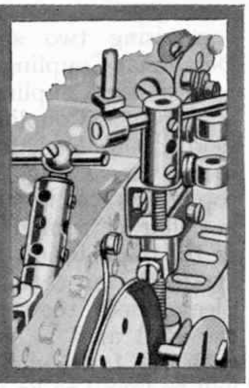
HOW TO USE Meccano Parts

II. GIRDERS (CLASS B)



For the purposes of this series of articles we have grouped all the Meccano parts into two main sections, termed the Structura and Mechanical Sections, and these sections have been further divided into a number of separate classes. The complete grouping was published in last month's "M.M." as follows. Structural Section: Class A, Strips; Class B, Girders; Class C, Brackets, Trunnions, etc.; Class D, Plates, Boilers, etc.; Class E, Nuts and Bolts, Tools, and Literature. Mechanical Section: Class M, Rods, Cranks and Couplings; Class N, Wheels, Pulleys, Bearings, etc.; Class O, Gears and Toothed Parts; Class P, Special Accessories; Class Q, Miscellaneous Mechanical parts. In addition to these classes, the following should be added to the Mechanical Section: Class T, Electrical Parts; Class X, Motors, Accumulators, etc.

MECCANO Girders play a very important part in Meccano engineering. They give great rigidity to any structure in which they are incorporated and serve admirably as bearings for shafting. A few Girders placed together with proper care and braced by one or two Strips or Rods will form a structure capable of supporting a man's weight, without the slightest disruption.

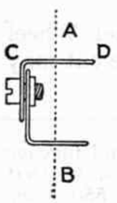


Fig. 1

The secret of the strength of the Meccano Angle Girders is found in the right-angle formation of their flanges, which enables them to withstand bending stresses in any direction. This will become more clear from the following:—

If a wooden beam is mounted so that both ends only are supported, as in Fig. 4, and a heavy load is placed upon it, it will naturally bend. When this happens it is obvious that the upper part of the beam will be in compression and the lower part in tension. These compressive and tensional forces exert a maximum effect along the outer edges (AB, CD in the sketch) of the beam, and decrease toward the centre, in proportion with their distance from the centre, so that there is a zone between the upper and lower portions where the material of the beam is neither in compression nor in tension. It will be obvious that the more material there is above and below the neutral axis, as this zone is termed, the stronger will be the beam. Hence it will be clear that the strength of a beam is determined by its depth rather than by its width.

If a Meccano Strip is laid flat across the two supports shown in Fig. 4 and a small load placed upon it, it will bend considerably, since the areas in compression and tension will be very small, but if the Strip is placed on edge it will withstand a very much greater load. Now a single Angle Girder combines the property of two ordinary Strips secured rigidly at right angles along their lengths; hence its great rigidity. When a Meccano boy runs short of Girders he often improvises by placing two Strips together lengthwise and bolting them at right angles by means of Angle Brackets.

List of Parts in Class B: Girders

Angle Girders (L-Section, ½″ × ⅝″)

No.			s.	d.	No.			s.	d.
7.	24½″ long	... each	0	8	9a.	4½″ long	... ½ doz.	0	10
7a.	18½″ „	... „	0	6	9b.	3½″ „	... „	0	8
8.	12½″ „	... ½ doz.	1	9	9c.	3″ „	... „	0	8
8a.	9½″ „	... „	1	3	9d.	2½″ „	... „	0	7
8b.	7½″ „	... „	1	2	9e.	2″ „	... „	0	6
9.	5½″ „	... „	1	0	9f.	1½″ „	... „	0	6

Braced Girders (2″ deep)

No.			s.	d.	No.			s.	d.
97.	3½″ long	... ½ doz.	0	9	99a.	9½″ long	... ½ doz.	2	0
97a.	3″ „	... „	0	8	99b.	7½″ „	... „	2	0
98.	2½″ „	... „	0	8	100.	5½″ „	... „	1	0
99.	12½″ „	... „	2	6	100a.	4½″ „	... „	0	10

Flat Girders ($\frac{17}{16}$″ wide)

