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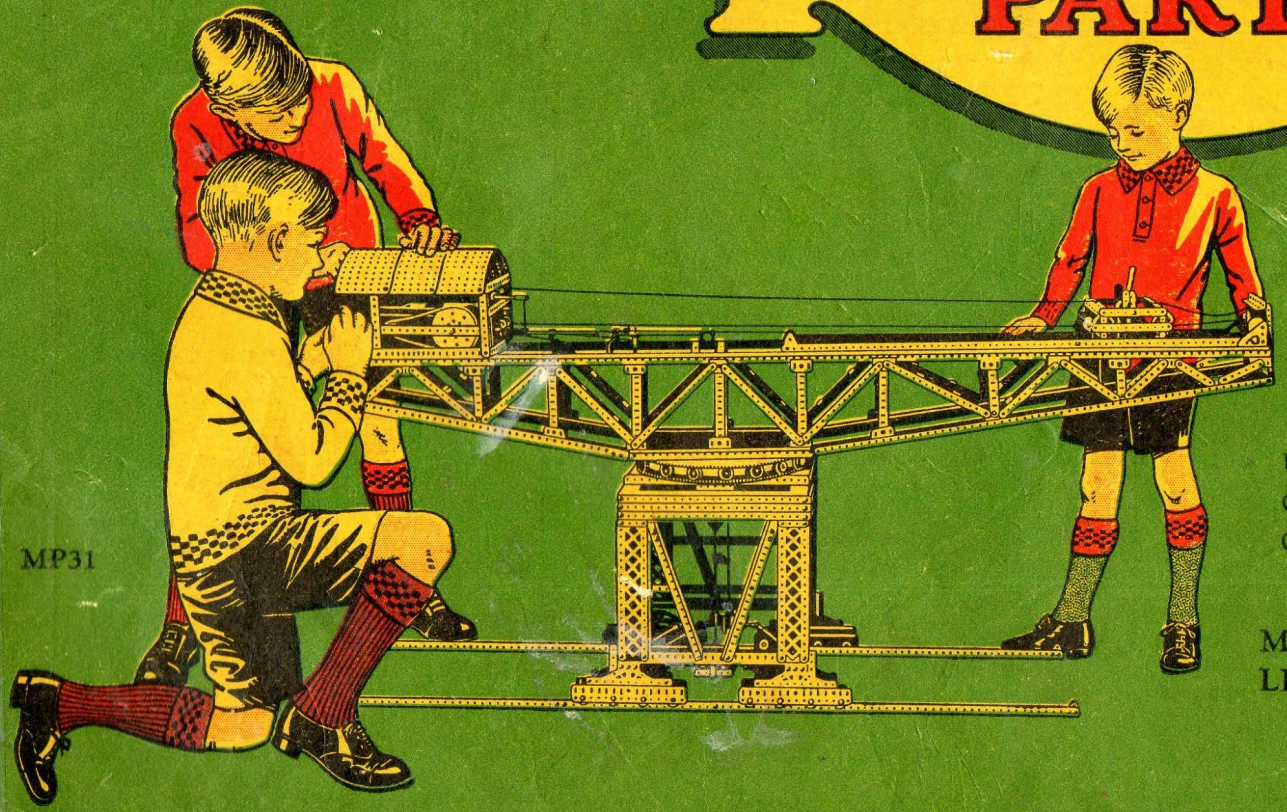
TRADE MARKS :
296321, 501113, 76, 12633, 10274, 55/13476, 569/13, 884/25, 2913, 80, 124, 336, 18066, 5403, 41812, 4174, 9048, 5549, 2389, 91637, 83171, 157149, 32822, 200639, 209733, 214061, 214062, 12892, 29094, 33316, 1818, 16737, 16900, 72286, 494933-4-5-6, 139420, 383/13, 5848, 50204, 10/12258, 22826, 18982, 20063/925, 2189, 7315, 29041, 26877, 6595, 404718, 410379, 55096, 12240.

HORNBY'S ORIGINAL SYSTEM—FIRST PATENTED IN 1901

HOW TO USE MECCANO PARTS



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How Meccano Parts are Classified

THE primary object of this booklet is to outline the principal functions of the standard parts that together constitute the Meccano system.

It would be impossible to enumerate every function of every part, but we believe that by pointing out the special purposes for which the various parts have been designed, together with a few of the other uses that have been suggested from time to time by Meccano boys themselves, we shall help Meccano enthusiasts to build more interesting models, and also construct them on scientific and practical lines.

Before any attempt could be made to describe the uses of the individual parts it was necessary to classify them in some systematic manner. For the purpose of this book we have grouped the parts first of all into two main sections, which we have termed respectively the "Structural Section" and the "Mechanical Section." Secondly, we have divided these Sections into a number of classes, each of which is dealt with separately.

The Structural Section includes all those parts that are used principally for the construction of frames, beams, bases, supports, etc., as opposed to parts intended essentially for assembly in mechanical movements (gear boxes, driving mechanisms, etc.), which are grouped under the various classes in the Mechanical Section. The grouping of the parts in the different classes will be made clear by reference to the table printed on this page.

This classification and grouping should not be taken too literally, for it is impossible to state definitely all the functions of any one Meccano part, nor can we say that certain parts are used only for frames, beams, girders, etc., and others only for gear boxes, driving mechanisms, and other mechanical movements. The Meccano Strips, for example, are used principally in the construction of frames; that is, as structural parts. They may however be used also as levers, connecting rods, and for other similar purposes; and when thus employed they would more correctly be considered, not as structural but as mechanical parts. From this it will be seen that the arranging of Meccano parts in definite groups is a difficult matter. Nevertheless we think that the method adopted will enable anyone who is not already familiar with the various components of the system to see at a glance all the parts that are most likely to fulfil any desired function.

STRUCTURAL SECTION

Class A—Strips.
„ B—Girders.
„ C—Brackets, Trunnions, etc.
„ D—Plates, Boilers, etc.
„ E—Nuts and Bolts, Tools and Literature.

MECHANICAL SECTION

Class M—Rods, Cranks, and Couplings.
„ N—Wheels, Pulleys, Bearings, etc.
„ O—Gears and Toothed Parts.
„ P—Special Accessories (i.e., designed for specific purposes).
„ Q—Miscellaneous Mechanical Parts.
„ T—Electrical Parts.
„ X—Power Units and Accessories.

The parts included in Class A, Strips, may be said to form the backbone of the Meccano system, for some of them are to be found in practically every Meccano model.

Class B deals with Girders and similar parts, which are used principally to give rigidity to various structures. Class C comprises the smaller parts that are intended to form connecting links between the larger structural parts in Classes A and B. In Class D are included all the parts intended for "filling in" the framework of models, and for building floors, gear-box frames, etc.

Class E deals with certain parts that are indispensable for all kinds of model-building, namely, Nuts and Bolts and tools. It also includes the Meccano Instruction Manuals, Super Model Leaflets, and other publications.

The contents of Classes M, N, and O are clearly indicated by their descriptive titles, and therefore need no explanation.

After the appropriate parts had been allocated to Classes M, N, and O, it was found that there still remained a large number of unclassified mechanical parts, not counting Motors and similar units. In order to deal with this remainder, the special electrical parts were grouped together into a class by themselves—Class T. Then, of the parts still left, some were found to possess characteristics quite different from the rest, and these were collected together as Special Accessories, Class P. By Special Accessories we mean those parts that are designed for specific purposes, such as Shuttles (for Looms), Signal Arms, etc. Finally, all the accessories still unclassified were placed under Class Q.

The Electric Motor, Accumulator, Transformer, Steam Engine and Clockwork Motor, are grouped under Class X, Power Units and Accessories.

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Class A: Strips

PERFORATED STRIPS :

No. 1, 12½″ long **No. 1b, 7½″ long** **No. 2a, 4½″ long** **No. 4, 3″ long** **No. 6, 2″ long**
No. 1a, 9½″ long **No. 2, 5½″ long** **No. 3, 3½″ long** **No. 5, 2½″ long** **No. 6a, 1½″ long**

Provided that they are placed properly, a few Strips can be converted into a perfectly rigid frame, but it is always advisable to use Angle Girders for the larger Meccano structures.

Fig. 1 shows a simple rectangle built up from 5½″ Strips and 2½″ Strips, and made perfectly rigid by the addition of a single diagonal tie composed of 5½″ and 2½″ Strips overlapped four holes.

Fig. 3 is a model of a simple roof truss. The sides 1, which have to withstand a compressive force, are constructed from Angle Girders ; the side 2, which is merely in tension, consists of two 12½″ Strips overlapped and bolted together. The triangle so formed would be quite rigid for ordinary purposes, but struts and ties are usually added at 3 and 4 respectively in order to obtain still greater rigidity. Fig. 4 shows an openwork girder of the built-up truss type that is used to a large extent in the construction of bridges. The various members are arranged so that a number of triangles are formed, an arrangement that gives the girder great rigidity and strength, for the triangle is the only figure that cannot be distorted without altering the length or form of the sides. The ties are represented by 4½″ Strips and the struts by 5½″ Angle Girders.

Fig. 2 shows a braced tower such as might be used to support a crane, etc. The corner members are composed of Angle Girders, since they must withstand the compressive force exerted by the dead weight upon the structure. In order to make these girders rigid diagonal ties are added. These consist of 5½″ Strips.

DOUBLE ANGLE STRIPS :

No. 46, 2½″×1″ **No. 48a, 2½″×½″**
No. 47, 2½″×1½″ **No. 48b, 3½″×½″**
No. 47a, 3″ ×1½″ **No. 48c, 4½″×½″**
No. 48, 1½″× ½″ **No. 48d, 5½″×½″**

Similar to the ordinary Strips except that their ends are bent at right angles. They are extremely useful in the construction of frames and bearings for shafting, etc.

SLOTTED STRIPS : No. 55, 5½″ long **No. 55a, 2″ long**

No. 55 is provided with three ordinary holes and two slots, each 1⅛″ long, while No. 55a has two ordinary holes and a slot ⅝″ long. These slots may be used as guides for sliding mechanisms ; they are also invaluable in obtaining small adjustments between parts, that would be impossible with the ½″ standard holes.

CURVED STRIPS :

No. 89, 5½″ long, 10″ radius, 12 to circle. **No. 90, 2½″, 2⅜″ radius, 8 to circle.**
No. 89a, 3″ cranked, 1½″ radius, 4 to circle. **No. 90a, 2½″, cranked, 1⅜″ radius, 4 to circle.**

These are useful for ornamental purposes and in the construction of rotating mechanisms. Fig. 5 shows a flywheel built up from four 2½″ small radius Curved Strips. Complete circles suitable for flywheels, etc., may also be built up from eight 2½″ large radius Curved Strips or from four 3″ Curved Strips.

No. 145, CIRCULAR STRIP, 7″ diam. overall.

May be used in circular structures, as a flywheel, or in a built-up roller bearing as a means of supporting the rollers (see Standard Mechanism No. 136).

