



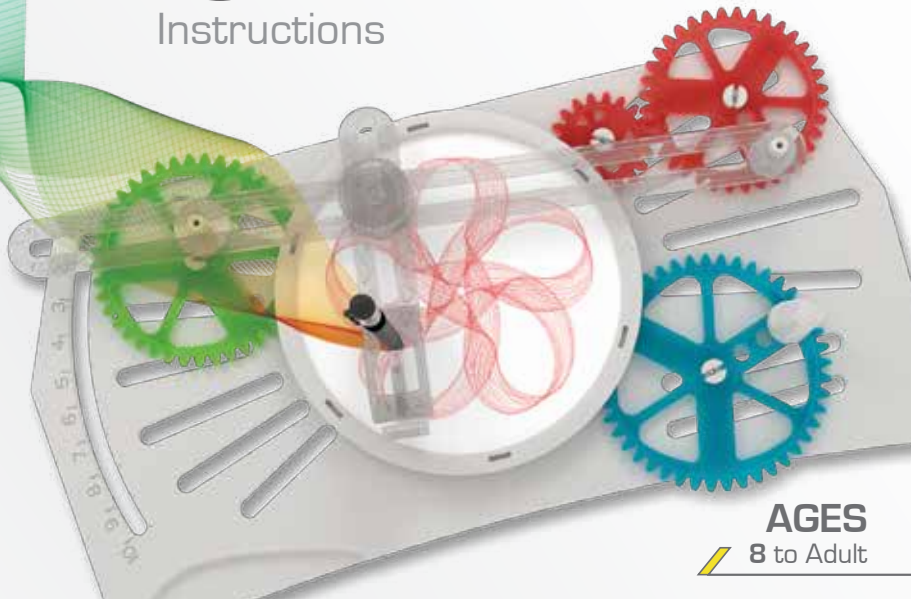
HYPNO GRAPH™

Instructions



The Evolution
of the
Drawing Machine

Capable of
Infinite Designs!



AGES
8 to Adult

Introduction

Creating beautiful patterns has never been this much fun! ThinkFun's HypnoGraph™ uses gears of different sizes and fully adjustable parts to realize sophisticated curved designs. Numbered gears offer mathematical lessons in gear ratios; learn how to calculate pattern loops using common denominators and discover why lines created with prime numbered gears do not create repeating loops. The HypnoGraph connects mathematics, art, and mechanics in a hand-operated machine capable of creating sensational patterns and designs.



Includes:

1. HypnoGraph Base¹
2. Turntable Gear with Outer Ring
3. T-Arm
4. 13 Repositionable Gears²
5. Gear Spindles
6. Gear Crank Handle
7. T-Arm-to-Gear Connectors
8. T-Arm-to-Base Connector
- 9a. Adjustable Pen Holder³
- 9b. Pen Holder Connector
10. Gear Puller/Spindle Tightener⁴
11. Fine-tip Drawing Pen
12. 20 Paper Discs