No.			s.	d.	No.			s.	d.
103.	5½″ long	... ½ doz.	0	10	103e.	3″ long	... ½ doz.	0	6
103a.	9½″ „	... „	1	2	103f.	2½″ „	... „	0	5
103b.	12½″ „	... „	1	3	103g.	2″ „	... „	0	4
103c.	4½″ „	... „	0	9	103h.	1½″ „	... „	0	4
103d.	3½″ „	... „	0	7	103k.	7½″ „	... „	1	0

No.			s.	d.
No. 113.	Girder Frames, 5¼″ long	... . each	0	3
No. 143.	Circular Girders, L-section, 5½″ diam.	... „	1	0

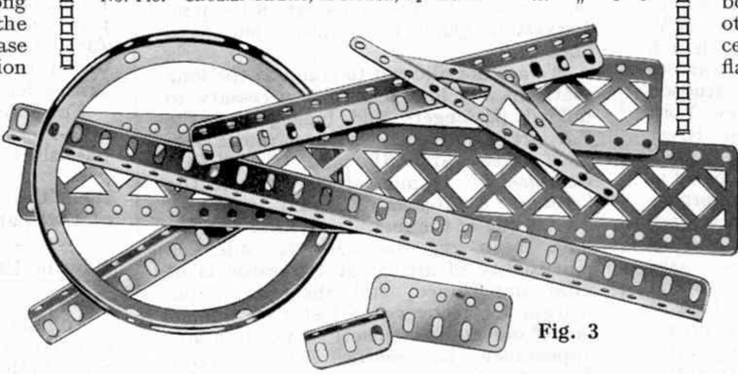


Fig. 3

L-section Angle Girders (Nos. 7 to 9f)

The Meccano Angle Girders, parts Nos. 7-9f, differ only in their lengths. Each is perforated with round holes in one flange and elongated holes in the other. The object of the elongated holes is to provide the "play" that often is necessary when bolting a Girder to other parts. The value of this play is illustrated in Figs. 1 and 2, which represent sections of two Angle Girders that are bolted together to form channel-section girders. Fig. 1 shows the right method of securing the Girders and Fig. 2 the wrong method. In the former the narrow flange of one Girder is bolted to the broad flange of the other, with the result that the centres of the holes in the remaining flanges are exactly opposite, whereas the centres of the corresponding holes in Fig. 2 are not in line.

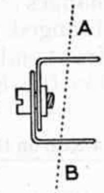


Fig. 2

The importance of thus bolting the Girders correctly together will become at once apparent when it is desired to journal a Rod through the flanges of a channel girder of this type. Of course to journal the Rod in a girder of the form shown in Fig. 1, it will be necessary to bolt a short Strip to the flange CD, so that one of its round holes may be used instead of the elongated hole of the Girder to receive the Rod.

How Girders are Designed

All Meccano boys will know that girders are of various shapes, but it may not be altogether clear to some why this should be so. It might be thought that if a girder is to be placed across two supports as in Fig. 4 and used to support a heavy compressive force, it should be of a rectangular shape. But a rectangular shape is not always the strongest form, weight for weight. It has already been pointed out that the compressive and tensional forces to which the

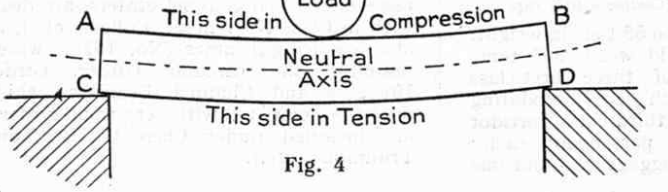


Fig. 4

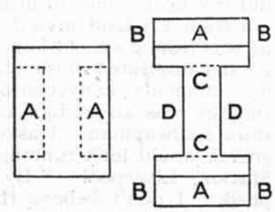


Fig. 5

girder is subjected diminish towards the centre, or neutral axis. Hence if a rectangular girder is used to withstand a bending stress a good deal of material would be subjected to comparatively little strain. Fig. 5 shows rectangular and I-shaped girders having the same sectional area. The I–girder would be stronger than the other, for it is deeper and has a large proportion of its mass concentrated at the points A, where the stresses are greatest. In the rectangular girder the material corresponding with the portions A occupies the positions indicated, where it is subjected to comparatively little compressive or tensional force.

