Meccano Twin-Elliptic Harmonograph

Model No. 7.31:

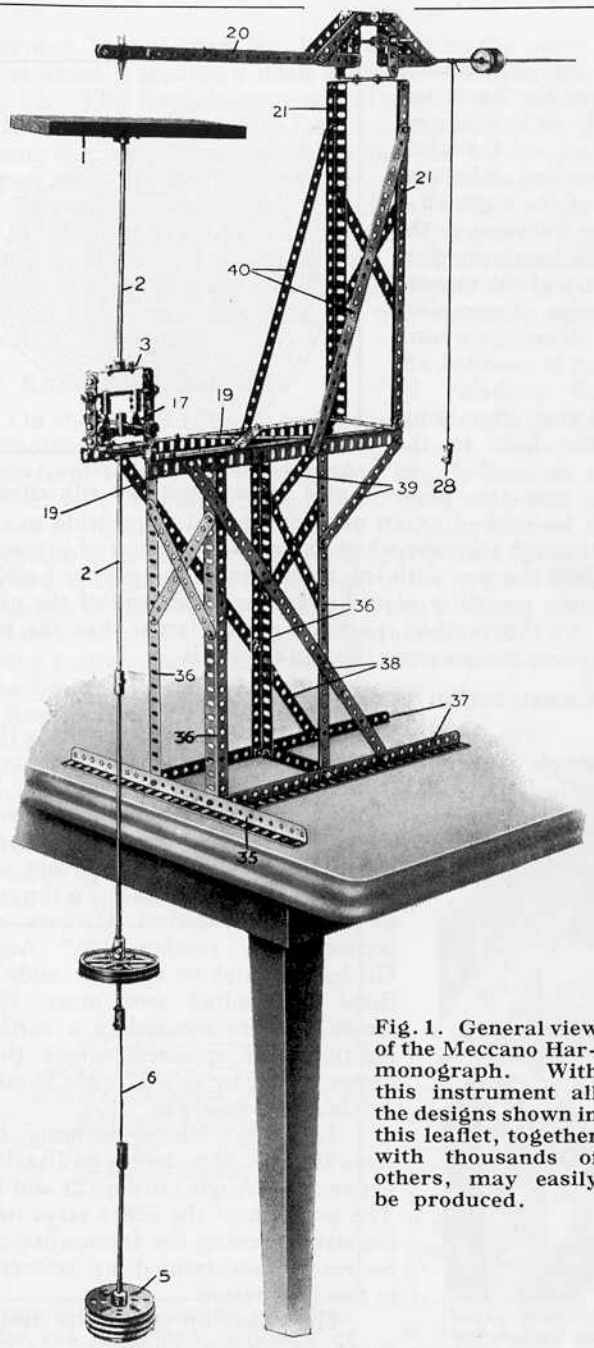


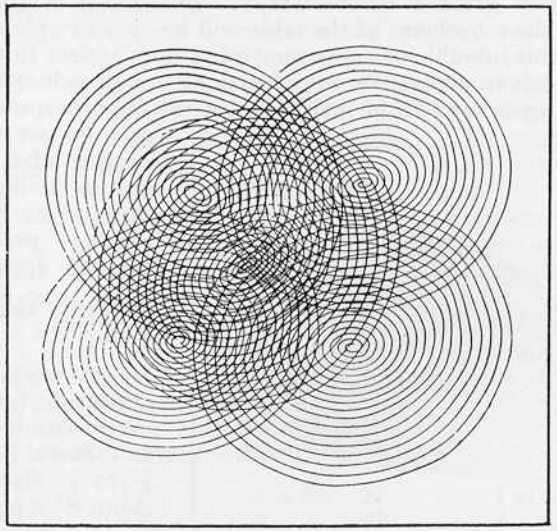
Fig. 1. General view of the Meccano Harmonograph. With this instrument all the designs shown in this leaflet, together with thousands of others, may easily be produced.