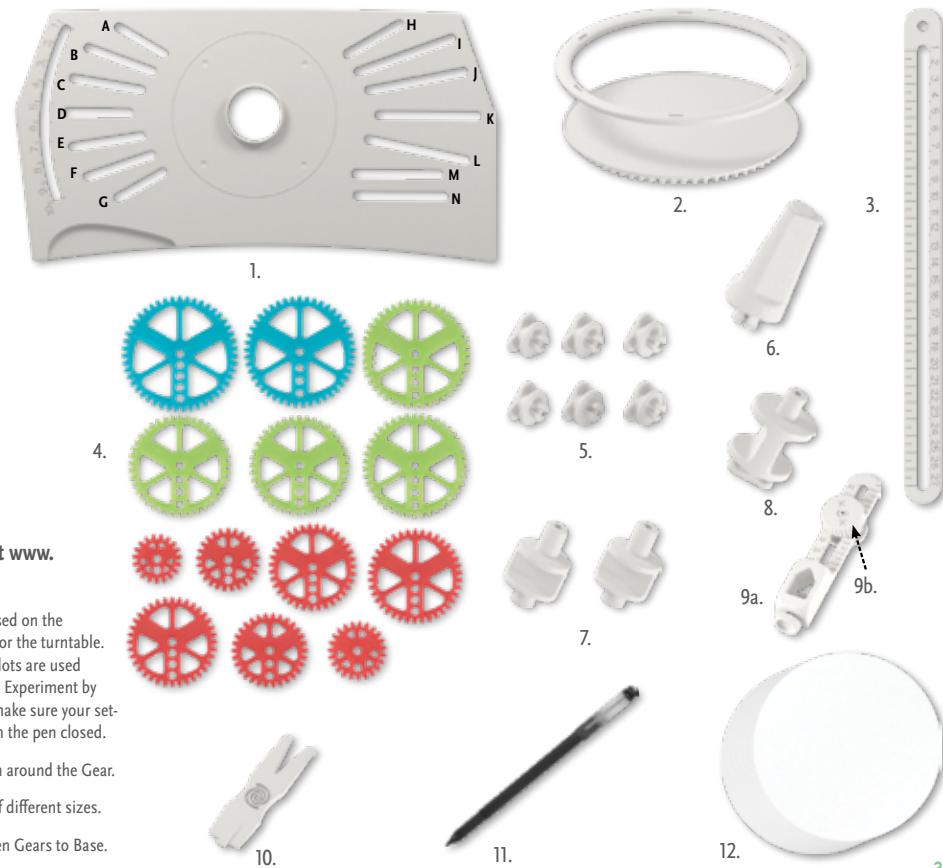
Download additional Paper Discs at www.ThinkFun.com/HypnoGraph

¹ The different slots allow the gears that are used on the HypnoGraph Base to touch other gears and/or the turntable. For certain drawings, we will tell you which slots are used to get the wonderful patterns in this manual. Experiment by placing different gears in different slots! To make sure your set-up will work properly, do a few test turns with the pen closed.

² Numbers correspond to the number of teeth around the Gear.

³ The Adjustable Pen Holder works for pens of different sizes.

⁴ Used to pull Gears off of Spindles and tighten Gears to Base.



Getting Started

Get to know the HypnoGraph by creating a simple pattern.

Start with the simplest pattern using a 30 Gear with stationary point. Here are the parts you'll need:

30 Gear

45 Gear

2 Gear Spindles

Gear Crank Handle

Pen Holder/Connector

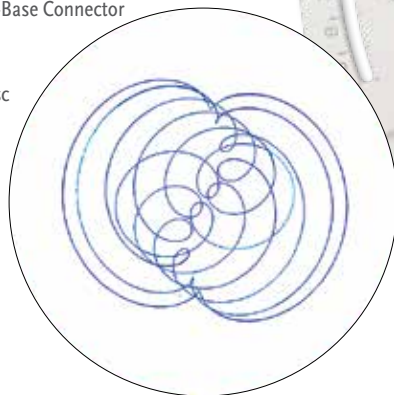
T-Arm-to-Gear Connector

T-Arm-to-Base Connector

T-Arm

Paper Disc

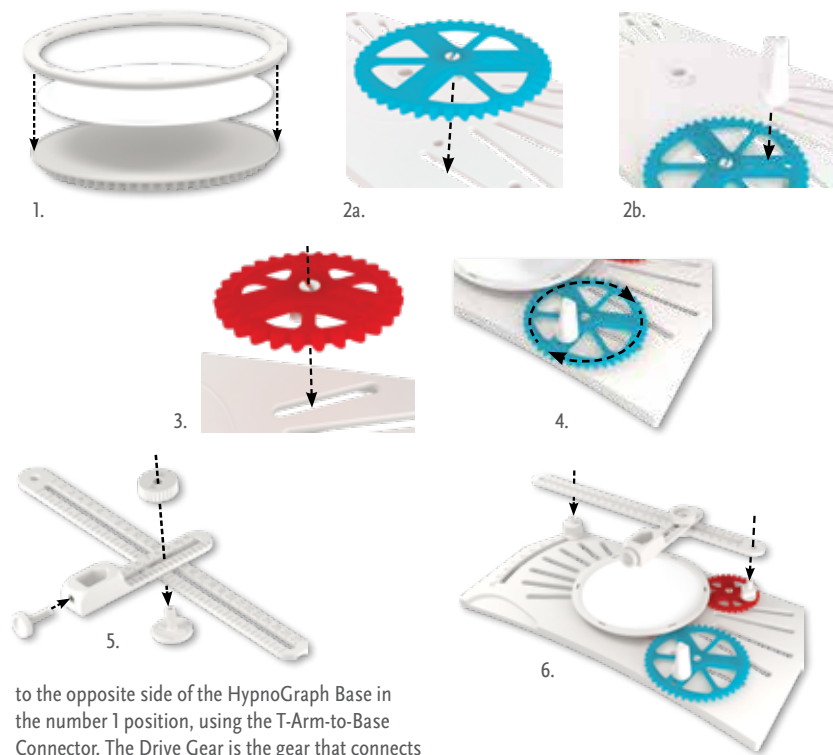
Pen



Here is how this HypnoGraph setup looks before drawing.
Step-by-step instructions are on the next page.

Setup:

1. Place 1 Paper Disc on the Turntable and secure in place with the Outer Ring.
- 2a. Place the number 45 Gear in the bottom right slot (N) of the HypnoGraph Base and attach through the center with a Gear Spindle.
- 2b. Next, insert the Gear Crank Handle through the center of the remaining holes in the Gear. Turning this handle will move the Turntable.
3. Place the number 30 Gear in the upper-right slot (H) of the HypnoGraph Base and attach through the center with a Gear Spindle.
4. Turn the Gear Crank Handle clockwise to move the gears to make sure the gears are aligned correctly. Do not force the gears! If they are aligned too tightly, stop and realign.
5. Assemble the Pen Holder and T-Arm parts using the Pen Holder Connector, joining from 8 to 10 on the T-Arm, and 8 on the Pen Holder.
6. Position the assembled Pen Holder over the paper and connect the fixed end of the T-Arm to the number 30 Gear with a T-Arm-to-Gear Connector. Then, connect the T-Arm



to the opposite side of the HypnoGraph Base in the number 1 position, using the T-Arm-to-Base Connector. The Drive Gear is the gear that connects to the hole on the T-Arm.

Spinning Around

Make your first drawing!

1. Tighten the Fine-tip Pen in place

Click the pen to extend the point to draw.

2. Draw

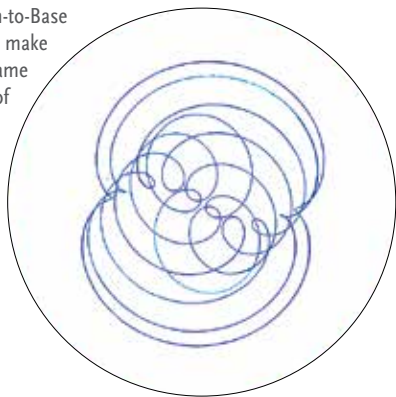
Slowly turn the Gear Crank Handle to create the drawing.

3. Try different variations:

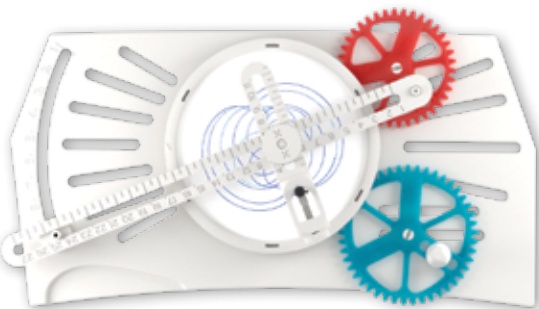
Retract the pen.

Move the T-Arm-to-Base Connector to number 3 on the numbered slot. Lower the pen and draw.

Continue moving the T-Arm-to-Base Connector to 5, 7 and 9 and make multiple drawings on the same piece of paper, one on top of another.



1.



3.

Setup Tips

Tips to get the best drawings from your HypnoGraph

Gear Alignment

Gears should be positioned with a little space between them. If the gears are too tight, they will jam. If the gears are too loose, there will be too much 'play' and the drawings will not be accurate.

Gear Train

If, during rotation, any of the T-Arm Connectors strike the turntable, there will be problems with the final drawing.