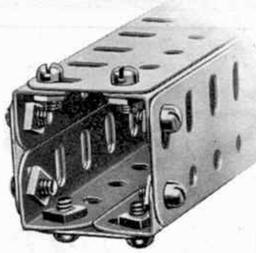


Fig. 6

The parts BB of the I–girder are known as the " flanges " and the vertical part CC is called the " web." In practice the shape of the I–girder shown would be modified still further in order to make the best possible use of the material of which it is composed.

As a rule, I–girders designed for ordinary purposes, such as railway lines, etc., are rolled from the solid, but if they are required to be of exceptional size or to withstand exceptional loads, as may be the case in bridge-building, they are sometimes built up from a number of steel plates or smaller girders. Similarly, in Meccano engineering, it is possible to build up girders of this shape and of almost any size. A typical Meccano I–girder is shown in Fig. 7. It consists of four Angle Girders bolted to a Flat Girder, which forms the web.

It will be seen that the I–girder resembles two channel girders bolted together. A simple built-up channel girder, consisting of two Angle Girders connected together by Flat Girders or by Flat Brackets, is illustrated in Fig. 11. It will be found extremely useful in building up large structures.

Figs. 10 and 12 illustrate different types of built-up girders that are capable of withstanding tremendous bending stresses. The jib of the Meccano Stiff Leg Derrick (model No. 7.9, Special Instruction Leaflet No. 6) which has to withstand both bending and compressive forces, consists of Angle Girders bolted together in the formation shown in Fig. 10. Fig. 6 shows a built-up rectangular girder, consisting of four Angle Girders connected together by Flat Girders, which form the four sides. A girder of this type is best suited for use as a supporting column or pillar, for it will withstand very great compressive force.

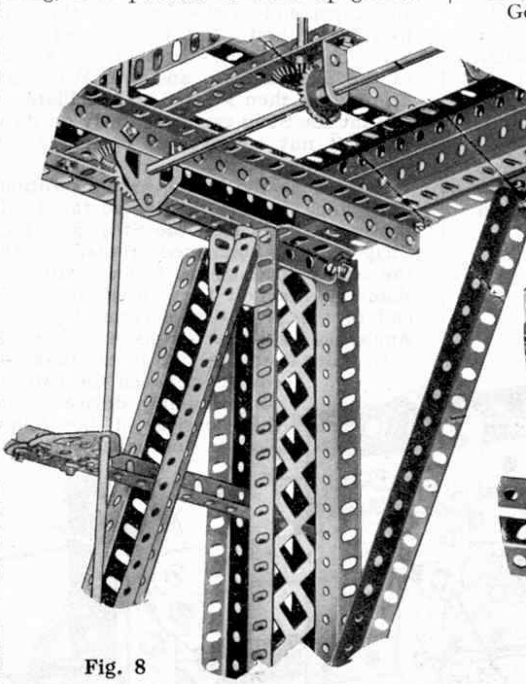


Fig. 8

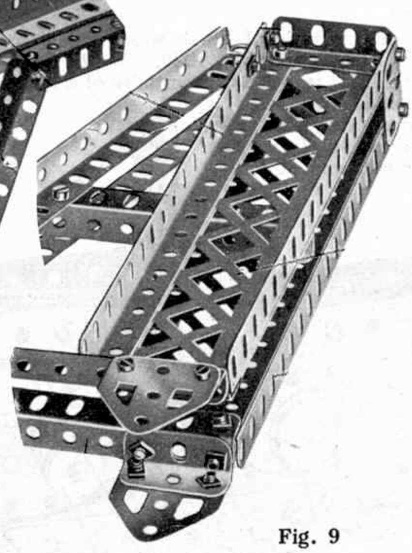


Fig. 9

Two excellent examples of Meccano construction are illustrated in Figs. 8 and 9, the subjects being sections of the Giant Blocksetting Crane (Special Instruction Leaflet No. 4). Fig. 8 shows a portion of the travelling gantry, viewed from underneath, while Fig. 9 is a detail view of one of the four columns that support the gantry. It will be noticed that the upper horizontal girders, which have to withstand considerable bending stresses, are of the " I " type, similar to that shown in Fig. 7 but larger. The supporting columns are in reality large rectangular girders; note the use of Braced Girders, which form two sides of the rectangle and serve to strengthen the corner Angle Girders.