THE Meccano Harmonograph fulfils two functions. It forms a fascinating toy with which many pleasant hours may be passed by producing an innumerable variety of beautiful designs, and it is also a scientific instrument by means of which it is possible to record harmonic motions in a permanent visual form. Harmonic motion is a general term applied to a reciprocating motion like that of a piston or pendulum. The records obtained by means of an instrument of this kind are invaluable to the scientific investigator as a means of studying the laws of vibration, for the movements of a pendulum are vibrations just as much as are the rapid movements of the particles of a heated body.

There is something very thrilling in operating the Meccano model and speculating as to what form the design will take. The Meccano boy—and his friends and parents as well—will find abundant pleasure in watching the Harmonograph at work, producing thousands of fascinating and lovely patterns in endless succession.

In its earliest form the Harmonograph consisted of a heavy weight hung on the end of a cord and so arranged that when set in motion the weight was free to move in any direction according to the manner in which it was set swinging. A pointer attached to the weight traced in sand or other suitable material the path through which the weight travelled.

It was found that by varying the mass of the weight and altering the length of the cord by which it hung considerable difference could be produced in the design drawn by the pointers. It was also discovered that if instead of only one pendulum, two or more were employed and so arranged that their combined movements operated the same pencil or pointer the resultant designs became much more complex and beautiful. Based on the information gained from these early experiments it has been possible



A specimen Harmonograph design, obtained by superimposing five similar patterns.

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to construct harmonographs which will produce at will practically any type of design.

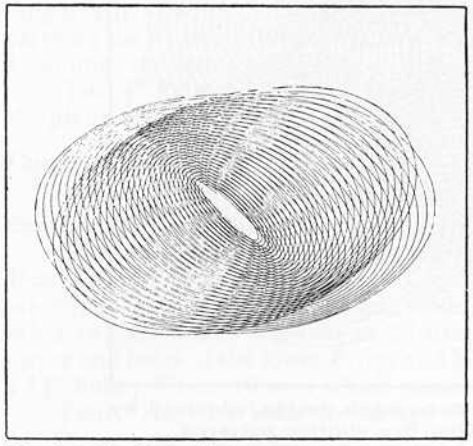
It may be thought that it is necessary to possess artistic skill in order to make beautiful designs such as are illustrated in this leaflet, but really it is so simple that even a child can obtain equally successful results. All that is necessary is to pin a sheet of white paper to the table of the harmonograph, fill the pen with ink—which by the way may be either black or coloured—and then set the pendulum rod and weights swinging.

How a Harmonograph Works

To produce the finest designs it is necessary to know something of how the instrument operates. Referring to Fig. 1, which is a general view of the Meccano Harmonograph, it will be seen that the table 1 is supported from a frame that is pivoted on knife edge bearings. Attached to the lower side of the frame is a primary weighted pendulum. A second pendulum is attached to the primary pendulum by means of a piece of cord, the whole thus forming a single compound pendulum.

The pen is held in a pivoted arm, the latter being provided with an arrangement of weights whereby the pressure of the pen on the table may be adjusted.

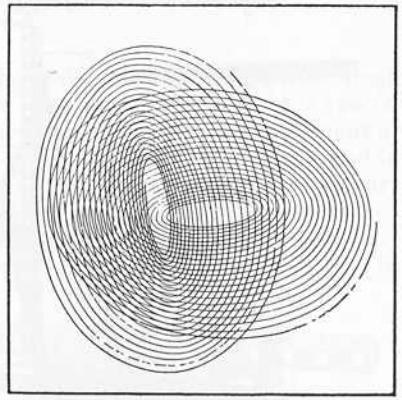
Owing to the knife-edge pivots the table is able to move in all directions quite freely. To set the instrument in operation the pendulum is given a steady swinging movement in any direction. When the secondary pendulum is given a different movement to that of the primary, the movement of the table will be very complex, and it is this "double or compound pendulum" effect that enables such an endless variety of designs to be produced. When one gets used to the instrument it will become quite easy to set the compound pendulum swinging in the correct manner to produce practically any predecided design.



Notice the beautiful watered-silk effect obtained in this simple Harmonograph design.