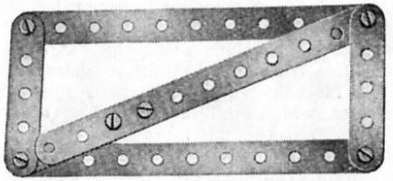

Fig. 1

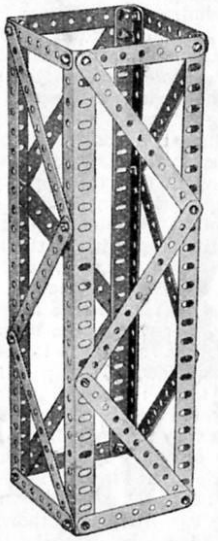

Fig. 2

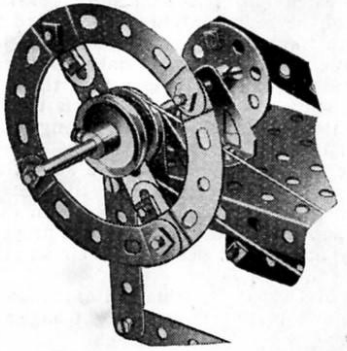

Fig. 5

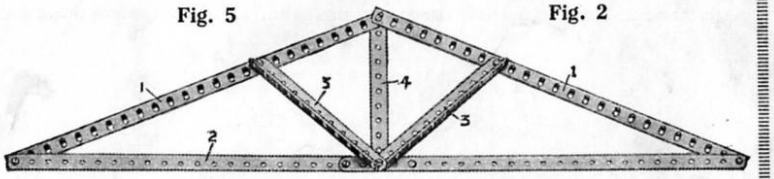

Fig. 3

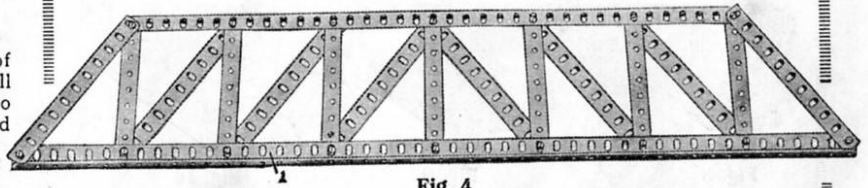

Fig. 4

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Class B: Girders

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.

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 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 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 two supports 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. A single Angle Girder combines the property of two ordinary Strips secured rigidly at right angles along their lengths; hence its great strength.

When a Meccano boy runs short of Girders he usually improvises by placing two Strips together lengthwise and bolting them at right angles by means of Angle Brackets.

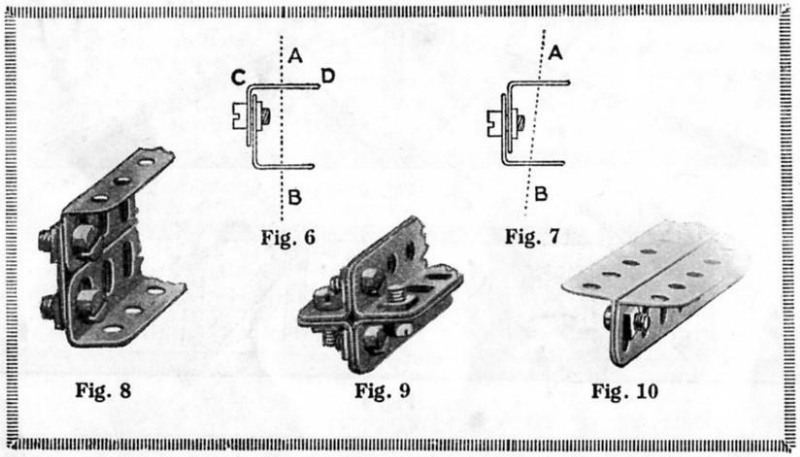

Fig. 6 Fig. 7

Fig. 8 Fig. 9 Fig. 10

ANGLE GIRDERS:

No. 7, 24½" long	No. 8a, 9½" long	No. 9a, 4½" long	No. 9d, 2½" long
No. 7a, 18½" long	No. 8b, 7½" long	No. 9b, 3½" long	No. 9e, 2" long
No. 8, 12½" long	No. 9, 5½" long	No. 9c, 3" long	No. 9f, 1½" long

Angle Girders 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. 6 and 7, which represent sections of two Angle Girders that are bolted together to form channel-section girders, Fig. 6 showing the right method of securing the Girders and Fig. 7 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—a feature that is important when it is desired to journal a Rod through the flanges of a channel girder of this type. Whenever a Rod is to be journalled through the wider flange of an Angle Girder, a short Strip should be bolted to the flange so that the Rod may pass through it as well as through the elongated hole in the Girder.

The Angle Girders lend themselves very readily to the construction of the different types of Girders used in actual practice. Fig. 12 shows a built-up I-section Girder, consisting of four Angle Girders bolted to a Flat Girder. Fig. 8 shows a built-up Channel Girder consisting of two Angle Girders connected together by Flat Girders or by Flat Brackets. Figs. 9, 10, and 13 illustrate further examples of built-up Girders that are capable of withstanding tremendous bending or compressive stresses. Figs. 11 and 14 are typical examples of complicated girder construction, the subjects being sections of the Giant Block Setting Crane (Instruction Leaflet No. 4). Fig. 11 shows a portion of the travelling gantry, viewed from underneath, while Fig. 14 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. 12 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 GIRDERS:

No. 97, 3½" long	No. 98, 2½" long	No. 99a, 9½" long	No. 100, 5½" long
No. 97a, 3" long	No. 99, 12½" long	No. 99b, 7½" long	No. 100a, 4½" long

These 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. 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 the addition of a narrow strip of metal at right angles to the sides. 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.

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Class B: Girders *(continued)*

FLAT GIRDERS :

No. 103, 5½" long	**No. 103b, 12½" long**	**No. 103e, 3" long**	**No. 103h, 1½"l ong**
No. 103a, 9½" long	**No. 103c, 4½" long**	**No. 103f, 2½" long**	**No. 103k, 7½" long**
	No. 103d, 3½" long	**No. 103g, 2" long**	

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. 12, 13, and 8). 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 employed as bearings for the wheel axles and rods of the 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. 12. 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.

No. 113, GIRDER FRAME.

This 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. 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.

No. 143, CIRCULAR GIRDER, 5½" diam.

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.). Another important function of the Circular Girder is illustrated in the Steam Shovel (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. 136). 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, but are much larger. Girder Brackets and Channel Bearings, which might be compared with very small girders, are included under Class C (Brackets, Trunnions, etc.).

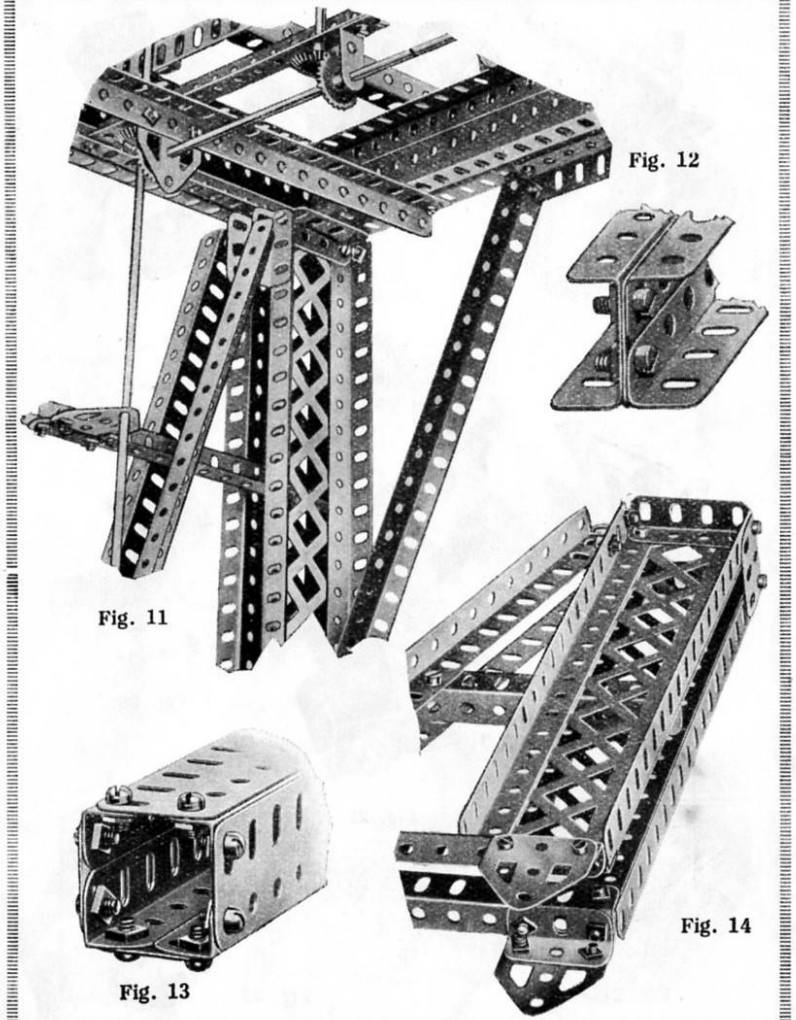

Fig. 12

Fig. 11

Fig. 14

Fig. 13

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Class C: Brackets, Trunnions, etc.

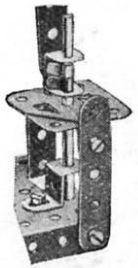

Fig. 15

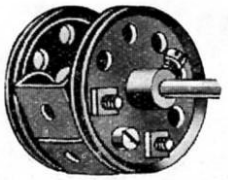

Fig. 16

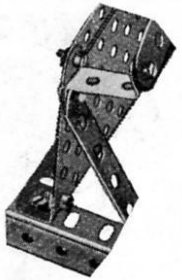

Fig. 17

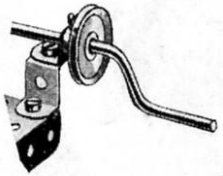

Fig. 19

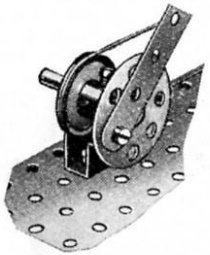

Fig. 18

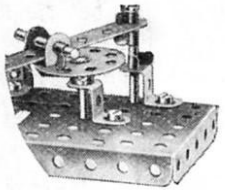

Fig. 20

Fig. 22

Fig. 21

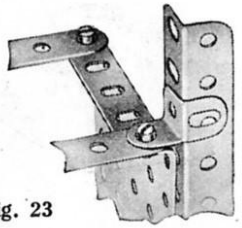

Fig. 23

No. 10, FLAT BRACKET, ½" wide, ⅜" long.

Perforated by one round hole and one elongated hole. The latter enables the part to be used in cases where it is necessary to make small adjustments that are not possible with the ordinary ½" equidistant holes. For connecting parallel Strips or Girders, or for use as a short Strip. Fig. 22 shows two Flat Brackets in use as shackle couplings attached to the end of a Meccano leaf spring.

No. 11, DOUBLE BRACKET.

