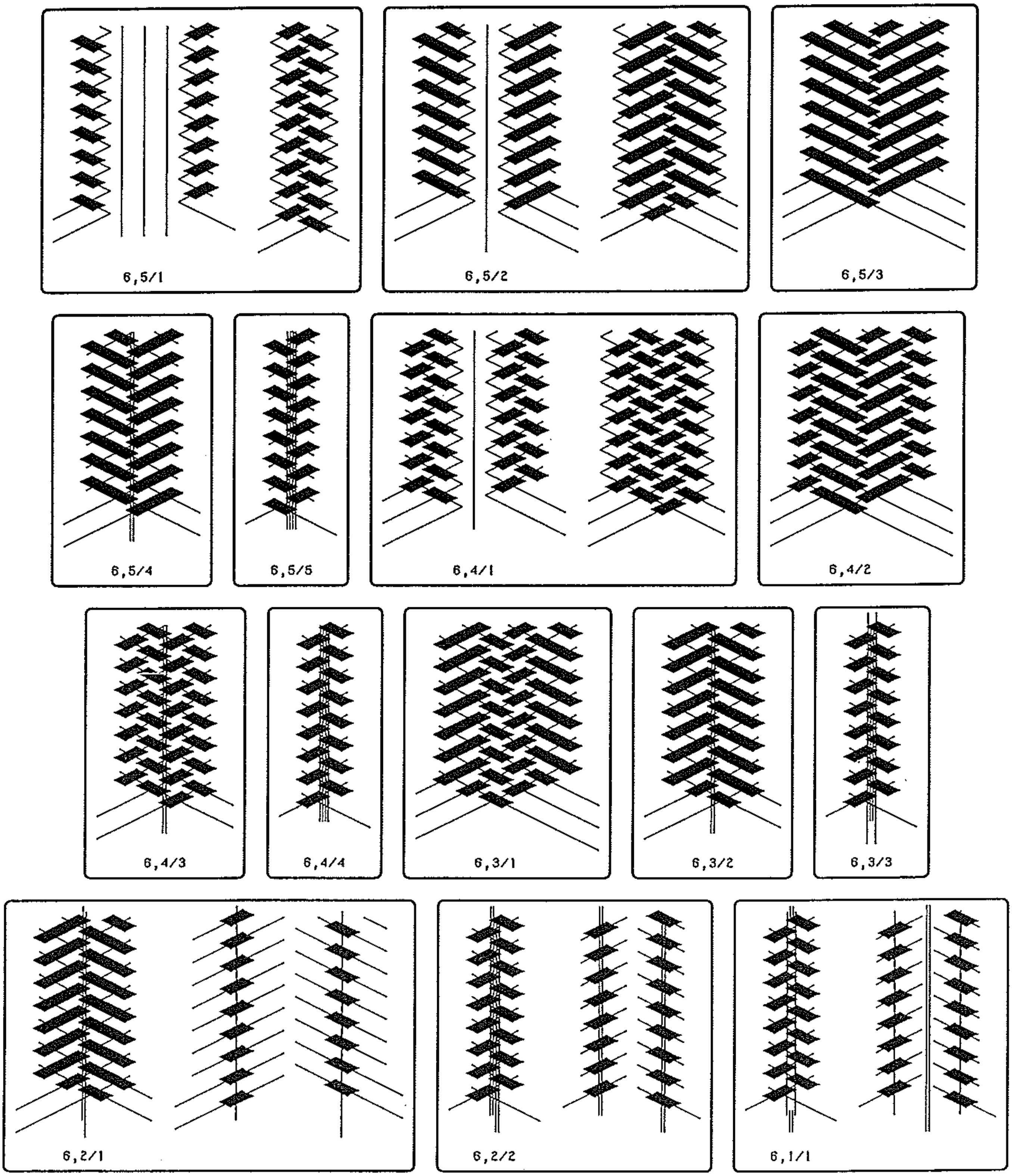


Fig. 711 — Grid-diagrams associated with Example 1.

Example 2 : $n = 7$

(A). No passive strings; $u - o = \dfrac{n-1}{2} = \dfrac{7-1}{2} = 3$. Hence Murphy Weave is a regular flat braid without passive strings.

(i). $u = 6$, hence $o = 3$; (7, 6/3).