Making the Special Glass Pen

A special pen has been designed for use with the model and is made quite easily as follows. Secure a piece of $\frac{1}{8}$" or $\frac{1}{4}$" diameter glass tubing about 6" long. Hold this in a Bunsen or other flame until quite soft (see Fig. 4) then draw the ends of the tube slowly apart until only a very fine portion remains in the centre as shown in the illustration. Withdraw the glass from the flame and allow it to cool gradually (it is necessary to place the heated glass on a slightly warmed surface when cooling, otherwise the sudden contraction of the outer shell of the tube will produce fractures in the glass). When quite cold break the glass in two pieces at the centre of the tapered portion and hold the point of one piece in the flame again until the end is rounded off. It will probably be found that after doing this the hole in the point is sealed, in which case the point should be rubbed on an oilstone until it is possible to just blow through the tube when using a fair amount of pressure.



Another composite design, which also gives a watered-silk effect.

Load the pen with ink by means of the rubber bulb of a fountain pen filler placed over the upper end of the glass tube ; by this method, particles of dirt larger than the hole in the point cannot enter the pen to clog it.

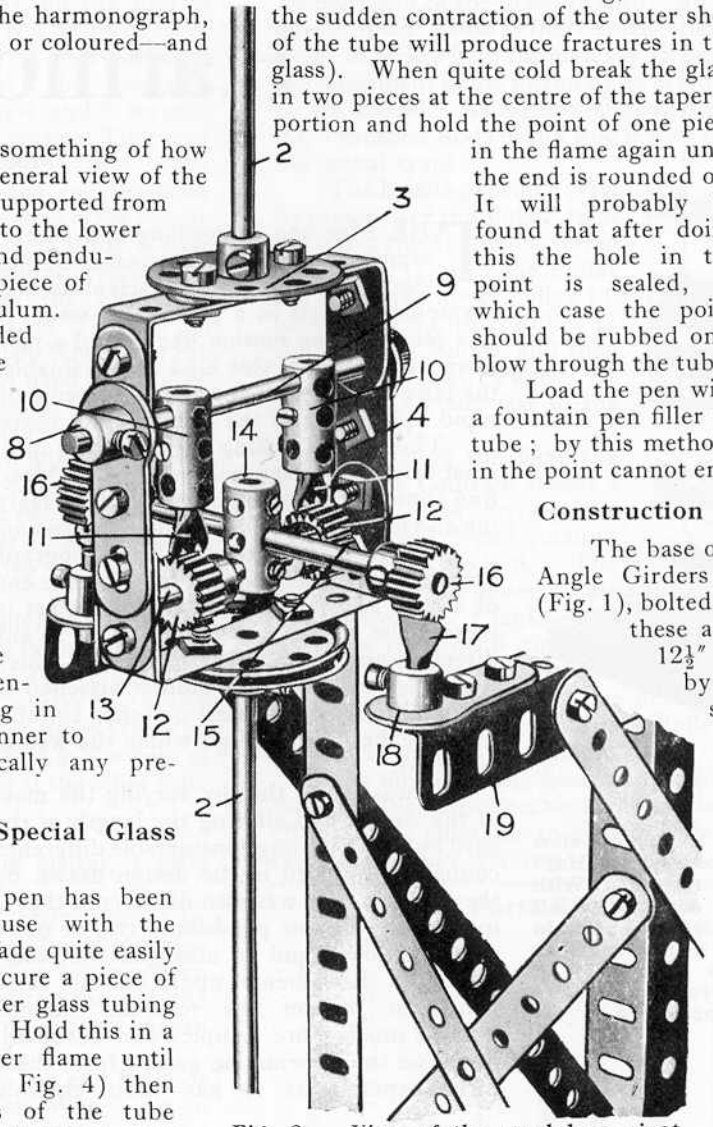


Fig. 2. View of the pendulum pivot frame, showing details of the knife edge bearings, etc.