Braced and Flat Girders

The Meccano Braced Girders (parts Nos. 97–100A) are not only very useful in building large structures, but are also very ornamental. They consist, in effect, of two parallel strips placed so that the opposite holes are 1½″ between centres, and connected together by a series of diagonal ties and struts. They are

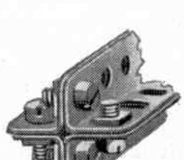


Fig. 10

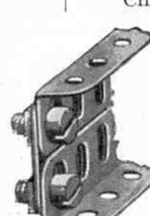


Fig. 11

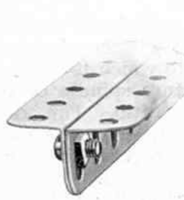


Fig. 12

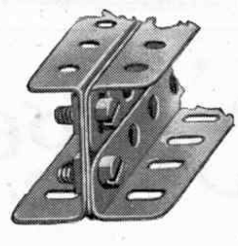


Fig. 7

beautifully made, the perforations being cleanly cut and rounded off so that there is no roughness or sharp edges. Until quite recently the parallel strips were left unconnected at the ends, but all Braced Girders now being made are finished off at the ends by a strip of metal at right angles to the sides, as will be seen in Fig. 3. This of course is a great improvement, as each Braced Girder now forms a complete unit in itself.

When connecting two Braced Girders together by overlapping, they should, wherever possible, be overlapped an odd number of holes, so that the diagonals coincide. If they overlap an even number of holes the diagonals of one Girder appear between those of the other, and the result is not so neat or realistic. The uses of Braced Girders will be obvious and a detailed description of them is not necessary therefore.

Flat Girders (parts Nos. 103–103K) are used principally in connection with Angle Girders in building up large girders. Several of their uses in this connection have already been mentioned (see Figs. 6, 7 and 11). In appearance they resemble an Angle Girder flattened out, and like the latter, they are perforated with one row of round holes and one row of elongated holes.

Good use of Flat Girders is made in various parts of the Meccano Dragline (Special Instruction Leaflet No. 27). For example, each of the four-wheeled bogies upon which this model runs, consists primarily of two 3½″ Flat Girders connected together by Double Brackets in such a way that their round holes can be used as bearings for the wheel axles and gearing, etc.

An interesting demonstration of the value of the elongated holes in the Meccano Girders will also be found in this model. The compensating beam, which is pivoted at a central point to the travelling base and is mounted across the rear pair of bogies, consists of an I–shaped girder similar to that shown in Fig. 7. Since the strain on this girder is at a maximum at its centre and diminishes towards the ends, in practice it is made deeper at the centre than at the ends, and this shape has been reproduced very closely in the Meccano model, owing to the fact that the play allowed by the elongated holes enables the lower flanges of the I–girder to be placed on a slant.

Girder Frames and Circular Girders

Part No. 113, Girder Frame, may be likened to a large Trunnion. It consists of a strip perforated with eleven holes, at the centre of which, and at right-angles to it, is a piece 1¼″ long supported by two diagonals. The part is clearly shown in Fig. 3. It is particularly useful for bolting to the sides of Meccano wagons, etc., to form bearings for the axles, and it can be used to form journal bearings in many other types of model. It also has a certain ornamental value, as is shown by the Meccano model Flyboats (Special Instruction Leaflet No. 33). In both the Single and Double Flyboats, Girder Frames are used as finishing pieces for the vertical A-frames which support the large revolving wheels.

Circular Girders (No. 143) prove useful wherever it is required to build a rigid circular structure. For example, two or more of these parts may be used as the " ribs " of a Meccano built-up boiler, a series of Strips being bolted round their circumference. (Incidentally, Hub Discs, part No. 118, could be employed equally well for this purpose, but these parts are included under Class N: Wheels, Pulleys, etc.)