To correct this, additional smaller gears may be added between the Turntable and gears with the T-Arm Connectors, allowing those gears with the T-Arm Connectors to be moved a bit further out. Adding these gears will not affect the drawing.

Add Extra Gears to Side of Turntable

You may want to add an extra gear to a side of the turntable with no gears. The extra gear will serve as an idler gear and will help stabilize the turntable.

Prime Gears

Gears that have a prime number of teeth create elaborate patterns. However, you'll find that you should probably not use two prime number gears together in a pattern.

Pen Adjustment

Make sure the Pen Holder is parallel to the paper. If your pen is skipping you can add a weight to the Pen.

Cranking Speed

While it may be fun to crank really fast, slower speeds will produce a better line quality.

Easy Does It

You may find that simpler setups produce better designs than elaborate ones.

Document & Record

Write down the gear setups you try so you can repeat the designs you like. Note the Drive Gear, the Sliding Gear, Pen Holder and T-Arm positions.

The easiest way to document your setup is to simply take a photo. Take multiple pictures to show the overall setup, a close-up of the Pen Holder, and another to show the finished drawing. Having photos makes it easy to retrieve your designs and make more variations.

Learn more at ThinkFun.com/HypnoGraph

Moving Pen Holder Assembly

Add complexity to even the simplest setups

1. Add a 41 Gear

Add the 41 Gear to slot A. Slide the 41 Gear until it connects with the turntable. Be careful that the gear is not too tight before you tighten the connector.

2. Test Spin

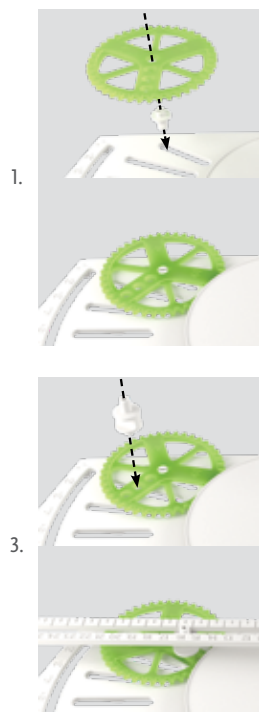
Make sure gears turn smoothly.

3. Connect 41 Gear to the T-Arm using the T-Arm-to-Gear Connector.

4. Completed Drawing

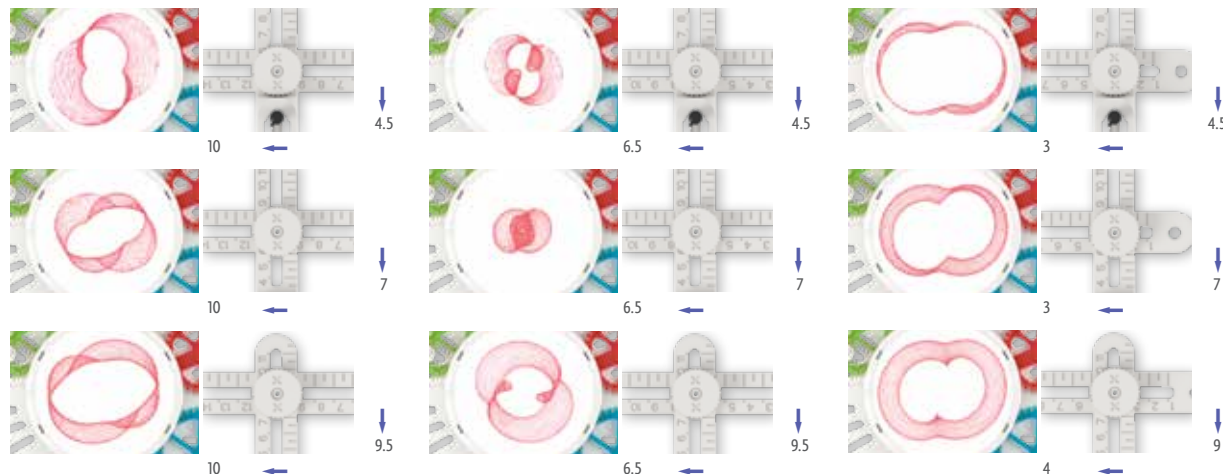
Here is the completed drawing. Big variations can be made by adjusting the Pen Holder.