In Fig. 22 this part is employed as a means of connecting together the shackles of a Meccano leaf spring. Fig. 16 shows three Double Brackets bolted between two 1½" Pulleys to form a cam. In Fig. 15 a Double Bracket is employed as a means of connecting a piston rod to a connecting rod, the Bracket being mounted on the former and attached pivotally to the latter by means of a bolt and two nuts. In Fig. 20 the part forms a sliding connecting piece that operates a rocking lever in a quick-return motion, the Double Bracket being pivoted to the Bush Wheel so that the rocking lever slides freely between its up-turned flanges.

ANGLE BRACKETS : No. 12, ½"×½" No. 12a, 1"×1" No. 12b, 1"×½"

Designed for connecting any two Meccano parts at right angles to each other. The extra holes provided in Nos. 12a and 12b add to the rigidity of the connection. On occasions they also prove very useful in building up small journal bearings for shafting.

REVERSED ANGLE BRACKETS : No. 124, 1" No. 125, ½"

The dimensions refer to the centre portions of the parts only, and in each case the ends are turned at right angles to form a flange that is about ½" long and perforated with a round or elongated hole. Fig. 17 shows the 1" Reversed Angle Bracket used as a support for one end of the dashboard in a Meccano motor chassis. Both types of Reversed Angle Brackets form excellent reinforced bearings for Axle Rods, and typical examples of the use of the ½" size for this purpose will be found in Figs. 15, 20, and 21. Fig. 19 is another illustration of the adaptability of this part.

CORNER ANGLE BRACKETS : No. 154a, Right. No. 154b, Left.

These are similar to part No. 12 but have an additional flange. Fig. 23 shows a Corner Angle Bracket used as a guide for a lift cage. As will be seen, the Bracket is secured by one of its flanges to the top of the cage, thus leaving the other two flanges free to slide against the vertical Angle Girder which forms one of the guides for the lift.

No. 44, CRANKED BENT STRIP. No. 102, SINGLE BENT STRIP.

These two parts are similar in appearance except that No. 102 has two holes in each side instead of one and one side of No. 44 is cranked so as to allow more space between the ends. The principal function of both parts is to form a simple and compact bearing for short Axle Rods (see Fig. 18). They are also used in the construction of innumerable small mechanisms, such as pulley blocks, castors, guides, etc., or as " claws " for gear-shifting levers, etc.

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Class C: Brackets, Trunnions, etc. *(continued)*

No. 45, DOUBLE BENT STRIP.

Designed to form reinforced "footstep" or extended bearings for Axle Rods, etc. (see Fig. 25). Invaluable where space is restricted; when bolted to a Strip or Plate ample journal bearings are provided for a short Axle Rod, the Rod passing through the Strip, of course, and through the centre hole of the Double Bent Strip.

No. 108, ARCHITRAVE.

Intended for strengthening corners of frames. Also extremely useful as an ornamental piece (the top of the Eiffel Tower, model No. 7.15 in the 4-7 Instruction Manual, consists principally of four Architraves).

FLANGED BRACKETS: No. 139, Right. No. 139a, Left.

The Right- and Left-hand Flanged Brackets resemble the Architraves except that in each of the former one side is bent over to form a flange. Fig. 24 shows these parts used as bearings for a horizontal shaft. They are also extremely useful for strengthening various structures.

No. 126, TRUNNION. No. 126a, FLAT TRUNNION.

In addition to their obvious use as bearings for axles of trucks, etc., these parts lend themselves to many other different adaptations. In Fig. 15 two Flat Trunnions are shown bolted together in such a way that they form a small plate 1½" square. In Fig. 27 two ordinary Trunnions, which differ from the Flat Trunnions only by the fact that one end is bent over to form a flange, are used to form a very rigid base for a small swivelling structure.

No. 133, CORNER BRACKET.

Like the Architrave, this part is designed primarily for use as a corner strengthening piece, but owing to its smaller size, can be used in many places where the Architrave would prove unsuitable. Fig. 26 indicates other uses for the Corner Bracket. The illustration is of the front footplating of the Meccano Tank Locomotive, and it will be noticed that two Corner Brackets are used as strengthening pieces between the footplating and the front buffer beam. Four other Corner Brackets are assembled to represent the steam pipes leading from the cylinders to the smoke box.

No. 160, CHANNEL BEARING, 1½"×1"×½".

Used principally to form bearings for Rods. Each side of the channel measures 1½"×1" and is perforated with six holes, while the connecting piece is ½" wide and is pierced with three holes. The part is small but rigid and therefore very valuable where space is limited. In Fig. 28 it is seen attached to the side of an Electric Motor, where it provides bearings for two Rods carrying a part of the Motor reduction gearing. To build up similar bearings from other Meccano accessories would require a good deal of time and a number of small parts and the result would not be nearly so neat or rigid.

No. 161, GIRDER BRACKET, 2"×1"×½".

Intended for forming bearings for shafting. A valuable feature of the part is the fact that the four holes in the flange are elongated, thus enabling certain adjustments to be made that would be impossible with the ordinary round holes.

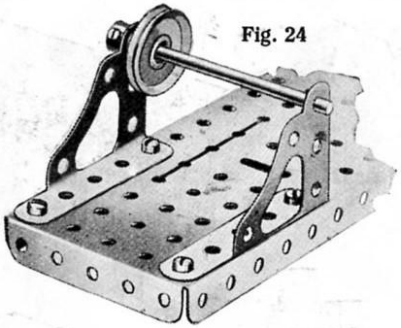

Fig. 24

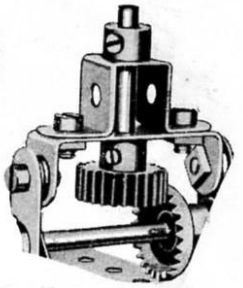

Fig. 25

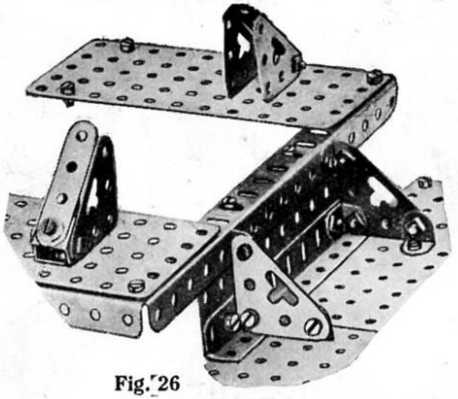

Fig. 26

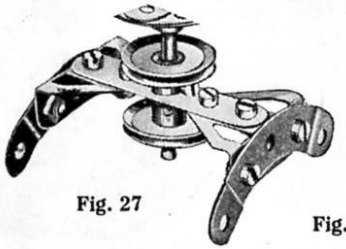

Fig. 27

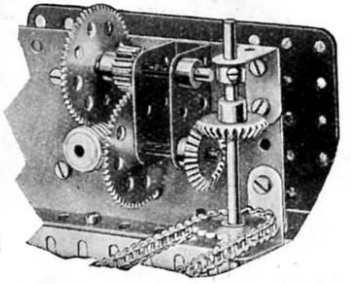

Fig. 28

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Class D: Plates, Boilers, etc.

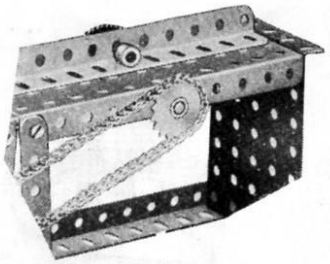

Fig. 29

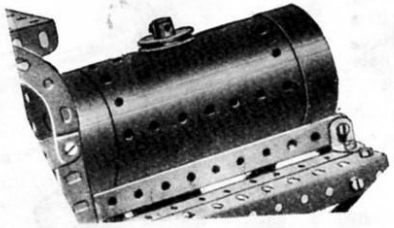

Fig. 30

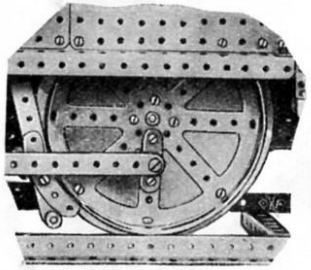

Fig. 31

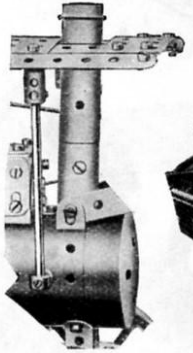

Fig. 32

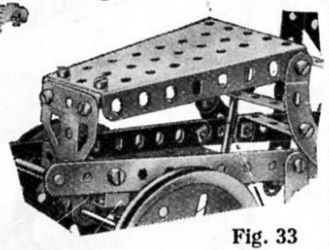

Fig. 33

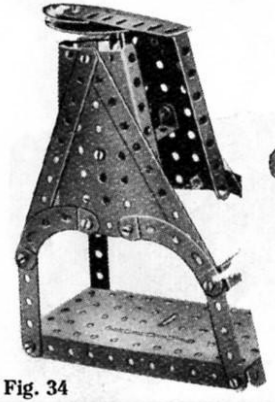

Fig. 34

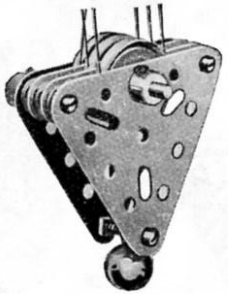

Fig. 35

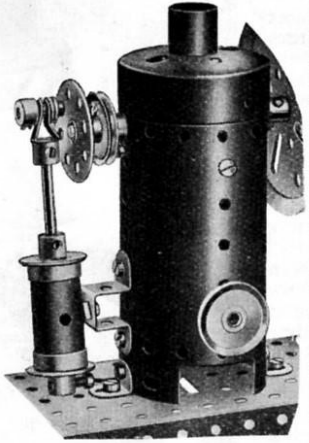

Fig. 36

PERFORATED FLANGED PLATES : No. 52, 5½″×2½″ No. 53, 3½″×2½″

No. 52 has flanges on all four sides, whilst No. 53 is flanged on only two sides. No. 52 is used to a large extent as a base for small models, and in the construction of work-tables, platforms and sides of gear boxes, etc. In addition to the usual perforations it has a slot 2″ long and a hole ⅝″×3/16″ near its centre. The purpose of the slot is to receive the blade of a Circular Saw when the latter is mounted beneath the Plate, whilst the elongated hole is intended to facilitate the adjustment of the Saw guide-piece. Fig. 29 shows the Plate incorporated in a model saw bench. The blade of the Saw, which is secured to the Sprocket wheel shaft, can just be seen above the Angle Girder that forms the guide piece. This Girder is held in place by the Collar shown, and the latter is secured on to the shank of a bolt passed through the elongated hole in the Plate.

If the Plate is used as the side of a gear box, a change-gear lever may be arranged to work in the slot.

FLAT PLATES :
No. 52a, 5½″×3½″ No. 53a, 4½″×2½″ No. 70, 5½″×2½″ No. 72, 2½″×2½″

The various types of Flat Plate, used in conjunction with the Flanged Plates, etc., enable covered structures of all kinds to be built up. If plates are required larger than the four sizes listed, it is, of course, a simple matter to build them up by joining two or three Plates together as shown in Fig. 43.