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comprising two short Rods joined together by an Octagonal Coupling. A Rod is held in the transverse bore of the Coupling and carries at its outer extremity a Universal Coupling, in the other portion of which is held a short Rod that passes upward through the centre of the tube 7 (Fig. 2). The top of this Rod is fitted with a Collar or similar part to fit the diameter of the tube. If the latter consists of a Sleeve Piece, the top end of the Rod may be equipped with a $\frac{1}{2}''$ fast Pulley, which will be found to be a sliding fit in the bore of the Sleeve Piece. The specimen to be cut is retained in place on the top of the plunger by means of a small quantity of paraffin wax and lard, etc.

The method by which the slicing motion is given to the razor blade is very ingenious. A sliding frame comprising two $5\frac{1}{2}''$ Angle Girders braced by $2\frac{1}{2}''$ and $3''$ Strips, slides on the up-turned flanges of the $7\frac{1}{2}''$ Girders that are bolted to the $5\frac{1}{2}'' \times 2\frac{1}{2}''$ Flanged Plates, and two $1''$ Gears are mounted on the front end of the sliding frame as shown in the illustrations. On the Rod of the far $1''$ Gear in Fig. 1; a $\frac{3}{4}''$ Pinion is secured, and meshes with a portion of a Rack Strip 6 (Fig. 2) attached to a fixed portion of the frame of the model. In engagement with the $1''$ Gears are two Rack Strips 5 bolted face to face with the razor blade 4 clamped between them. They are held in mesh with the Gears by means of the Strips 8 pressing down on the upper one and a Spring attached to the lower one and to the sliding frame.

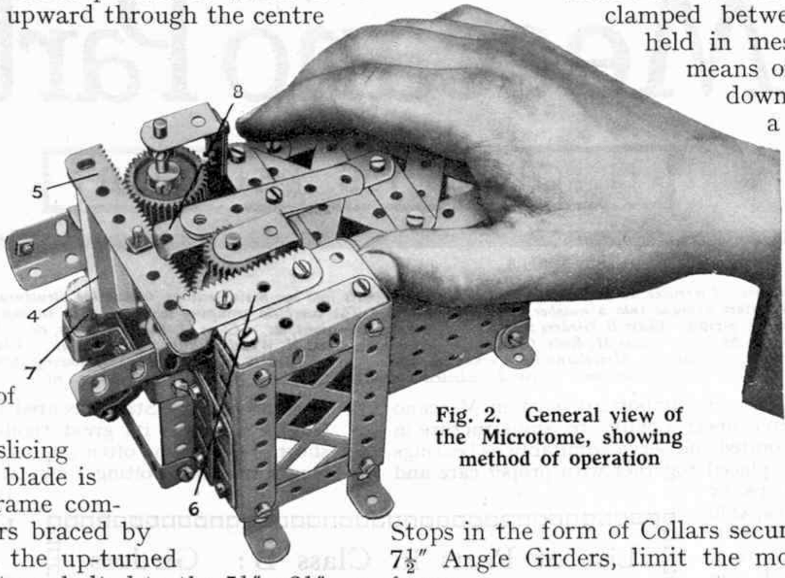

Fig. 2. General view of the Microtome, showing method of operation

When the frame is moved forward, the blade moves across the frame laterally at the same time, owing to motion imparted to the $\frac{3}{4}''$ Pinion by the Rack Strip 6. Thus a perfectly clean cut is given to the specimen. Stops in the form of Collars secured to either end of the $7\frac{1}{2}''$ Angle Girders, limit the movement of the sliding frame.

It will be seen that, by turning the Ratchet Wheel one or more teeth at a time, the thickness of the cut may be regulated to within very fine limits.

A Run on the "*Twentieth Century Limited*"

(*Continued from page* 99)

"thrashed" to her utmost limit.

Upward we go until at last, after 62 miles' continuous climbing, we reach the summit of Mount Washington. From here after a sharp drop to Pittsfield, where we may touch 70 to 80 m.p.h. the scenery is just one beautiful panorama after another.