Construction of the Framework

The base of the framework is built with two $12\frac{1}{2}$" Angle Girders 37 and one $12\frac{1}{2}$" Angle Girder 35 (Fig. 1), bolted together at right angles as shown. To these are bolted at vertical right angles four $12\frac{1}{2}$" Angle Girders 36, which are braced by four $5\frac{1}{2}$" Strips placed crosswise and secured to the Girders 36. To the tops of the four vertical Girders are secured two further $12\frac{1}{2}$" Angle Girders 19 and to the rear ends of these are bolted two more $12\frac{1}{2}$" Angle Girders secured in a vertical position and spanned across their upper ends by a $3\frac{1}{2}$"$\times\frac{1}{2}$" Double Angle Strip (see Fig. 3).

The $12\frac{1}{2}$" Strips forming the stays 40 (Fig. 1) may now be attached between the Angle Girders 21 and 19. The position of the other stays used for strengthening the framework can be readily ascertained by reference to the illustration.

The paper on which the design is to be drawn is placed on the

Designing Table 1 (part No. 107) carried on the upper 8″ Rod 2, to the lower end of which is secured a Bush Wheel 3, which, in turn, is bolted to a frame 4 (Fig. 2). This frame is composed of two 2½″ × 1″ Double Angle Strips and two 2½″ Strips bolted together to form a square as shown. Outside the 2½″ Strips forming the vertical sides of the square are bolted two Cranks 8 that provide support for a 3½″ Rod 9 passed through and secured in the Crank bosses.

The lower portion of the pendulum 2 (Fig. 1) consists of two 8″ Rods and an 11½″ Rod, and in order to obtain a "compound" movement of the table 1, the lower 8″ Rod is coupled flexibly to the remainder of the pendulum by a piece of string 6. This arrangement forms in reality two pendulums compounded into one. The weight 5 may be made up with several 3″ Pulley Wheels or other parts.

The Knife-edge Bearings

On the Rod 9 (Fig. 2) are mounted Couplings 10, in the longitudinal holes of which are secured two Centre Forks. These form knife-edge bearings and engage between the teeth of two ½″ Pinions 12 fixed on a 2″ Rod 13, which is secured in the end holes of a centre Coupling 14 that also carries in its centre transverse hole a 3½″ Rod 15, mounted at right-angles to the Rod 13. On the outer ends of the Rod 15 are carried two further ½″ Pinions 16 which rest upon Centre Forks 17 forming further knife-edge bearings and secured in the bosses of Cranks 18 bolted to the ends of the Angle Girders 19 (see also Fig. 1). As a result of this arrangement the frame 4 is balanced and free to swing in any direction about the knife-edge bearings 17 and 11.

The ink pen is held between the ends of the two 12½″ Strips 20 (Fig. 1) that form an arm which is supported pivotally as shown in Fig. 3. At the top of the vertical frame 21 (Fig. 1) is a 2½″ × 1½″ Double Angle Strip to which two Cranks 22 (Fig. 3) are secured. A Rod 23 mounted in the bosses of these Cranks carries two ½″ Pinions 24. The Strips 20 are coupled to the yoke formed by 3″ and 2″ Strips and 2½″ × ½″ Double Angle Strips as shown, in the rear of which is fixed a Rod 26 carrying a "balance weight" 27 composed of four 1″ fast Pulleys. A further weight 28 (Fig. 1) consisting of a Coupling is suspended from the Rod 26 by the cord 29.