No. 54, PERFORATED FLANGED SECTOR PLATE.

This part measures 2½″ across at its widest end and tapers down to 1½″ at its other end, and its sides are provided with flanges which are punched with slightly elongated holes. Fig. 45 shows two Sector Plates used to form the movable receptacle in a Meccano model of a foundry ladle. Fig. 33 illustrates a Sector Plate employed to form the bonnet of a motor car, and Figs. 34 and 37 indicate two ways in which the part can be used with great advantage in building-up bases or supports for machinery.

When a Sector Plate is bolted by one of its flanges to a Girder or other part, its other flange and the rows of holes punched in its face lie at an angle to the part, and this fact proves advantageous in numerous cases. In Fig. 40, for example, a Sector Plate is shown secured to the base of a rotating crane. Another is bolted to the opposite side of the base, so that Axle Rods journalled in Angle Brackets bolted to the Sector Plates are disposed radially to a fixed point near the rear of the model. These Rods carry the travelling wheels. Hence the model is capable of rotating completely about the fixed point.

TRIANGULAR PLATES : No. 76, 2½″ No. 77, 1″

These are intended principally for use as supports for journal bearings, as shown in Figs. 39, 41 and 44, but they have numerous other important uses. In Fig. 38 four 2½″ Triangular Plates form the sides of a grab and in Fig. 35 two are used in the construction of a pulley block.

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The 1" Triangular Plate enables ½" distances to be obtained, which is not always easy with the ordinary parts perforated at intervals of ½". Fig. 42 shows two of these parts attached to the rear of the Meccano Traction Engine, to receive the end of the drawbar attached to a trailer. The rear of the Traction Engine is 3" wide (six holes); hence it would not be advisable to attach the drawbar pin direct to one of the holes in the rear plate, since it would be out of centre. By attaching two 1" Triangular Plates as shown and securing the pin to their protruding ends, the drawbar is connected centrally.

No. 146. CIRCULAR PLATE, 6" diam. overall.

May be employed as a large flywheel or turntable, etc., or as a circular fixed base for machinery, or in the construction of driving wheels for giant Meccano locomotives. Fig. 31 shows one of the six driving wheels of the Baltic Tank Engine. It consists of a Circular Plate having a Hub Disc bolted to it to form the flange.

The Circular Plate has a large perforation at its centre through which the boss of a wheel may be slipped. The Plate is secured to an Axle Rod by first bolting it to a Bush Wheel or similar part mounted on the Rod.

No. 162, BOILER, COMPLETE WITH ENDS. No. 162a, BOILER ENDS. No. 162b, BOILER.

The Boiler can be incorporated in Meccano locomotives, stationary engines and other models of a similar type. It measures 4¾" × 2", and is fitted at each end with a movable cap or Boiler End. With one Boiler End removed it may be incorporated in a model as a vertical boiler (Fig. 36) or with both ends closed it will serve as a horizontal boiler.

No. 163, SLEEVE PIECE. No. 164, CHIMNEY ADAPTOR.

The Sleeve Piece is intended primarily for use in the construction of cylinders and chimneys. To form a complete cylinder, two ¾" Flanged Wheels should be pushed over its ends as shown in Fig. 36. The Sleeve Piece may be secured in position by bolts inserted in the holes punched round its centre.

When used as a chimney the Sleeve Piece may be secured to a model by means of a ¾" Flanged Wheel clamped over one end or by a Chimney Adaptor. In building up longer chimneys, two Sleeve Pieces may be connected together by pushing them over opposite ends of a Chimney Adaptor, but a more rigid and efficient method is that adopted in the chimney shown in Fig. 32.

This consists of three Sleeve Pieces placed end to end with the centre Sleeve Piece overlapping each of the other two by ⅜". A 3½" Rod passed lengthwise through the centre of the three Sleeve Pieces carries at one end a ¾" Flanged Wheel that forms the top of the chimney. The top and bottom Sleeve Pieces are held in place by means of bolts passed through them and inserted in the holes of new style Collars carried on the 3½" Rod.

Fig. 39 shows the Chimney Adaptor used as the oil receptacle in a syphon lubricator for journal bearings.

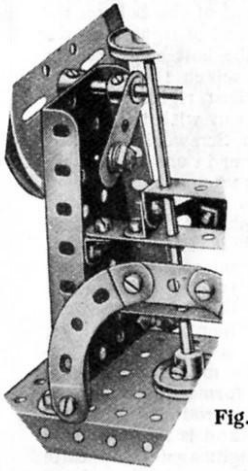

Fig. 37

Fig. 38

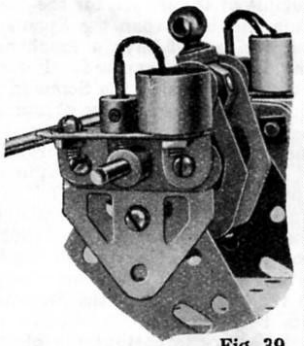

Fig. 39

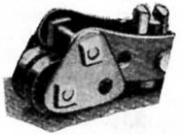

Fig. 41

Fig. 42

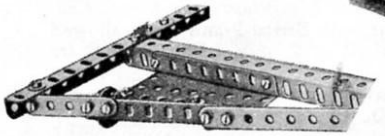

Fig. 40

Fig. 44

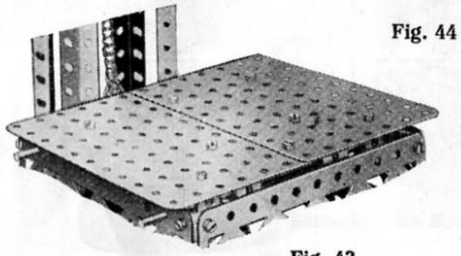

Fig. 43

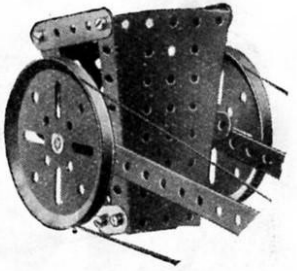

Fig. 45

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Class E: Nuts and Bolts, Tools and Literature

No. 37, NUTS AND BOLTS, 7/32".

The best method of securing nuts and bolts is with the head of the bolt on the outside of the model, for the Screwdriver forms a speedier method of tightening the nuts and bolts than the Spanner. Also, a model having all the bolt heads on the outer side will have a much neater appearance than one in which the nuts and shanks are all exposed. For ordinary model-building, sufficient rigidity can be obtained by using the Screwdriver only, merely steadying the nut with the fingers, but wherever excessive strain is expected, both Spanner and Screwdriver should be used simultaneously, the nut being held firmly by the Spanner in one hand while the bolt is turned by the Screwdriver in the other hand, or *vice versa*.

Fig. 53 shows a Meccano gear-changing lever in which a single bolt plays a novel and important part. The head of the bolt 9 presses against a 2½" small radius Curved Strip 10, which forms the quadrant. The head of the bolt tends to slip into the holes in the Strip 10 and thus retain the lever 5 firmly in any one of three different positions. The gearing on the shaft 3, which is controlled by the lever, should be arranged so that the different engagements are brought about in these three positions of the lever 5; then the gears will not easily ride out of engagement once the lever has been moved.

A very important use of the nut and bolt is found in the making of pivotal connections between various Meccano parts. Typical pivots so formed are described under Standard Mechanism Nos. 262 and 263. S.M. 262 is reproduced herewith (Fig. 52). In this case the bolt 1 passes through the Strip 2 and is securely held to Strip 3 by means of two nuts 4 and 5, which are screwed tight against opposite sides of the Strip. Sufficient space is left between the nut 5 and the bolt head to allow free movement of the Strip 2.

S.M. 263 is a similar arrangement except that both Strips 2 and 3 are allowed freedom of movement about the bolt instead of Strip 2 only. Both Strips are first placed on the bolt 1 and the nuts 4 and 5 are then placed together on its shank. The nuts are turned in opposite directions until they securely grip each other in position on the bolt. S.M. 262 is to be preferred wherever it is required to move only one Strip about the bolt, for this method affords a minimum amount of "play" or slackness in the joint.

Another kind of pivot formed from a bolt and nut is included in Fig. 53. Bolt 1 in this illustration passes through the end hole of a Crank 6 and enters the threaded bore of a Collar 2, without touching the Rod 3. It is secured rigidly in this position by locking a nut 4 against the Collar. Sufficient freedom is allowed for the Crank 6 to turn easily about the bolt, and the Collar 2, which is free on the shaft 3, is held in position by two further Collars. By means of this pivotal connection, easy longitudinal movement of the Rod 3 is obtained on operation of the Crank 6.

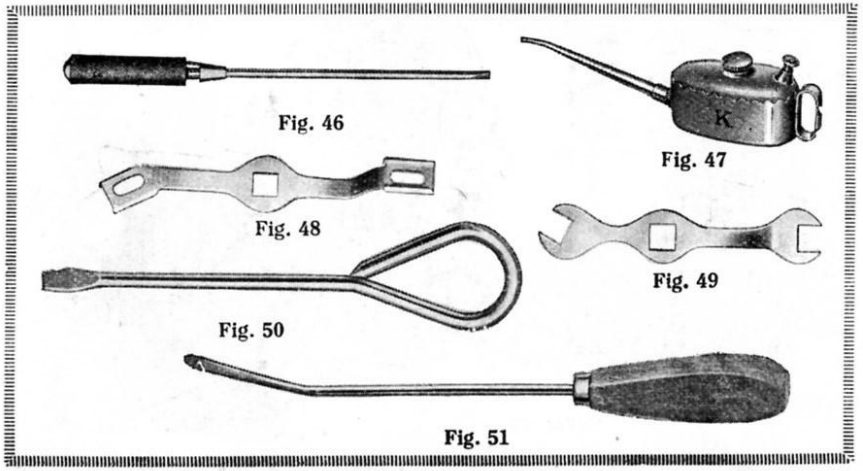

Fig. 46

Fig. 47

Fig. 48

Fig. 49

Fig. 50

Fig. 51

BOLTS, No. 111, ¾". No. 111a, ½". No. 111c, ⅜".

There are four different sizes of Meccano bolts, i.e., ¾", ½", ⅜", and 7/32" (No. 37b), but the pitch of the thread is the same in every case (32 threads to the inch). The 7/32" Bolt may be obtained separately (under part No. 37b) or complete with nut (under part No. 37). It is this size of bolt that is supplied in considerable quantities, complete with nuts, in all the Meccano Outfits. The other three kinds of bolts are for use in special cases where an extra long shank is required.

No. 69, SET SCREWS. No. 69a, GRUB SCREWS. No. 69b, 7/32" GRUB SCREWS.

No. 69 are of similar shape to the bolts but are only 3/16" in length, and are, of course, designed primarily for securing the various Meccano wheels to the Axle Rods. The Grub Screws have no head at all. They are employed for securing the smaller Meccano parts, such as Collars, Couplings, etc., to Rods. It will sometimes be found that the Set-screw of a Meccano Pulley or Gear Wheel fouls some other part of the model, in which case it may be substituted by a Grub Screw, which will fit almost flush with the boss.