Subtle variations can be made by moving the positions of the Connectors on the 30 and 41 Gears.



Pattern Matrix

This matrix shows the effect of changing the Pen Holder position when the setup uses the 30 and 41 Gears



This column: the Pen Holder is positioned at 10 on the T-Arm. The Pen Holder length varies from 4.5 on the top to 9.5 on the bottom.

This column: the Pen Holder is at 6.5 on the T-Arm. The Pen Holder length varies from 4.5 on the top to 9.5 on the bottom. Interesting patterns appear by moving the Pen Holder away from the middle position.

This column: the Pen Holder is positioned at 3, 3 and 4 on the T-Arm. The Pen Holder length varies from 4.5 on the top to 9 on the bottom.

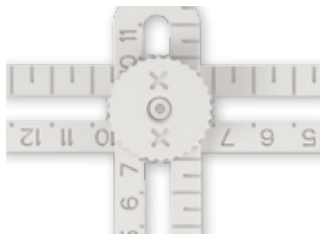
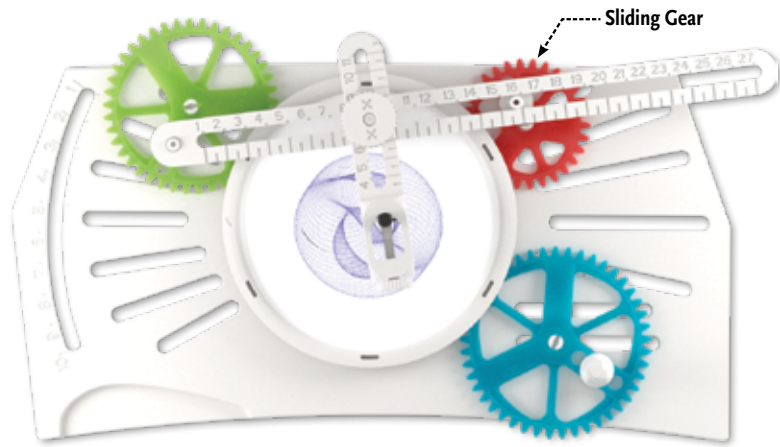
Reversed T-Arm Rod

Reversed T-Arm Rod using 30 and 41 Gears

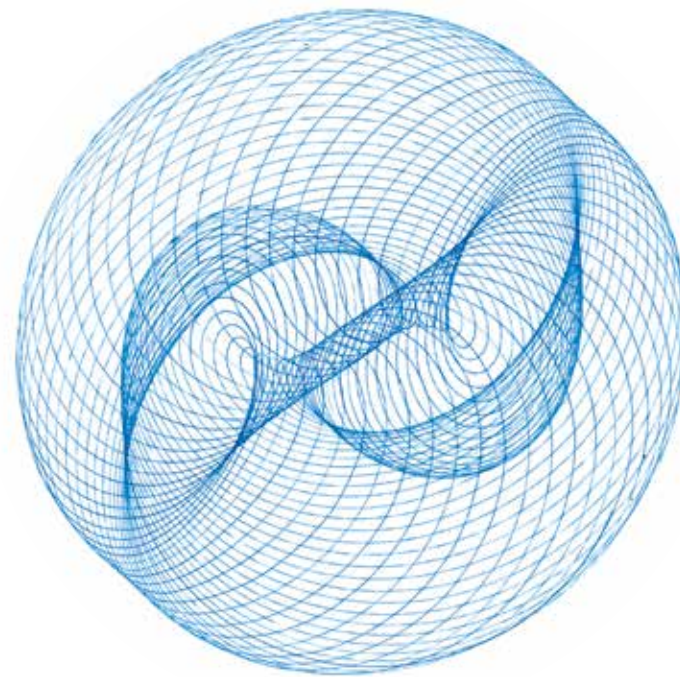
Reverse Pen Holder

You can reverse the T-Arm so the Pen Holder rod is driven by the 41 Gear with the 30 Gear used as the Sliding Gear. This fun variation turns the pattern inside out by moving the loops inward.