(ii). $u = 5$, hence $o = 2$; (7, 5/2).

(iii). $u = 4$, hence $o = 1$; (7, 4/1).

(iv). $u = 3$, hence $o = 0$; (7, 3/0).
This regular flat braid is identical to (7, 6/3) upside down.

(B). Passive strings; $u - o > \frac{n-1}{2}$. Hence $u - o > 3$. Murphy Weave consists of a regular flat braid and passive strings.

(i). $u = 6$, hence $o < 3$.

(7, 6/0). Number of passive strings is equal to $2u - 2o + 1 - n = 6$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 1$, hence it becomes after all also a passive string. Thus in the end no braid has been formed at all, consequently all strings are passive.

(7, 6/1). Number of passive strings is equal to $2u - 2o + 1 - n = 4$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 3$. Note also that the regular flat braid is identical to the regular flat braid in (6, 5/1).

(7, 6/2). Number of passive strings is equal to $2u - 2o + 1 - n = 2$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 5$. Note also that the regular flat braid is identical to the regular flat braid in (6, 5/2).

(ii). $u = 5$, hence $o < 2$.

(7, 5/0). Number of passive strings is equal to $2u - 2o + 1 - n = 4$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 3$. This regular flat braid is the regular flat braid in (7, 6/1) upside down. Note also that the regular flat braid is identical to the regular flat braid in (6, 4/0).

(7, 5/1). Number of passive strings is equal to $2u - 2o + 1 - n = 2$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 5$. Note also that the regular flat braid is identical to the regular flat braid in (6, 4/1).

(iii). $u = 4$, hence $o < 1$.

(7, 4/0). Number of passive strings is equal to $2u - 2o + 1 - n = 2$. Number of strings in regular flat braid is equal to $2n - 1 - 2u + 2o = 5$. This regular flat braid is the regular flat braid in (7, 6/2) upside down. Note also that the regular flat braid is identical to the regular flat braid in (6, 3/0).

(C). Passive strings; $u - o < \frac{n-1}{2}$, hence $u - o < 3$. Murphy Weave consists of a round braid and passive strings.

Note that the condition $u - o < 3$, hence $o > u - 3$, applies to all the cases below, and only occasionally has this been stated again in a particular case.

(1). $u = n - 1 = 6$; $o > \frac{n}{2}$, hence $o > 3$.

All passive strings fully encircled by round braid; round braid splits into two totally separated embrionic round braids when the passive strings are extracted.

(7, 6/4). Number of passive strings is equal to $2o - n = 1$. Number of strings in each embrionic round braid is equal to $n - o = 3$. Note that the embrionic round braids are identical to those in (6, 5/3).

(7, 6/5). Number of passive strings is equal to $2o - n = 3$. Number of strings in each embrionic round braid is equal to $n-o=2$. Note that the embrionic round braids are identical to those in (6, 5/4).

(7, 6/6). Number of passive strings is equal to $2o-n=5$. Number of strings in each embrionic round braid is equal to $n-o=1$. Note that the embrionic round braids are identical to those in (6, 5/5).

(2). $2u-o>n-2$; and $u<n-1$. Hence $u-3<o<2u-5$; $u<6$.

All passive strings fully encircled by round braid; round braid does not split into two parts when the passive strings are extracted.

(i). $u=5$, hence $2<o<5$.

(7, 5/3). Number of passive strings is equal to $n-2-2u+2o=1$. Number of strings in round braid is equal to $2(u+1-o)=6$. Note that the round braid is identical to the one in (6, 4/2).

(7, 5/4). Number of passive strings is equal to $n-2-2u+2o=3$. Number of strings in round braid is equal to $2(u+1-o)=4$. Note that the round braid is identical to the one in (6, 4/3).

(ii). $u=4$, hence $1<o<3$.

(7, 4/2). Number of passive strings is equal to $n-2-2u+2o=1$. Number of strings in round braid is equal to $2(u+1-o)=6$. Note that the round braid is identical to the one in (6, 3/1).

(iii). $u=3$, hence $0<o<1$. No solutions for o.

(3). $2u-o=n-2$, hence $o=2u-5$. $u-3<o$.

All passive strings fully encircled by round braid; round braid splits into two totally separated embrionic round braids when the passive strings are extracted.

