

# A Model Harmonograph

## Build this fine Designing Machine

THE complete Harmonograph is seen in Fig. 1. It consists of a pendulum that carries a table at its upper end and is mounted pivotally in such a manner that it is free to swing in any direction. When the pendulum is set in motion a ball pen suspended above the table traces out a design on a piece of paper attached to the table. The addition of a second pendulum, flexibly attached to the lower end of the first one, makes the designs produced by the machine more intricate.

The base of the Harmonograph is a box-shaped structure built by joining the ends of two  $12\frac{1}{2}$ " Angle Girders by  $5\frac{1}{2}$ " Strips. Four  $2\frac{1}{2}$ " Strips are bolted vertically to the ends of the Angle Girders; the upper ends of the forward pair are connected by a  $5\frac{1}{2}$ "  $\times$   $2\frac{1}{2}$ " Flanged Plate 1 and those of the rear pair by Angle Brackets and a  $5\frac{1}{2}$ " Strip. Two  $12\frac{1}{2}$ " Strips are also bolted between the shorter flanges of Plate 1 and the rear  $2\frac{1}{2}$ " Strips.

Each side of the base consists of two  $4\frac{1}{2}$ "  $\times$   $2\frac{1}{2}$ " Flexible Plates and one  $2\frac{1}{2}$ "  $\times$   $2\frac{1}{2}$ " Flexible Plate, which are bolted between the  $12\frac{1}{2}$ " Strips and the Angle Girders. The top of the base consists of a  $4\frac{1}{2}$ "  $\times$   $2\frac{1}{2}$ ", a  $2\frac{1}{2}$ "  $\times$   $2\frac{1}{2}$ " Flexible Plate and a  $2\frac{1}{2}$ "  $\times$   $1\frac{1}{2}$ " Flexible Plate, together with one  $5\frac{1}{2}$ "  $\times$   $1\frac{1}{2}$ " Flexible Plate 2. A  $5\frac{1}{2}$ " Angle Girder is bolted to Angle Brackets that are fixed in the 6th from end holes in the  $12\frac{1}{2}$ " Strips of the base. The Flexible Plates are arranged as shown in the illustration and are supported at the sides of the base by Angle Brackets. A  $9\frac{1}{2}$ " Strip 3, bolted down the centre of the base, strengthens the structure.

Two  $12\frac{1}{2}$ " Angle Girders are bolted at one end to a  $5\frac{1}{2}$ " Strip 4 fixed to the base in the position shown. They are bolted also to the Flanged Plate 1, and to them two Flat Trunnions 6 and 7 are fastened, each

bolt carrying two Washers on its shank between the Flat Trunnion and Angle Girder. Reversed Angle Brackets, one of which is shown at 8, are then bolted to the inner sides of the Flat Trunnions, and through the free end hole of each Bracket a bolt is fastened to form the supports for the swivel frame 9, which is constructed

by joining two  $2\frac{1}{2}$ "  $\times$   $\frac{1}{2}$ " Double Angle Strips with  $1\frac{1}{2}$ " Strips. Two

3" Screwed Rods passed through the centre holes of the  $1\frac{1}{2}$ " Strips are