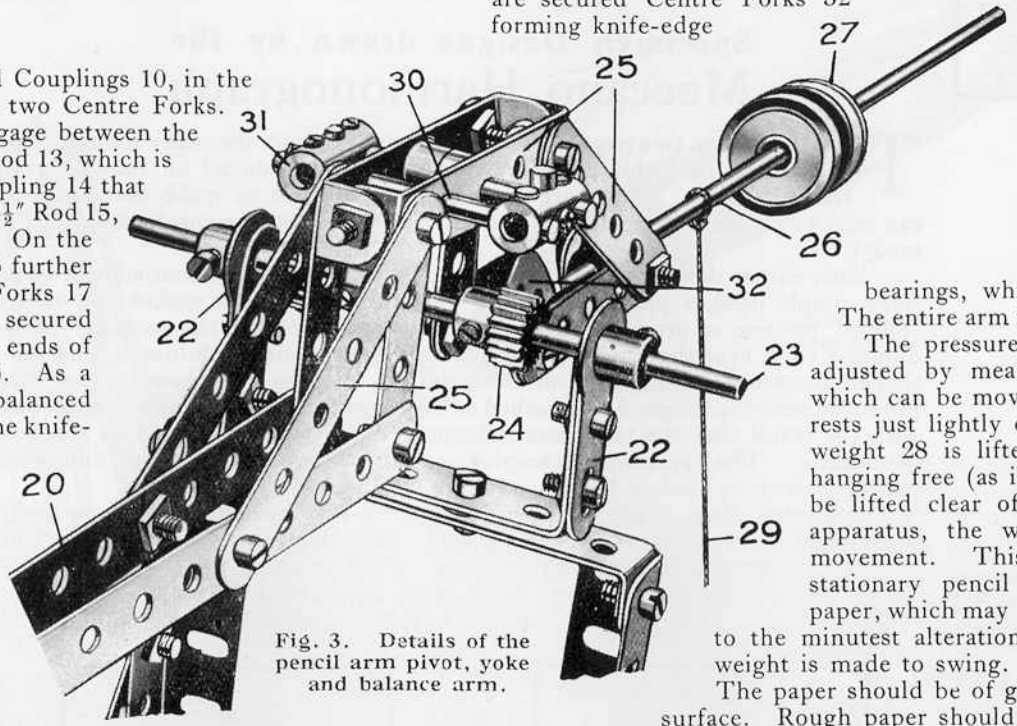


Fig. 3. Details of the pencil arm pivot, yoke and balance arm.

The Rod 26 is secured by passing it through Double Brackets that are held between the 3″ and 2″ Strips 25 forming the sides of the yoke. Collars placed on the Rod against the faces of the Brackets serve to hold it in position.

In the upper 2½″ × ½″ Double Angle Strips forming the yoke 25 are inserted two Rods 30 carrying Couplings 31 and in the centre holes of these Couplings are secured Centre Forks 32 forming knife-edge bearings, which engage the ½″ Pinions 24. The entire arm is free to swing about this point.

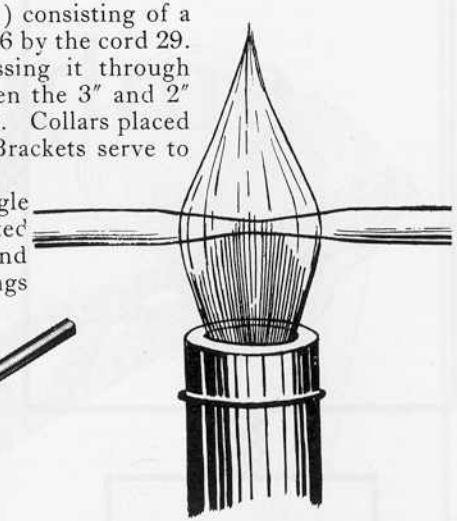
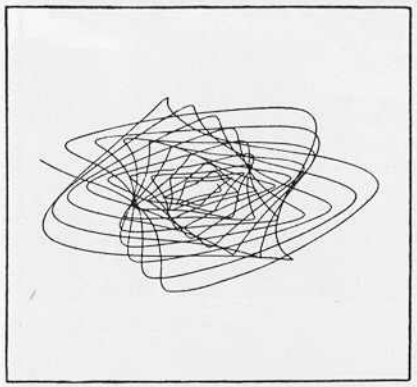


Fig. 4. Showing method of drawing the glass pen point.

The pressure of the pencil on the paper is adjusted by means of the balance weight 27, which can be moved along the Rod until the pen rests just lightly on the table 1, when the extra weight 28 is lifted. When the weight 28 is hanging free (as in Fig. 1) the pen point should be lifted clear of the table. To operate the apparatus, the weight 5 is given a swinging movement. This oscillates the table 1 and the stationary pencil describes a diagram on the paper, which may be varied indefinitely according to the minutest alteration in the direction in which the weight is made to swing.