(i). $u=5$, hence $o=5$.

(7, 5/5). Number of passive strings is equal to $n-2-2u+2o=5$. Number of strings in each embrionic round braid is equal to $u+1-o=1$. Note that (7, 5/5) is identical to (7, 6/6) upside down. Note also that the embrionic round braids are identical to those in (6, 4/4).

(ii). $u=4$, hence $o=3$.

(7, 4/3). Number of passive strings is equal to $n-2-2u+2o=3$. Number of strings in each embrionic round braid is equal to $u+1-o=2$. Note that (7, 4/3) is identical to (7, 6/5) upside down. Note also that the embrionic round braids are identical to those in (6, 3/2).

(iii). $u=3$, hence $o=1$.

(7, 3/1). Number of passive strings is equal to $n-2-2u+2o=1$. Number of strings in each embrionic round braid is equal to $u+1-o=3$. Note that (7, 3/1) is identical to (7, 6/4) upside down. Note also that the embrionic round braids are identical to those in (6, 2/0).

(4). $2u-o<n-2$; and $u>\dfrac{n-2}{2}$. Hence $o>2u-5$. $u>2$.

Only some of the passive strings are fully encircled by the round braid; they form the central set of passive strings. The rest of the passive strings are divided into two sets with equal numbers; the left-hand set is only encircled by the right-hand helixes, while the right-hand set is only encircled by the left-hand helixes. The round braid splits into two totally separate embrionic round braids when the cental set of passive strings is extracted. Each embrionic round braid encircles its set of passive strings.

(i). $u = 5$. No solutions for o.

(ii). $u = 4$. Then $o > 3$.

$(7, 4/4)$. Number of passive strings in central set is equal to $2u+2-n = 3$. Number of passive strings encircled by each embrionic round braid is equal to $n-2-2u+o = 1$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 1$. Note that the embrionic round braids are identical to those in (6, 3/3).

(iii). $u = 3$. Then $o > 1$.

$(7, 3/2)$. Number of passive strings in central set is equal to $2u+2-n = 1$. Number of passive strings encircled by each embrionic round braid is equal to $n-2-2u+o = 1$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 2$. Note that the embrionic round braids are identical to those in (6, 2/1).

$(7, 3/3)$. Number of passive strings in central set is equal to $2u+2-n = 1$. Number of passive strings encircled by each embrionic round braid is equal to $n-2-2u+o = 2$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 1$. Note that the embrionic round braids are identical to those in (6, 2/2).

(5). This case cannot exist when n is **odd**.

(6). $u < \dfrac{n-2}{2}$, hence $u < 3$. $o > 0$.

Some of the passive strings fall outside the round braid; they form the central set. The rest of the passive strings are divided into two equal sets; the left-hand set is only encircled by the set of right-hand helixes, while the right-hand set is only encircled by the left-hand helixes. The round braid splits up into two totally separated embrionic round braids, each of which encircles its set of passive strings.

(i). $u = 2$. $o > 0$.

(7, 2/1). Number of passive strings in central set is equal to $n - 2 - 2u = 1$. Number of passive strings encircled by each embrionic round braid is equal to $o = 1$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 2$. Note that the embrionic round braids are identical to those in (6, 2/1).

(7, 2/2). Number of passive strings in central set is equal to $n - 2 - 2u = 1$. Number of passive strings encircled by each embrionic round braid is equal to $o = 2$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 1$. Note that the embrionic round braids are identical to those in (6, 2/2).

(ii). $u = 1$. $o > 0$.

(7, 1/1). Number of passive strings in central set is equal to $n - 2 - 2u = 3$. Number of passive strings encircled by each embrionic round braid is equal to $o = 1$. Number of strings in each embrionic round braid is equal to $u + 1 - o = 1$. Note that the embrionic round braids are identical to those in (6, 1/1).

(7). $o = 0$. $u < 3 + o$, hence $u < 3$.

All passive strings fall outside the round braid. The round braid splits up into two separated embrionic round braids, one with a right-hand helix and the other with a left-hand helix.

(i). $u = o$.

(7, 0/0). Number of free passive strings is equal to $n - 2 - 2u = 5$. Number of strings in each embrionic round braid is equal to $u+1 = 1$. The left-most string receives a right-hand helix, and the right-most string receives a left-hand helix. Note that the embrionic round braids are identical to those in (6, 0/0).