screwed into the boss of a 1" Pulley 10,

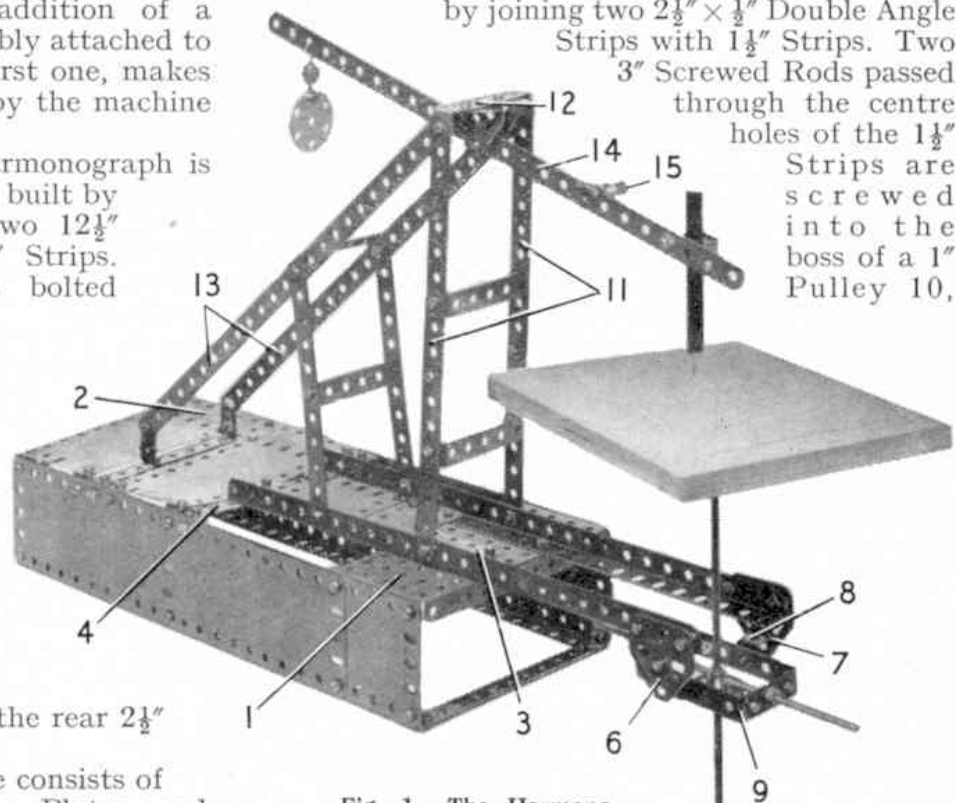


Fig. 1. The Harmonograph, a machine that produces fascinating designs by means of a swinging pendulum.

which holds a  $11\frac{1}{2}$ " Rod in its boss. This Rod is joined at its lower end to the pendulum by a Coupling.

The pendulum consists of three or four  $11\frac{1}{2}$ " Rods coupled end to end, and carries a bob weight, which can be made up from any convenient parts or pieces of metal available. The weight should be about 1 lb.

The designs are drawn on sheets of paper pinned to the table, which is of wood and is approx. 6 in. square. A Bush Wheel is

screwed to its underside and this is fixed on the end of the  $11\frac{1}{2}$ " Rod held in Pulley 10. If desired a Hinged Flat Plate can be used as a table by fastening it to the Bush Wheel by two Double Brackets. The paper used should be of good quality and have an even surface. Rough paper, and also paper with a highly finished surface, should not be used. Ordinary writing paper will do.

The support for the pen arm consists of two compound strips 11, each comprising two  $5\frac{1}{2}$ " Strips overlapping four holes, which are secured to the  $12\frac{1}{2}$ " Girders on the top of the base. The Strips 11 are joined at their upper ends by a Double Angle Strip 12, the bolts holding also two  $12\frac{1}{2}$ " Strips 13. The lower ends of the  $12\frac{1}{2}$ " Strips are fastened to Fishplates bolted to the lugs of a further  $2\frac{1}{2} \times \frac{1}{2}$ " Double Angle Strip that is fixed to the base of the model. The pen arm 14 is a  $12\frac{1}{2}$ " Strip and is pivotally mounted on a lock-nutted  $\frac{3}{4}$ " Bolt to Trunnions bolted underneath the Double Angle Strip 12. Washers and nuts are used to space the arm centrally on the Bolt. It is best to use a ball pen and this can be held in a Double Bent Strip fixed to the pen arm as shown. A lock-nutted Bolt can be used to grip the pen lightly and hold it in place.

The pressure of the pen on the paper can be regulated by adjusting a balance weight 15, which is moved along the arm until the pen just rests