No. 147b, PIVOT BOLT WITH TWO NUTS.

The Pivot Bolt is of a quite different design to the ordinary bolts. The greater portion of its shank is smooth and the part is particularly suitable for use as a small pivot or fixed pin about which a small pulley or lever may rotate. It is secured in position by clamping the two nuts on its shank to a Meccano Strip or other part, as in Fig. 52.

No. 68, WOODSCREWS, ½".

Woodscrews are also included in the Meccano system. These are of course, for the benefit of those boys who wish to secure their models to wooden bases. They are supplied in ½" lengths only. Any model that does not travel will be improved in appearance and operation if it is screwed down to a wooden base.

No. 34, SPANNER. No. 36, SCREWDRIVER.

Parts Nos. 34 and 36 (Figs. 49 and 50) are the tools that are found in every Meccano Outfit and are the only essential ones.

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No. 34b, BOX SPANNER.

The Box Spanner (Fig. 48) has a kind of slot at each end into which the nut may be slipped. With the aid of this tool a nut may be placed in positions impossible to reach with the fingers.

No. 36a, EXTRA LONG SCREWDRIVER. No. 36b, SPECIAL SCREWDRIVER.

Part No. 36a is of similar pattern to part No. 36, but the blade is 5" long instead of 3½", and instead of the end being flattened slightly it is of the same diameter as the shaft. This enables the blade to be passed completely through the standard Meccano holes.

The Special Screwdriver (Fig. 46) is all-metal and measures 8" in length. Like part No. 36a the blade of this tool is of such a diameter that it may be passed through standard Meccano holes.

No. 105, REED HOOK.

This is designed to facilitate the threading of the warp threads through the Meccano Loom.

OIL CANS, No. 1 (ordinary type). No. 2 ("K" type).

The latter type is reproduced herewith (Fig. 47). The oil may be ejected drop by drop by depressing the valve. The No. 2 Oil Can measures 5" in overall length. A specially prepared lubricating oil is included in the Meccano system and may be obtained in small bottles. This oil is particularly suitable for lubricating Meccano Clockwork and Electric Motors.

MECCANO ENAMEL. Colours: Red, Grey and Green.

All Meccano parts may now be obtained enamelled in colours, and for the benefit of those boys who wish to convert nickelled parts to coloured ones, the Meccano Enamel is supplied in small tins. There are three colours available, red, grey, and green, each colour being identical in shade with the enamel used in the Meccano factory for spraying Meccano parts. The enamel should be applied with a small brush, the surface of the part having first been cleaned thoroughly with fine emery cloth. When quite dry the enamel gives a splendid finish to the Meccano parts.

MECCANO INSTRUCTION MANUALS

No. 56b, for Outfits 00-0. No. 56a, for Outfits 00-3. No. 56, for Outfits 4-7.

The greatest thrill of Meccano model-building is to be derived from building according to one's own ideas, but before a Meccano boy attempts to do this he should make a point of building all the models shown in the Meccano Instruction Manual that are within the range of his Outfit.

The Meccano Instruction Manual is obtainable in three separate portions, as listed above. The first portion, No. 56b, describes models that may be built with Outfits Nos. 00 and 0, the second shows models that may be built with Outfits Nos. 00 to 3 and the third describes models built with the larger Outfits, Nos. 4 to 7. It should be mentioned that the 00-3 Manual (No. 56a) contains all the models described in the 00-0 Manual (No. 56b) in addition to a great number of models built with Outfits Nos. 1, 2, and 3. Hence a Meccano boy who wishes to form a complete Manual need only buy the 00-3 and 4-7 Manuals.

Instructions are included wherever the illustrations are not sufficiently clear, but for the rest the Meccano boy is expected to use his own eyes and ingenuity! After a little practice it is surprising how easy it becomes to build the most elaborate model from quite a small illustration.

SPECIAL SUPER MODEL INSTRUCTION LEAFLETS.

Some of the models included in the Manuals require so many illustrations in order to show each detail clearly that they would occupy several pages. Such models therefore are dealt with in special instruction leaflets, which are beautifully printed and profusely illustrated from actual photographs. These leaflets are included in the Outfits with which the respective models can be built, and they may also be obtained separately. A complete list of the leaflets available, together with a brief description of the subject of each, appears on page 10.

STANDARD MECHANISMS MANUAL

The Meccano Standard Mechanisms Manual is designed for the use of the more advanced model-builder. It contains details of a large number of Meccano movements that are to a large extent standardised, in that they may be applied to more than one model with very little alteration.

The various devices dealt with in the Manual have been divided into thirteen different sections, under such headings as Gear Ratios, Belt and Rope Mechanism, Clutches, Reversing and Drive-changing Mechanisms, etc., so that used in conjunction with the ordinary Instruction Manuals, the Standard Mechanisms Manual will form a very useful and instructive book.

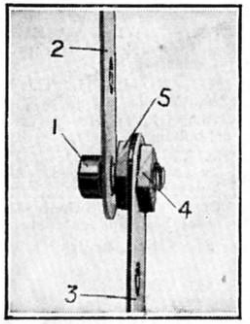

Fig. 52

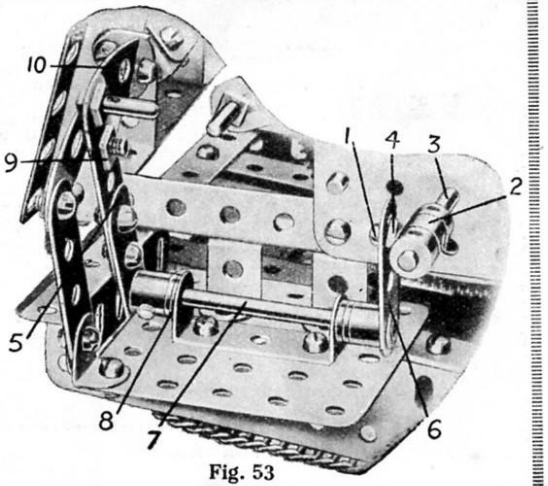

Fig. 53

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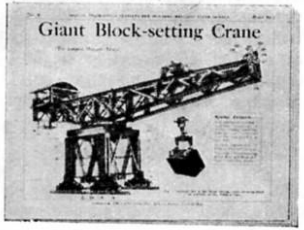
Class E: Nuts and Bolts, Tools and Literature *(continued)*

Meccano 4-7 Manual



No. 4 Leaflet

Meccano "Standard Mechanisms" Manual

SUPER MODEL INSTRUCTION LEAFLETS

A brief description of each model dealt with in the series of special Instruction Leaflets is given below and the number of the leaflet is indicated. Copies of the leaflets may be obtained from any Meccano dealer or direct from Meccano Ltd., Binns Road, Old Swan, Liverpool.

No. 1 MOTOR CHASSIS. This model runs perfectly under its own power. It has Ackermann Steering, Differential, Gear Box and Clutch, etc.

No. 2 SHIP COALER. All the movements of a real ship-coaler are reproduced in this model.

No. 3 MOTORCYCLE AND SIDECAR. The sidecar is of stream-line design and is mounted on springs. The motorcycle is complete with lamps, horn, exhaust pipes, etc.

No. 4 GIANT BLOCK-SETTING CRANE. This realistic model is fitted with an accurate reproduction of Fidler's block-setting gear.

No. 5 TRAVELLING BUCKET DREDGER. In this model trucks and wagons can be run underneath the chute through which falls the material raised by the dredger buckets.

No. 6 STIFF-LEG DERRICK. This model has many interesting movements, including hoisting, luffing and swivelling, which are controlled by suitable levers.

No. 7 PLATFORM SCALES. This model will weigh articles up to 4½ lbs. with remarkable accuracy.

No. 8 ROUNDABOUT. This model is most attractive when in motion. As the roundabout rotates the cars spin round and the horses rise and fall.

No. 9 BAGATELLE TABLE. This is an interesting model that will give hours of fun to the players.

No. 10 LOG SAW. In this model the saw is driven rapidly to and fro while the work table travels beneath it.

No. 11 SINGLE-CYLINDER HORIZONTAL STEAM ENGINE. Fitted with balanced crankshaft, crosshead, and centrifugal governor.

No. 12 STONE SAWING MACHINE. The model is equipped with adjustable work table and overhead trolley with self-sustaining chain hoist.

No. 13 MECCANOGRAPH. This wonderful model will draw hundreds of beautiful designs.

No. 14 GRANDFATHER CLOCK. A practical example of Meccano model-building. The model keeps accurate time.

No. 15 BALTIC TANK LOCOMOTIVE. The driving wheels are operated by an Electric Motor. An accurate reproduction of Walschaerts' Valve Gear is fitted.

No. 16 LOOM. This is perhaps the greatest Meccano success. The model weaves beautiful material.

No. 17 PLANING MACHINE. Fitted with quick-return motion.

No. 18 REVOLVING CRANE. This model is fitted with screw-cperated luffing gear.

No. 19 STEAM SHOVEL. This model embodies travelling, rotating, racking and digging movements, and jib hoisting and lowering gear.

No. 19a STEAM EXCAVATOR, OR MECHANICAL DIGGER. A Meccano Steam Engine is incorporated in this interesting model and provides the power for operating the four movements, viz.: hoisting, slewing, racking, and travelling.

No. 20 MOBILE CRANE. This model has hoisting, luffing, travelling and slewing movements. It is fitted with an automatic brake on the hoisting shaft, an internal expanding brake on the front axle, and a limit switch to prevent over-winding of the jib.

No. 21 TRANSPORTER BRIDGE. The carriage automatically travels to and fro for as long as the motor is driven, pausing for a few seconds at each end of its travel.

No. 22 TRACTION ENGINE. A remarkably realistic model that will pull a boy of average weight. Fitted with two speeds.

No. 23 VERTICAL LOG SAW. While the saws are in motion, the logs are fed slowly to them.

No. 24 TRAVELLING GANTRY CRANE. The movements of this model comprise the traversing of the entire gantry, hoisting and lowering, and the traversing of the crane trolley.

No. 25 HYDRAULIC CRANE. The hydraulic ram is represented realistically by a powerful screw mechanism.

No. 26 TWIN ELLIPTIC HARMONOGRAPH. Some beautiful designs may be produced with this model.

No. 27 DRAGLINE. This imposing model of a giant excavator is fitted with travelling, luffing, slewing, and dragging movements.

No. 28 PONTOON CRANE. The movements of this model include the operation of the two hoisting blocks, slewing of the entire crane, and luffing.

No. 29 HAMMERHEAD CRANE. This is a very realistic and powerful model, comprising traversing, hoisting and slewing motions.

No. 30 BREAKDOWN CRANE. This model is equipped with travelling, slewing, luffing, and hoisting motions, and also is fitted with laminated springs, brakes, out-riggers, etc.

No. 31 WAREHOUSE WITH ELEVATORS. The two cages are driven automatically and work alternately, pausing at top and bottom positions.

No. 32 TWO-CYLINDER STEAM ENGINE AND BOILER. This is a realistic working model of a complete steam plant, equipped with valve gear, governor, balanced cranks, etc.