(ii). $u = 1$.

(7, 1/0). Number of free passive strings is equal to $n - 2 - 2u = 3$. Number of strings in each embrionic round braid is equal to $u + 1 = 2$. Note that the embrionic round braids are identical to those in (6, 1/0).

(iii). $u = 2$.

(7, 2/0). Number of free passive strings is equal to $n - 2 - 2u = 1$. Number of strings in each embrionic round braid is equal to $u + 1 = 3$.

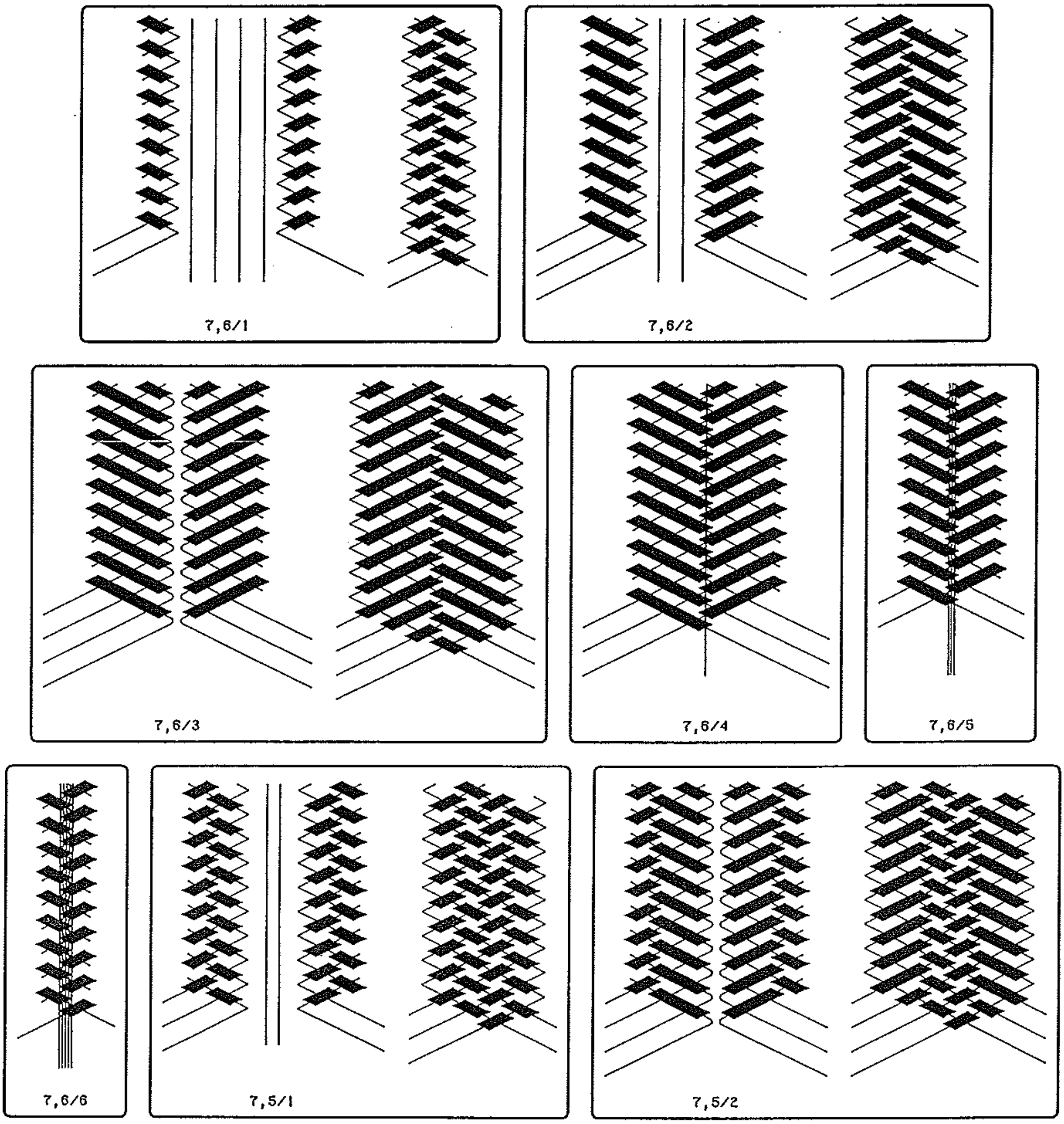


Fig. 712A — Grid-diagrams associated with Example 2.