The T-Arm is positioned at 9 on the rod and at 8 on the Pen Holder length.

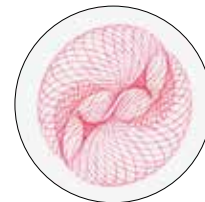


This Setup by the Numbers	
Drive Gear	41
Drive Gear	slot A
Sliding Gear	30
Sliding Gear	slot H
T-Arm	9
Pen Holder Length	8

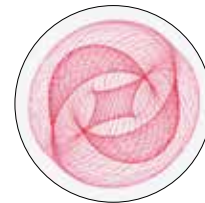


Variations

Any of the Prime Number Gears can be used in conjunction with any of the Composite Number Gears. Different combinations will result in very different patterns. The patterns below used the same Pen Holder setup as the pattern on page 10.



23 Drive Gear
30 Gear as Sliding Gear



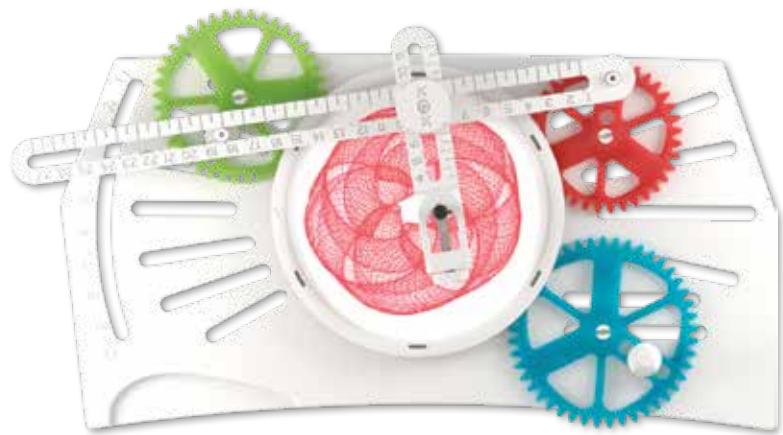
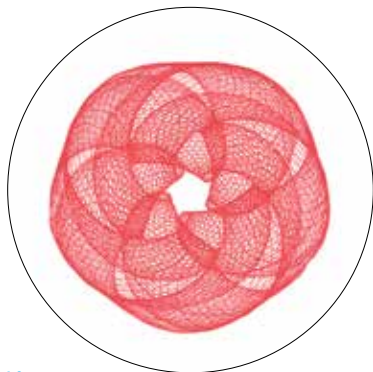
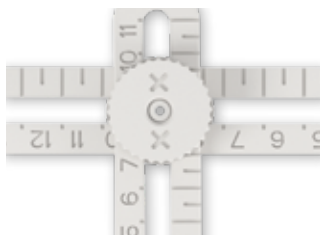
47 Drive Gear
30 Gear as Sliding Gear

Five Loop Patterns

Changing the 30 Gear to a 36 Gear makes 5 loop patterns

36 to 41 Setup

Change the 30 Gear to the 36 Gear. This will make a pattern with 5 loops.



This Setup by the Numbers	
Drive Gear	36
Drive Gear Slot	I
Sliding Gear	41
Sliding Gear Slot	A
T-Arm	9.5
Pen Holder Length	8.5

Five Loop Patterns Reversed

41 Gear is the Drive Gear with the 36 Gear as the Sliding Gear

41 to 36 Setup

This setup uses the same gears but reverses the Pen Holder.

The drive hole on the Pen Holder is connected to the 41 Gear with the 36 Gear as the Sliding Gear.



This Setup by the Numbers	
Drive Gear	41
Drive Gear Slot	A
Sliding Gear	36
Sliding Gear Slot	I
T-Arm	9.5
Pen Holder Length	8.5

Gear Chart and the Loops They Make

Why do some Gears create 3 loops while others create 12?

Composite Number Gears

The number on each gear represents the number of teeth it has. Composite Number Gears share a greatest common factor with the turntable and the resulting drawings will have a fixed number of loops.