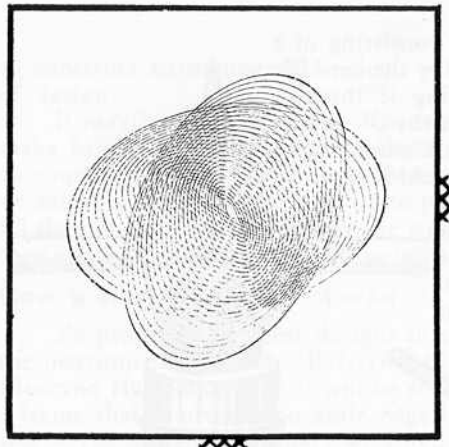
The paper should be of good quality and afford an even surface. Rough paper should be avoided as also paper with a highly finished surface such as "art" paper, as it is too absorbent. Excellent results are obtained on Bristol Board.

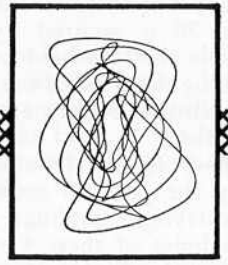


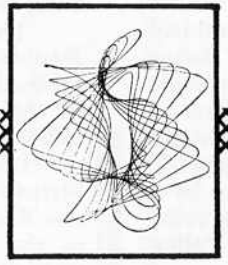
An intricate little design produced under the combined influence of the two pendulums.

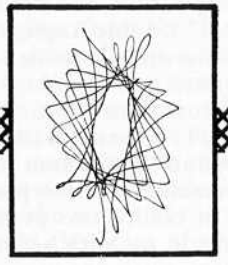
List of Parts required.

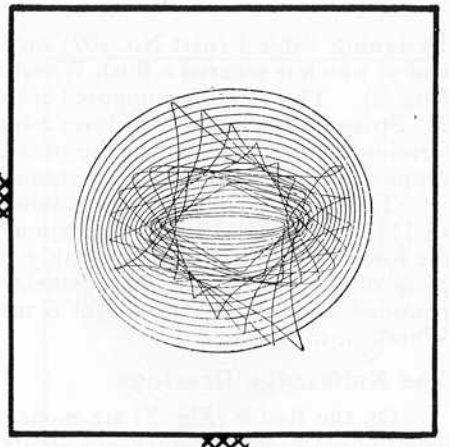
8	of No.	1	2	of No.	12	3	of No.	22	1	of No.	48b
10	,,	2	2	,,	13	2	,,	22a	4	,,	59
3	,,	3	2	,,	13a	2	,,	24	6	,,	62
4	,,	4	1	,,	14	6	,,	26	9	,,	63
6	,,	5	3	,,	16	86	,,	37	6	,,	65
4	,,	6	2	,,	16a	2	,,	37a	1	,,	107
11	,,	7	1	,,	17	2	,,	38	2	,,	111
5	,,	11	1	,,	21	3	,,	46			











Specimen Designs drawn by the
Meccano Harmonograph

THE designs on this page are selected at random from the many thousands of varied and beautiful patterns which may be produced on the Meccano Harmonograph. They are so delightfully simple to make that any boy can start to produce them immediately he has completed the construction of the model.

Each corner design is a composite one ; that is to say, it consists of two or three simple designs placed one upon the other. Each one makes use of the "spiral" pattern, to produce which it is necessary to remove the secondary pendulum 5 (Fig. 1) so that the table is influenced by only one pendulum. The star-shaped pattern superimposed on the spiral in the top right-hand corner was produced with the weight 5 re-attached to the upper portion or primary pendulum, with the result that the table was influenced by the vibrations of two separate pendulums. The remaining examples are all "compound" designs, and were produced with the aid of both pendulums and weights.

It is interesting to note the beautiful watered-silk appearance of the design in the lower right-hand corner. It was formed by superimposing two single pendulum designs, the paper having been moved very slightly after finishing the first and before drawing the second design. The same effect is obtained in the examples on page 2.