No. 33 SINGLE AND DOUBLE FLYBOATS. These two models represent popular pleasure-fair attractions.

No. 34 THREE-ENGINE BIPLANE. This is a realistic model if an "Argosy" machine, and is fitted with ailerons, elevators and rudders.

No. 35 LEVEL-LUFFING AUTOMATIC GRABBING CRANE. The crane is provided with level luffing gear, by means of which the load maintains a constant height when the jib is luffed. An important feature is a grab that may be opened and closed automatically.

No. 36 ELECTRIC DERRICK CRANE (Scotch Type). This model is built to a scale of ¾ in. to 1 ft., the jib measuring 6 ft. in length. Three movements, hoisting, luffing and slewing are driven from a specially designed gear-box. The model is capable of level-luffing and is driven by means of a 6-volt Electric Motor.

No. 37 8-INCH HOWITZER, LIMBER AND TRACTOR. The gun fires ammunition (Washers) with considerable accuracy and force. The tractor is fitted with "creeper" track.

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AXLE RODS :
No. 13, 11½" long **No. 14, 6½" long** **No. 15a, 4½" long** **No. 16a, 2½" long** **No. 17, 2" long** **No. 18b, 1" long**
No. 13a, 8" long **No. 15, 5" long** **No. 16, 3½" long** **No. 16b, 3" long** **No. 18a, 1½" long**

The Rods are made to a diameter of .160 inches. If very long lengths are required two Axle Rods may be joined end to end by means of a Coupling. In addition to their obvious uses as shafting or spindles for rotating machinery, the Rods are often employed as levers, guides for sliding mechanisms such as the work-table of a lathe or planing machine, tie rods or struts in structural work, etc.

In assembling rotating machinery the bearings should receive careful attention. When very heavy strains are to be met it is a good plan, instead of journalling the Rod in a hole in a single Plate or Strip, to reinforce the bearing by bolting a Wheel or Crank to the Plate so that the Rod may turn freely in the boss. If the Wheel is bolted so that the set-screw hole is uppermost, an excellent oil receptacle will be provided.

For all ordinary purposes the set-screws provided with the various Meccano Wheels and Cranks should be sufficient to hold the parts rigidly in position on the Axle Rods. In the latest Meccano parts, however, the set-screw hole has been extended right through the boss so that two set-screws can be inserted if desired, one on each side.

CRANK HANDLES : No. 19, 5" long. No. 19s, 3½" long.

These parts are in reality ordinary Axle Rods with their ends bent to form convenient handles. In addition to their obvious uses, they may be employed where a bent handrail is required, or as a crankshaft when the crank is required at one end only and not in the centre as in part No. 134. The stroke of the crank so provided is roughly 1½".

No. 134, CRANKSHAFT, 1" stroke.

May be used to convert rotary motion to reciprocating motion, or *vice versa*. It gives a stroke or total rectilinear movement of 1". An ordinary Meccano Strip is intended to be used as the connecting Rod. It should be slipped into place in the centre of the crank portion and held in position by two Spring Clips. A more elaborate connecting rod may be built-up as shown in Fig. 56. It consists of an Axle Rod 2, the big-end bearing being formed from two 1½" Strips mounted on the crank and bolted to a Coupling 1. The Strips are held in place by a ½" Bolt 3 passing completely through the end of the Coupling, and by a pair of set-screws 4, which serve also to grip the connecting rod in the Coupling. The position of the connecting rod in the centre of the crank is maintained by a Spring Clip 5 mounted between two Washers.

SCREWED RODS :
No. 78, 11½" long **No. 79a, 6" long** **No. 80a, 3½" long** **No. 81, 2" long**
No. 79, 8" long **No. 80, 5" long** **No. 80b, 4½" long** **No. 82, 1" long**

The Screwed Rods are cut throughout their lengths with the Meccano standard thread (32 threads to the inch). Their principal function is the conversion of rotary motion to longitudinal motion, as in screw elevating machinery, etc. Also, in cases where a long bolt is required, one of the shorter Screwed Rods may be used with advantage.

Several Meccano parts are specially designed for use in connection with the Screwed Rods, such as the Threaded Boss, Threaded Crank and Threaded Coupling. If one of these parts is secured to a portion of a model and a Screwed Rod threaded through it, then the latter may be caused to move longitudinally as it rotates, or this movement may be prevented and instead that portion of the model carrying the threaded part caused to move up and down the rod.

If it is required to fix a Threaded Boss or Threaded Coupling on a Screwed Rod, a nut should be placed on the Rod and screwed tightly against the part. It should never be secured by a set-screw, as this will damage the thread of the Rod. Any other Meccano Wheel, Pinion, etc., may be attached rigidly to a Screwed Rod by gripping it tightly between two nuts threaded on the Rod.

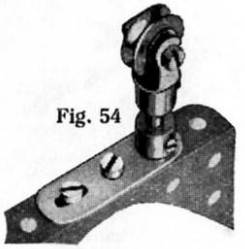
Fig. 54

Fig. 55

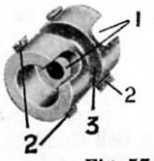

Fig. 57

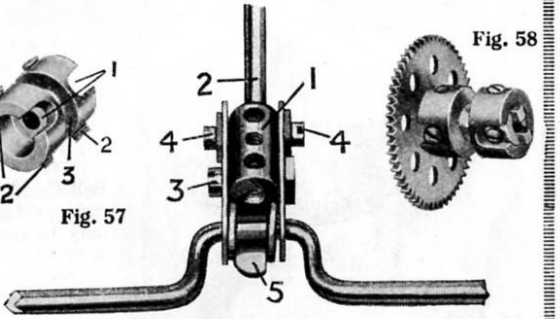

Fig. 56

Fig. 58

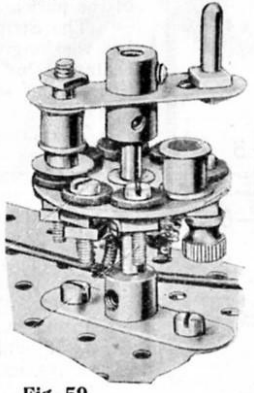
Fig. 59

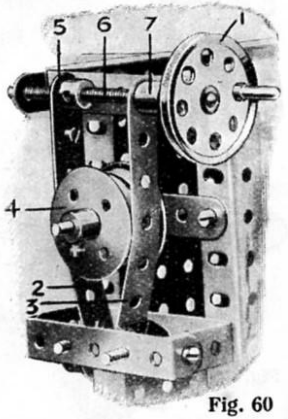

Fig. 60

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Class M: Rods, Cranks and Couplings *(continued)*

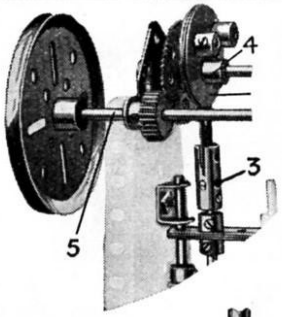

Fig. 61

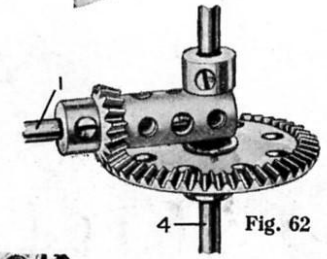

Fig. 62

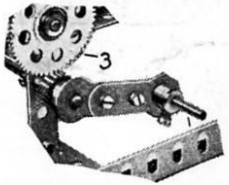

Fig. 63

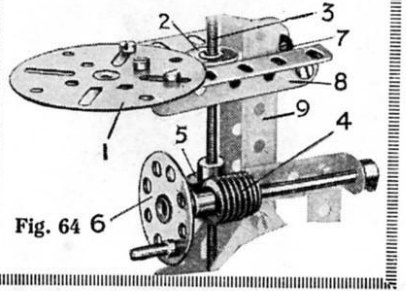

Fig. 64

When it is required to journal a Screwed Rod so that it may rotate like an ordinary Axle Rod, it should be connected by Couplings to Axle Rods so that the latter may be journalled in the bearings instead of the Threaded Rod. If this is not possible the Rod should be journalled in the boss of a Crank or Wheel, etc., in order that the bearing surfaces shall be as large as possible.

It should be remembered that the Screwed Rod proves invaluable as a means of increasing the available power, although at a considerable loss of speed. It may be used wherever it is necessary to cope with specially heavy loads. Fig. 60 shows a Screwed Rod employed to expand or contract the bands of a brake (see S.M. No. 106). In Fig. 64 a Screwed Rod is employed as a simple means of elevating or lowering the worktable in a model drilling machine.

No. 62, CRANK.
No. 62a, THREADED CRANK.
No. 62b, DOUBLE ARM CRANK.
No. 127, SIMPLE BELL CRANK.
No. 128, BOSS BELL CRANK.

No. 62 is in reality a short Strip fitted with a boss so that it may be attached easily to an Axle Rod. In addition to its obvious uses as a crank, it may be employed to secure an Axle Rod to any other Meccano part, or to form handles as in Fig. 63.

The Threaded Crank is similar to the ordinary Crank except that the longitudinal bore of the boss is tapped, or threaded. The functions of this part have already been indicated in connection with the Screwed Rods.

The Double Arm Crank has similar functions to part No. 62, but when a crank stroke of only 1" is required it proves far more adaptable. It is ideal for securing Rods to Strips or Plates, as will be seen from Fig. 59. This illustration shows a Meccano electric controller and it will be seen that another Double Arm Crank is used as the controller handle. The Crank is free to turn about the fixed vertical Rod, being held in position by a Collar placed on the extreme upper end of the Rod, and one arm is used to carry the spring contact whilst the other is fitted with the Threaded Pin that forms the handle proper.

The only difference between parts Nos. 127 and 128 is that the Simple Bell Crank has no boss. The Meccano Bell Crank is a lever of the first order and is employed as a means of changing the direction of a force through a right angle. For example, supposing the Bell Crank is mounted on a horizontal Rod, a downward pull on one arm may be converted to a transverse pull or push on the other. Another important use of the Bell Crank is found in strengthening the corners of a rectangular framework of Strips, where it forms a very neat connecting piece.

No. 63, COUPLING.
No. 63a, OCTAGONAL COUPLING.
No. 63b, STRIP COUPLING.
No. 63c, THREADED COUPLING.
No. 121, TRAIN COUPLING.
No. 140, UNIVERSAL COUPLING.
No. 171, SOCKET COUPLING.

Part No. 63 is intended primarily for connecting Meccano Rods at various angles to each other. Typical uses of the part are shown in Figs. 55 and 62. The use of the Coupling in Fig. 56 has already been described.

The Strip Coupling is intended for coupling a Strip to a Rod as shown in Fig. 61. The Threaded Coupling has the longitudinal bore tapped for half its distance, so that a Screwed Rod may be inserted in one end and an ordinary Rod in the other. The Octagonal Coupling has a number of flat surfaces, the object of which is to receive Strips when it is required to bolt them to the side of the Coupling. The part will also form a kind of ratchet when it is desired to turn a Rod step by step, a spring strip being caused to press upon the flats.