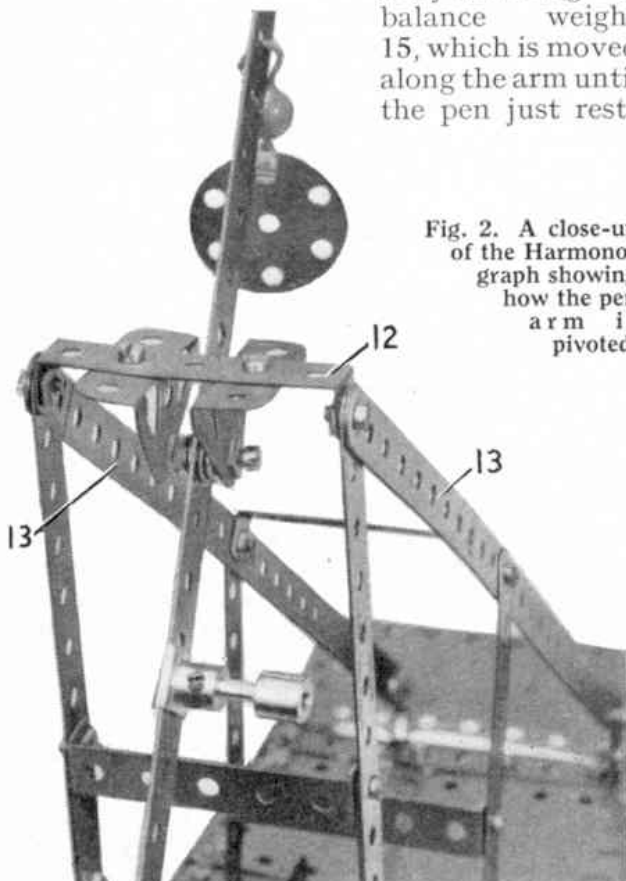


Fig. 2. A close-up of the Harmonograph showing how the pen arm is pivoted.

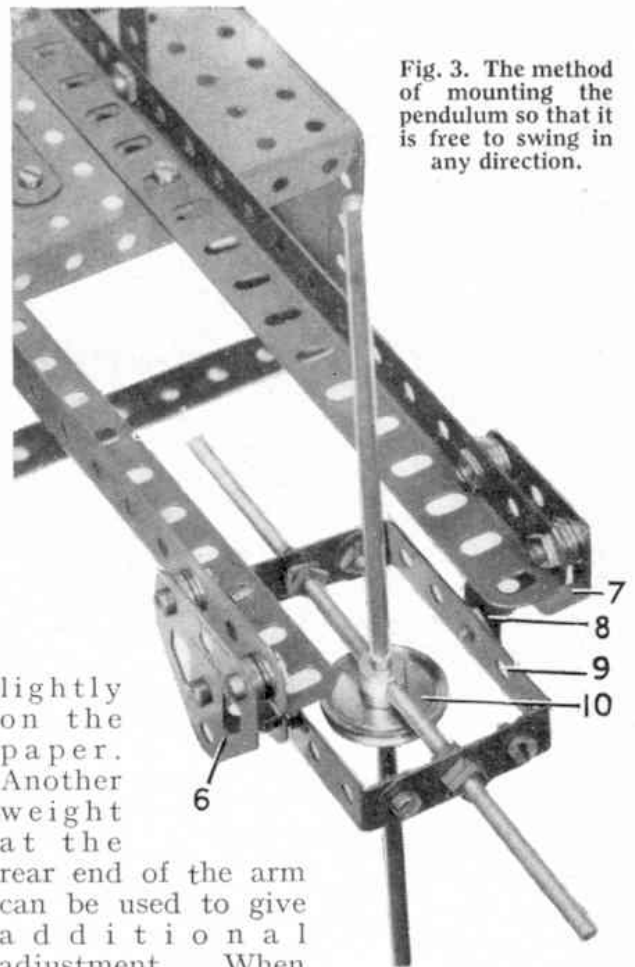


Fig. 3. The method of mounting the pendulum so that it is free to swing in any direction.

lightly on the paper. Another weight at the rear end of the arm can be used to give an additional adjustment. When the model is completed some very

interesting effects can be obtained by superimposing one design on another, and by using a compound pendulum designs of a more intricate type can be produced. A compound pendulum is made simply by making up a weight, such as a quantity of nuts and bolts enclosed in two Boiler Ends and then connecting the extra weight to the end of the main pendulum by a piece of string about 6" in length. Also by adding extra weights to the pendulum the latter will continue to swing for a longer period. Another way of introducing variety into the designs is to vary the weights on the two pendulums, increasing the load on one and slightly decreasing that on the other.

Parts required to build the Harmonograph: 5 of No. 1; 1 of No. 1a; 10 of No. 2; 4 of No. 5; 2 of No. 6a; 4 of No. 8; 3 of No. 10; 9 of No. 12; 4 of No. 13; 1 of No. 22; 1 of No. 24; 1 of No. 24c; 95 of No. 37a; 89 of No. 37b; 14 of No. 38; 1 of No. 45; 8 of No. 48a; 1 of No. 50; 1 of No. 52; 1 of No. 57c; 1 of No. 63; 2 of No. 80; 1 of No. 111a; 6 of No. 111c; 2 of No. 125; 2 of No. 126; 2 of No. 126a; 1 of No. 173a; 1 of No. 188; 1 of No. 189; 4 of No. 190; 2 of No. 191; 4 of No. 192.