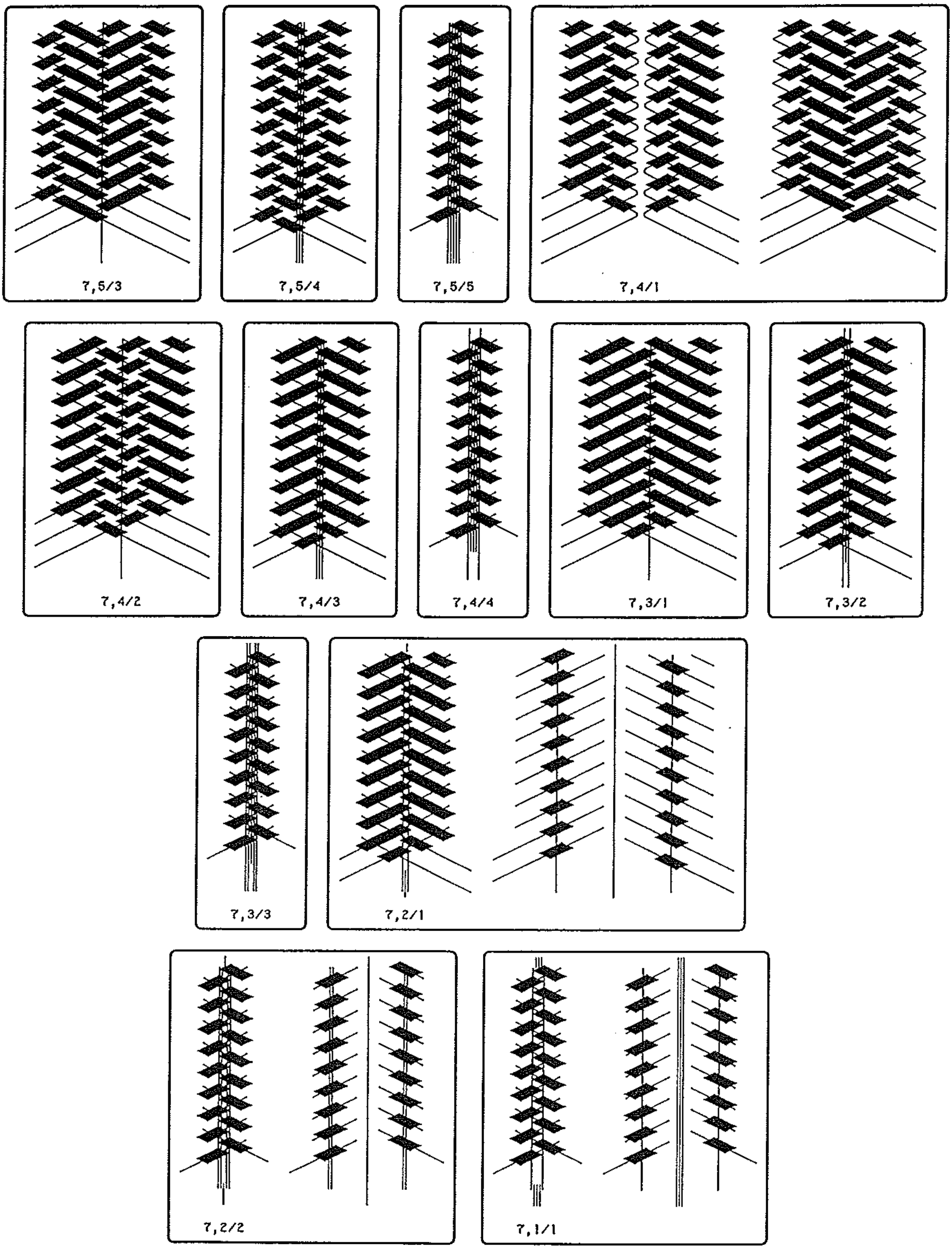


Fig. 712B — Grid-diagrams associated with Example 2.