Loops (Nodes)	Gear
2	30
3	40
4	45
5	36
10	42
12	25, 35
15	44
30	38

Prime Number Gears

Four gears have a prime number of teeth: 19, 23, 41 and 47. Very complex drawings can be created by combining these gears with gears that create repeating loops—the gears in the table on the left.

Prime Number Gears can also be used directly with the turntable to produce drawings with many loops.

NOTE: A prime number is a whole number whose only factors are 1 and itself. A factor is a whole number that can be divided evenly into another number. A composite number is a whole number that has two or more factors

Greatest Common Factor

You can calculate the number of loops a gear will make by finding the greatest common factor of the gear and the turntable, which has 60 teeth.

Let's say you want to find the number of loops a 45 tooth gear will make. Start by listing the prime factors of each number as shown below:

$$45 = 3 \times 3 \times 5$$

$$60 = 2 \times 2 \times 3 \times 5$$

You can see the common factors by aligning the numbers in the two rows like this:

$$45 = \quad \quad \quad 3 \times 5 \times 3$$

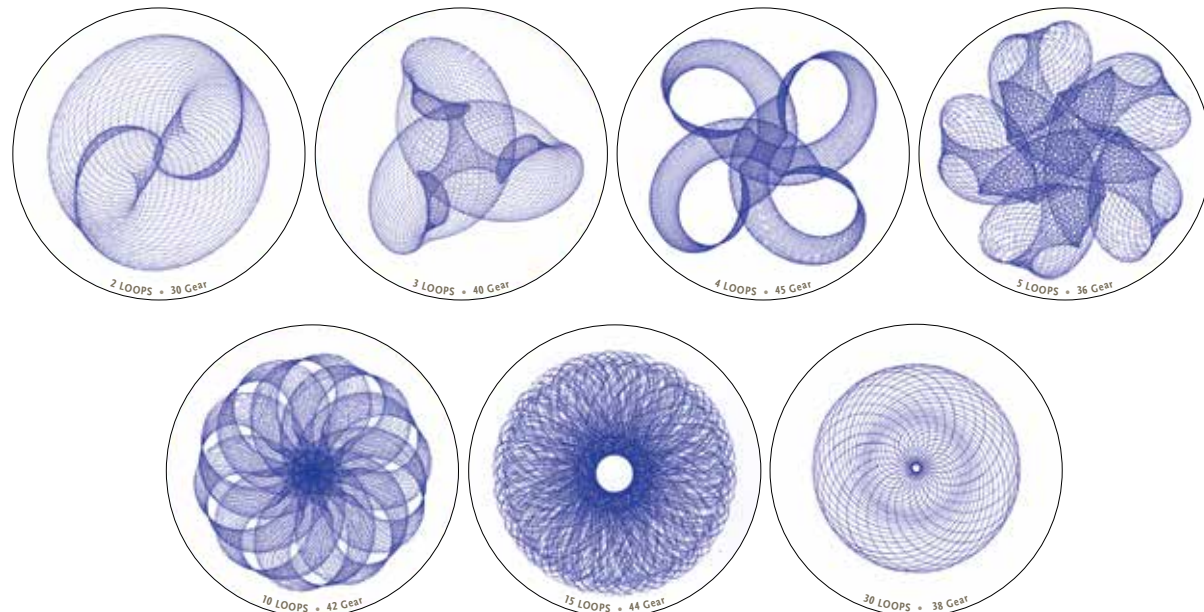
$$60 = 2 \times 2 \times 3 \times 5$$

$$15 = \quad \quad \quad 3 \times 5$$

The greatest common factor is 15 (3 x 5). Dividing the turntable (60) by the greatest common factor of 15 results in the number of loops in the drawing, which is 4.

About the Inventor

Joe Freedman lives and works in Portland, Oregon with his partner Ilisha Helfman. Together they make optical toys, paper pop-ups, and dollhouse miniatures. Joe started his career as a letterpress printer and book designer. His handmade books featured pulp paper paintings and beautiful letterpress typography. He has also designed hundreds of trade books and museum catalogs. Joe has created numerous drawing machines and is known for making the underlying math accessible. His epicycloid machines draw patterns in unique and unusual ways never before seen in toy drawing machines.



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