Through sleepy towns and villages we tear, the speedometer hanging steadily on at the 72 mark, until, as we start to cross the historic Hudson River we commence to decelerate in readiness for our entry into the great Union Station at Albany, N.Y. Here, two minutes to the good, we detach our train, leaving it to be taken forward to Chicago by one of the new "Hudson Speed" type of engines of the New York Central. Recrossing the Hudson River we reach our resting place where "596" will be thoroughly inspected and washed in preparation for the return on the morrow.

No doubt you feel ready now for a wash and a sleep but that does not prevent tongues from chattering. How, asks somebody, would that great "Hudson Speed" or even our gallant "596" look at the head of the "*Cornish Riviera*" express! That reminds me of an amusing little incident that occurred to me quite recently. That day I was driving "598" on the "*South Western Limited.*" We rolled into the terminal station of Boston and a few minutes later as I was looking over the engine a young fellow addressed me. It did my heart good to hear him speak. I am from England myself, you know, and he was from good old Lancashire! He was greatly interested in the engine and after a few moments' conversation he mentioned that he was an ex-Lancashire and Yorkshire Railwayman. I asked him how the engine would look running into Exchange Station, Liverpool. "By gum!" he replied, "I don't believe the beggar could get in!"

Famous Trains—(*continued from page* 109)

the first trough we have seen all the way from Liverpool!—and mount the $2\frac{1}{2}$ miles at 1 in 125 to Belstead Signalbox. A quick run down to the Stour Valley, with a last "60" maximum, precedes a severe slowing over the North curve at Manningtree, which takes us on to the Harwich branch. Sharp ups-and-downs along the right bank of the Stour estuary have to be negotiated with our heavy load, and then, as we run down the final incline from Wrabness, the lights of our arrival being timed at 9.18 p.m. Parkeston Quay bear into view dead ahead.

We are not allowed to stand at the long platform any longer than is necessary to unload passengers and luggage, as the "*Esbjerg Continental*" is due from Liverpool Street at 9.31 p.m., the "*Hook Continental*" 11 min. after that, and the "*Antwerp Continental*" 10 min. later still. This is one of the reasons why our timings have been on the leisurely side, as punctuality of arrival at Parkeston is of vital importance, and there is ample margin for recovery of lost time should one of our many connections put in a late appearance *en route*. After leaving Parkeston Quay we have but another two miles to run, calling on the way at Dovercourt Bay, ere we "make the port of Harwich" at 9.31 p.m. We have had, as I am sure you will agree, a most interesting day.

The New Channel Tunnel—

(*Continued from page* 131)

each dining car would be 55 tons in weight. A train unloaded would weigh 505 tons, and would consist of three first-class corridor coaches, each accommodating 100 passengers; two third-class corridor coaches seating 132 passengers each; one dining car; one luggage van and one locomotive. The passengers and luggage represent an additional 45 tons, so that a loaded train would weigh 550 tons.

The estimated total cost of the project is £189,177,094. Of this enormous sum the English "overland" section is estimated to cost £58,529,345, the Channel Tunnel £30,811,200, and the French "overland" section £99,836,549. It is calculated that the fare for the entire journey would be approximately £2; that for the journey to Boulogne £1, and the shorter journey from Ashford to Boulogne 10/-. Based on these figures, the gross receipts are estimated at £35,166,664 per annum, of which £23,209,998 would be required to meet working expenses, leaving a net profit of £11,956,666.

The interesting details of the proposed high-speed railway given in our article were published exclusively by "*Modern Transport.*" We have been able to reproduce them through the courtesy of the Editor of that paper.

How to Use Meccano Parts

(*Continued from page* 135)

Another important function of the Circular Girders is illustrated in the Steam Shovel (Model No. 7.7, Special Instruction Leaflet No. 19,) where it is used as the upper guide rail of a built-up roller bearing unit (see also Standard Mechanism No. 106). The part is invaluable in building models of large cement-mixing machines, wagon tipplers, and similar models where circular structures are necessary.

Channel Segments (part No. 119), which resemble curved channel girders, are dealt with in Class N (Wheels, Pulleys, etc.), as also are Ring Frames (No. 167B), which resemble the Circular Girder. Girder Brackets and Channel Bearings, which might be compared with very small girders, are included under Class C (Brackets, Trunnions, etc.).