Not only does Murphy's (braid) construction-method produce braids which do **not** belong to one braid-class, but it produces also a large number of braids which have no practical value, and in fact no theoretical value either. It is therefore a (braid) construction-method which should not be used in order not to lead a braider up the garden path.

A Six Thong Round Braid Start

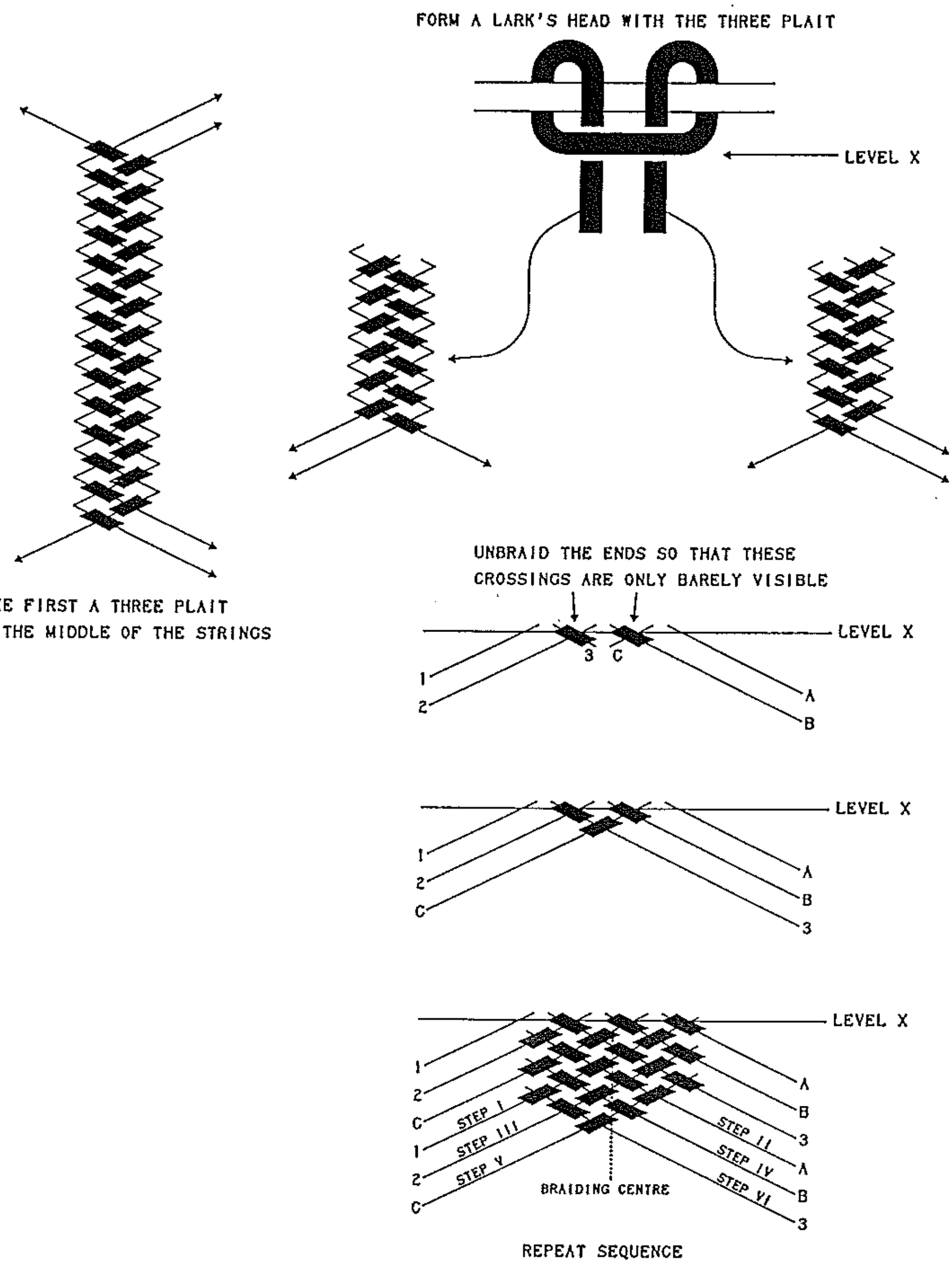


Fig. 713 — A six thong Round Braid start.