The Train Coupling provides means of connection between Meccano models of railway subjects and Hornby rolling stock. The Universal Coupling is intended to couple two shafts together end to end, so that they may rotate through almost any angle to each other.

The Socket Coupling is designed to couple two wheels or gears together rigidly so that they can turn as a unit upon a shaft, or alternatively remain stationary while the shaft carrying them turns in the Coupling. Fig. 58 shows a Socket Coupling used to connect a section of a Dog Clutch to a 57-teeth Gear Wheel. The slots 1 of the Coupling (Fig. 57) enable wheel bosses to be inserted without removing the set-screws, while the grub-screws 2 secure the bosses in position. The groove 3 facilitates the sliding movement of the Coupling.

No. 165, SWIVEL BEARING.

Intended for coupling Rods together when they are used as levers, etc. Two Swivel Bearings are illustrated in Fig. 55, which shows a linkage for converting a pull on one lever to a thrust on another.

No. 166, END BEARING.

The End Bearing has functions similar to those of the Strip Coupling. It may be used as a crosshead between the piston rod and connecting rod of a small reciprocating engine.

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No. 19a, WHEELS, 3" diam.

No. 19a has a smooth circumference and is provided with ten spokes. It is intended for use as a travelling wheel in vehicles of all descriptions.

FLANGED WHEELS : No. 20, 1¼" diam. No. 20b, ¾" diam.

Intended primarily for use in all kinds of models that are required to run upon rails. They have other important uses, however, chief of which is their employment as belt pulleys. An excellent belt pulley may be formed by mounting two Flanged Wheels together as shown in Fig. 66. An important adaptation of the ¾" Flanged Wheel for forming the ends of a realistic cylinder is described in connection with the Sleeve Piece (Class D). Incidentally, another novel use for the part was shown in Fig. 32 on the same page, for the chimney of the Meccano Traction Engine illustrated therein is topped by a ¾" Flanged Wheel, the boss of which is inserted in the upper Sleeve Piece.

No. 24, BUSH WHEEL, 1¾" diam.

The functions of the Bush Wheel are too numerous to mention in detail, but the chief are its use as a boss to which other Meccano parts, such as Hub Discs, etc., may be bolted, or as an end plate for a cylinder, etc.

No. 109, FACE PLATE, 2½" diam. No. 137, WHEEL FLANGE, 2½" diam.

The Face Plate and Wheel Flange used in conjunction are very useful for building up large flanged wheels. Fig. 65 shows a section of a large Meccano locomotive, the bogie wheels of which each consist of a Wheel Flange bolted to a Face Plate.

The Wheel Flange, in addition, has many widely different adaptations. Fig. 70 shows it used as part of a centrifugal governor. In this mechanism the governor weights 5, which are attached to short Strips 3 carried on a Bush Wheel 1, fly outward when the latter rotates and press against the inside of the Wheel Flange, so preventing the Bush Wheel exceeding a certain speed limit. In the Meccano Motor Chassis Wheel Flanges form the brake drums for the internal expanding brakes on the rear axle.

The Face Plate also fulfils other functions. Its obvious use is in a lathe, where it serves as a face plate and thereby justifies its name. In Fig. 72 two Face Plates are shown employed as a hub for a large built-up flywheel.

No. 118, HUB DISC, 5½" diam.

When bolted to a Circular Plate, this part is well suited to form a large Flanged wheel. In Fig. 65 it is shown in this connection where it forms one of the main driving wheels of a Meccano locomotive.

In addition to this important adaptation, the Hub Disc is admirably suited to form a flywheel or large travelling wheel. Fig. 71 shows one of the rear travelling wheels of the Meccano Traction Engine, and as will be seen it consists of two Hub Discs bolted together so that a wheel of specially wide tread is obtained. A number of nuts and bolts are inserted round the circumference

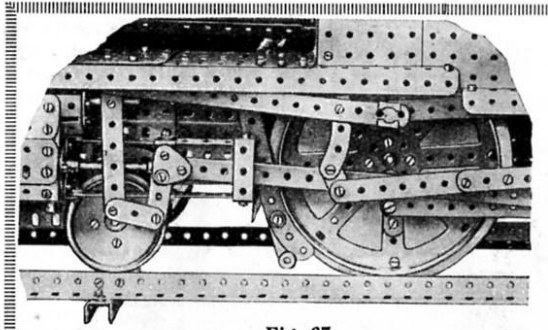

Fig. 65

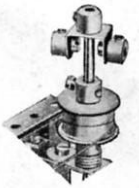

Fig. 66

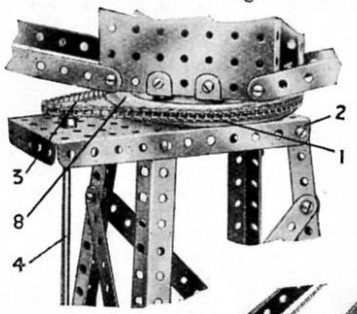

Fig. 67

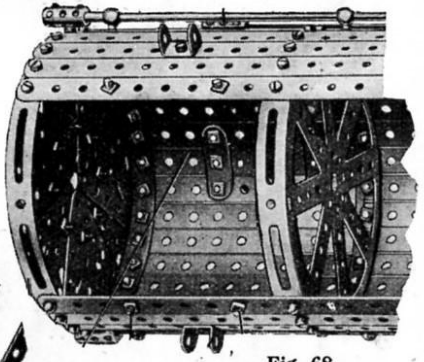

Fig. 68

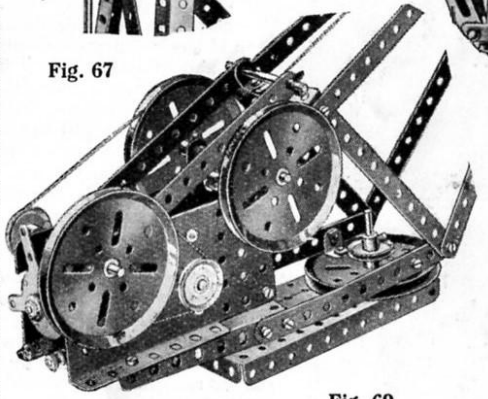

Fig. 69

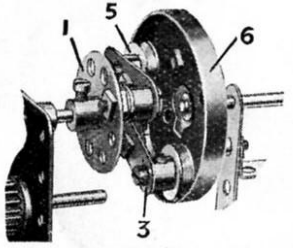

Fig. 70

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Class N: Wheels, Pulleys, Bearings, etc. *(continued)*

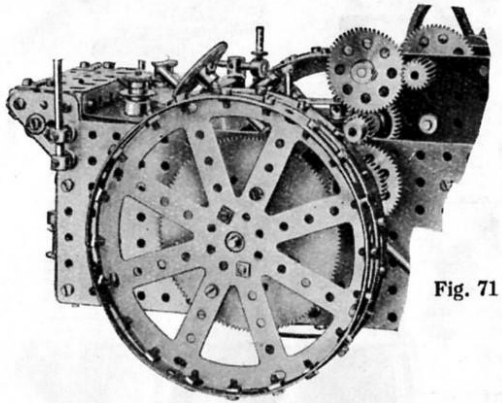

Fig. 71

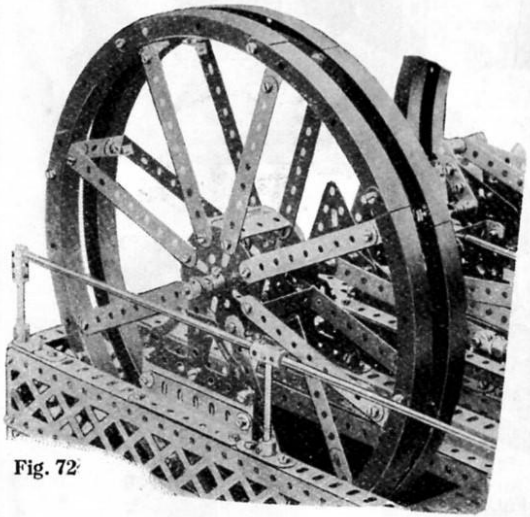

Fig. 72

of the Hub Discs to obtain a better grip on the road. When it is desired to secure a Hub Disc to an Axle Rod it will be necessary first to bolt the Disc to a Bush Wheel or 1½" Pulley, etc., so that the set-screw of the latter may be utilised to grip the Rod. In Fig. 68 a Hub Disc forms the end plate of a Boiler, while another serves as an internal supporting rib.

No. 119, CHANNEL SEGMENT (8 to circle, 11½" diam.)

The Channel Segments are intended to be bolted together end to end to form a circle or portion of a circle 11½" in diameter. This can be used as a flywheel, or as a base for rotating structures. Fig. 72 shows a heavy flywheel, built up from two circles of Channel Segments connected together and supported by Strips radiating from a central hub.

No. 132, FLYWHEEL, 2¾" diam. Weight 5 oz.

Made of lead alloy, with brass boss. May be employed wherever it is required to smooth over unequal stresses in rotating machinery. The hub and the circumference of the wheel itself are provided with grooves to receive belt drives.

PULLEY WHEELS :

No. 19c, 6" diam., with centre boss and set-screw.
No. 19b, 3" diam., with centre boss and set-screw.
No. 20a, 2" diam., with centre boss and set-screw.
No. 21, 1½" diam., with centre boss and set-screw.
No. 22, 1" diam., with centre boss and set-screw.
No. 23a, ½" diam., with centre boss and set-screw.
No. 22a, 1" diam., without centre boss and set-screw.
No. 23, ½" diam., without centre boss and set-screw.

Pulleys form one of the mechanical powers, and by coupling a series of them to a Meccano Motor or even to a Crank Handle, considerable loads may be lifted with comparative ease. Pulleys enable a small force to overcome a greater load by reason of the fact that they enable the force to move through a greater distance than the load, just as a lever enables one, by moving one end through a certain distance, easily to raise a heavy load through a smaller distance at the other end. The greater the number of Pulleys used the greater will be the mechanical advantage obtained, but it is important to remember that increased advantage is only obtained at the expense of the speed at which work can be done.

It must here be explained that a pulley block consists of a frame comprising one or more wheels, or "sheaves," capable of rotating independently, and round which a rope may be passed or "rove." Hence if Meccano Pulleys are employed to construct a model pulley block, they are referred to in technical language as "sheaves."

Supposing a model crane is capable of lifting a load of 1 lb. attached directly to the crane hook, then if the hoisting cord, instead of being attached to the hook, is led round the sheave of a pulley block and taken back and fastened to the jib of the crane, a load of 2 lbs. could be raised with only a very slight increase in the power, this slight increase being necessary to overcome friction created in the pulley block, and in the bending of the cord. The load of 2 lbs. could only be raised at half the speed of the former load, however.

Similarly, if an extra sheave is incorporated in the suspended pulley block and the hoisting cord, after passing round the first sheave, is led back and round another pulley at the jib head, then round the second sheave in the pulley block, and finally is fastened to the jib head, then the crane hook will move at a quarter of its original speed and the crane will be capable of raising a load of 4 lbs. (or slightly less, allowing for friction).

