Meccano hexagons gallery

https://github.com/heptagons/meccano/hexa/gallery

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Abstract

We build rigid meccano [1] regular pentagons from sides 4 to 24. We restrict all internal strips to remain inside the hexagons's perimeter and don't permit they overlap with others. The internal strips must not be parallel to any side of the hexagon.

1 Internal strips

We run a software program to look strips that can make rigid two consecutive internal sides of any hexagon. Figure 1 show the smaller four cases found. Consider the figure at top left, the internal hexagon angle is $\theta \equiv \angle GBC = 2\pi/3$ and the hexagon side is $s \equiv \overline{BC}$. Consider the triangle $\triangle GBC$ and define the other two sides as $b \equiv \overline{GB}$ and $c = \overline{GC}$. By the law of cosines we know that:

$$\begin{aligned} c &= \sqrt{b^2 + s^2 - 2bs\cos\theta} \\ &= \sqrt{b^2 + s^2 - 2bs\left(-\frac{1}{2}\right)} \\ &= \sqrt{b^2 + s^2 + bs} \end{aligned} \tag{1}$$

By defining $a \equiv s + b$ we get:

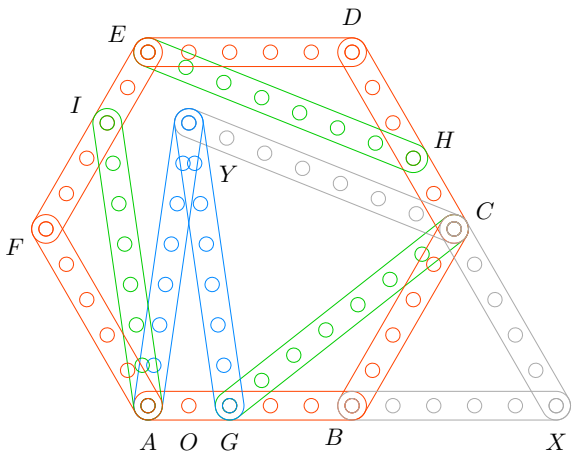
$$c = \sqrt{a^2 + b^2 - ab} \quad \texttt{where } a > b \tag{2}$$

Running the software iterating first over a and then by b and filtering c to be integer we get the first rows:

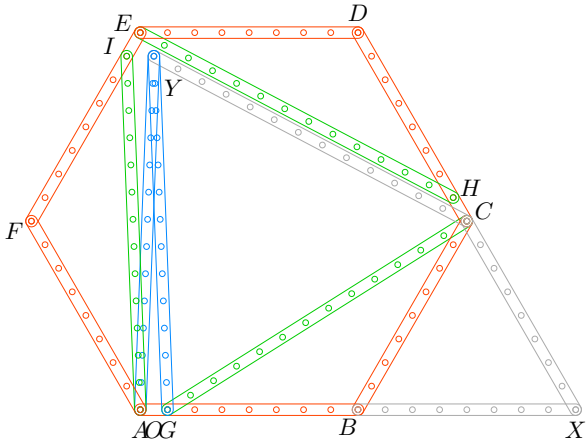
a	b	c	s
8	3	7	5
15	7	13	8
21	5	19	16
35	11	31	24
40	7	37	33
48	13	43	35

2 Hexagons of size 13

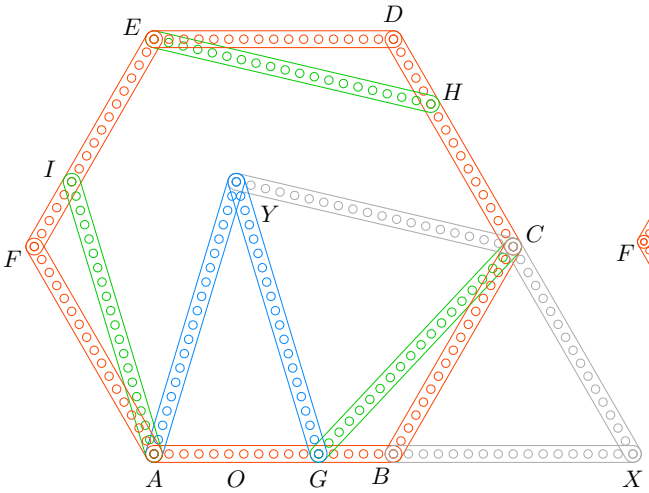
[1] Meccano mathematics by 't Hooft



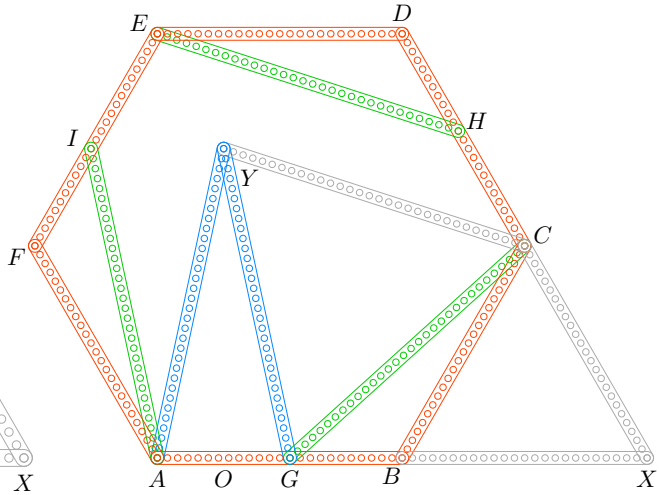
$a = 8, b = 3, c = 7, s = 5$



$a = 15, b = 7, c = 13, s = 8$



$a = 21, b = 5, c = 19, s = 16$



$a = 35, b = 11, c = 31, s = 24$

Figure 1: First cases where internal strip $c = \overline{GC}$ is an integer and makes rigid two consecutive regular hexagon sides $s = \overline{AB} = \overline{BC}$. We use two numbers to identify every solution a and b where $b = \overline{GB}$ and $a = s - b$.