Besides their use as sheaves for pulley systems, the Meccano Pulleys may be used as the running wheels of travelling models of all descriptions, and most important function of all, they make possible the construction of belt gearing. Fig. 69 shows a belt system constructed with their aid, by which the speed of an Electric Motor is reduced so that a crane may be operated from it. It will be seen that a 1" Pulley secured to the armature shaft drives a 3" Pulley secured to a secondary shaft, while another 1" Pulley on the latter drives a second 3" Pulley on the winding shaft. Since the diameter of the driven pulley is roughly three times the diameter of the driving pulley a speed reduction of approximately 3:1 will be obtained in each case, thus resulting in a total reduction between the armature and winding shaft of 9:1.

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PULLEY BLOCKS :
No. 151, Single Sheave. **No. 152, Two Sheaves.** **No. 153, Three Sheaves.**

Complete with lifting hook and a lug to which the hoisting cord may be attached.

No. 123, CONE PULLEY.

A single Cone Pulley corresponds to three ordinary Pulleys of ¾", 1", and 1¼" diameters formed into a unit. Cone Pulleys are intended for use in pairs, so that a drive can be transmitted from one Cone Pulley to the other by a belt passing round, say, the ¾" diam. groove of one and round the 1¼" groove of the other. Then if it is desired to vary the relative speeds of the shafts, the belt may quickly be removed and placed over the 1" groove in each Pulley, or alternatively, round the 1¼" groove of the first Pulley and the ¾" of the second. The respective ratios so obtained are roughly 5:3 ; 1:1 ; 3:5.

No. 167, GEARED ROLLER BEARING, complete, 12" diam.
Components : No. 167a, GEARED ROLLER RACE, 192-teeth. No. 167b, RING FRAME.
No. 167c, PINION, 16-teeth.

The Meccano Complete Geared Roller Bearing consists of the following units : two Geared Roller Races, one Ring Frame, sixteen ¾" Flanged Wheels, sixteen Pivot Bolts each with two nuts, one 9½" Strip, two Bush Wheels, one 1½" Rod, ten Nuts and Bolts, and one special Pinion. The complete bearing measures 12" overall diameter and is intended for use in building large swivelling structures, such as rotating bridges, etc.

The Roller Bearing is assembled as follows : One of the Roller Races is secured to the fixed portion of the model and the 1½" Rod is fastened in the Bush Wheel bolted to its centre. The Ring Frame is then placed over the Race so that the flanges of the wheels run upon its raised rim. The second Roller Race is then placed over the Ring Frame so that its raised rim rests upon the flanges of the wheels. The 1½" Rod passes through the centre hole of the 9½" Strip that is bolted across the Ring Frame, and through the Bush Wheel in the centre of the upper Roller Race.

Fig. 73 shows a typical adaptation of the standard Roller Bearings. In this case the superstructure is caused to turn round on the Flanged Wheels 1 on operation of a certain lever incorporated in the control mechanism. The drive from the Motor controlling the rotational movement is directed to the vertical Rod 2, on the lower end of which is mounted the special 16-teeth Pinion. The latter engages with the teeth of the lower Roller Race 3 ; hence on rotation of Rod 2 the Pinion travels round the Roller Race, carrying the superstructure with it.

Alternatively, if the driving mechanism is in the fixed base of the model, the Pinion should be secured to a Rod journalled in a vertical position in the base and caused to engage with the upper Roller Race.

No. 168, BALL BEARING, complete, 4" diam.
Components : No. 168a, BALL RACE, Flanged. No. 168b, BALL RACE, Toothed.
No. 168c, BALL CASING, complete with Balls.

The complete Ball Bearing consists of three sections, namely, one Flanged Ball Race, one Toothed Ball Race, and one Ball Casing complete with Balls. Fig. 67 shows the application of the Ball Bearing to a small crane. The Flanged Ball Race 1 is secured to the Flanged Plate 2, and the Geared Ball Race 8 is fastened to the swivelling structure. The Ball Casing is placed between these two parts so that the Flanged Ball Race rests upon the Balls. A short Rod passed through the centre of the Ball Races 1 and 8 and maintained in its position by Collars, holds the unit together. The super-structure is rotated by means of a Sprocket Chain passed round the teeth of the Toothed Ball Race 8 and engaging a 1" Sprocket Wheel 3 which is secured to a driven Rod 4.

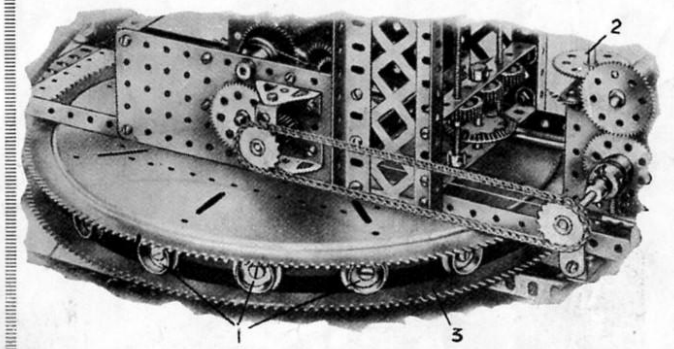

Fig. 73

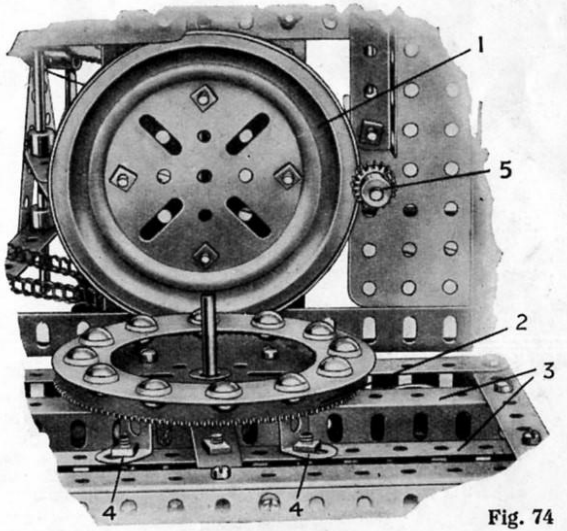

Fig. 74

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Class O: Gears and Toothed Parts

Fig. 75

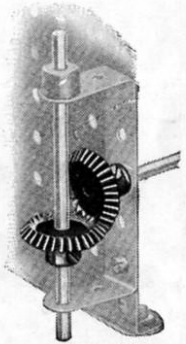

Fig. 76

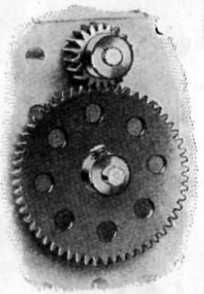

Fig. 77

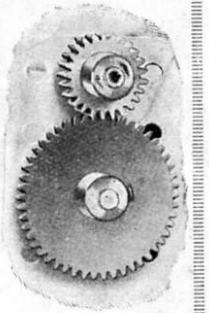

Fig. 78

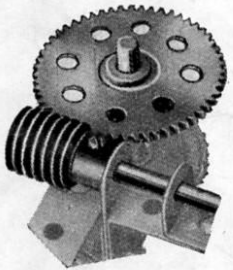

Fig. 79

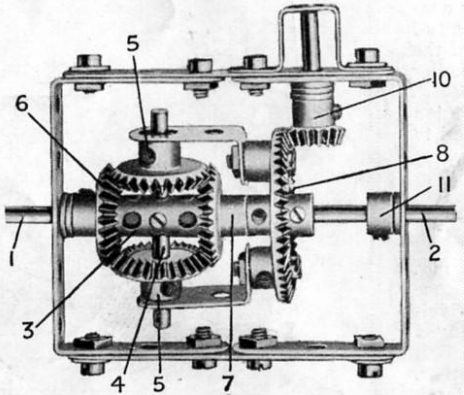

Fig. 80

The Meccano range of gear wheels is very comprehensive and enables almost any speed ratio to be obtained. The gears are manufactured from solid brass, with the exception of the 3½" Gear Wheel and the Sprocket Wheels, which are of specially fine steel. The teeth are cut one at a time, not stamped out, and the precision of the finished parts is such that they are regularly used in the construction of all kinds of scientific apparatus.

The Pinions and Gear Wheels enable ordinary gear trains to be assembled, whilst the Bevel Gears and Contrate Wheels are for transmitting the drive through right angles. The Sprocket Wheels are of course designed for use in connection with chain drive transmission.

The published diameters of the various Meccano Pinions and Gear Wheels do not represent the overall measurements of the Gears, for they are measured from the " pitch line." This is an imaginary line that runs through approximately the centre of the teeth; it indicates the points on the teeth where the actual thrust is imparted from one gear to the other.

PINION WHEELS :

No. 25, ¾" diam., ½ "wide.	**No. 25b, ¾" diam., ¾" wide.**	**No. 26a, ½" diam., ½" wide.**
No. 25a, ¾" diam., ½" wide.	**No. 26, ½" diam., ½" wide.**	**No. 26b, ½" diam., ¾" wide.**

GEAR WHEELS :

No. 27, 50-teeth, 1 5/16" diam. No. 27a, 57-teeth, 1½" diam. No. 27b, 133-teeth, 3½" diam.

In Fig. 78 a ¾" Pinion is engaged with a 50-teeth Gear Wheel. Let us assume that the Rod upon which the Pinion is fixed is rotated at a speed of 60 revolutions per minute. The ¾" Pinion has 25 teeth, and for every complete revolution that it makes it will cause the 50-teeth Gear Wheel to turn a distance occupied by 25 of its teeth, which is exactly one half of its circumference. Thus the 50-teeth Gear will turn only 30 revolutions per minute. The difference in speed obtained in this combination of Pinion and Gear is therefore as 2 to 1, and is written " ratio 2:1."

A ½" Pinion having 19 teeth is shown in Fig. 77 in mesh with a 57-teeth Gear Wheel. As the latter has three times as many teeth as the Pinion (and its pitch line diameter is three times as great), three revolutions of the Pinion are required for every complete revolution of the Gear Wheel. The ratio of this combination is therefore 3 : 1.

There are of course numerous other gear ratios obtainable, and the more usual ones are shown below, together with the alternative methods by which they may be produced. Meccano boys may find the list useful for reference.

Ratio 1 : 1—two ½" Pinions (axles ½" between centres); two 1" Gear Wheels (axles 1" between centres); two 57-teeth Gear Wheels (axles 1½" between centres); two ¾" Bevel Gears (see Fig. 76); ¾" Pinion and ¾" Contrate Wheel. 3 : 1—½" Pinion and 57-teeth Gear Wheel (axles 1" between centres); ½" Bevel and 1½" Bevel.

7 : 1—½" Pinion and 3½" Gear Wheel (axles 2" between centres). 19 : 1—½" Pinion and Worm. 57 : 1—57-teeth Gear and Worm (see Fig. 79).

A variety of gear ratios may of course be obtained by connecting two Sprocket Wheels of varying diameter with a length of Sprocket Chain.

The ½" and ¾" diam. Pinions are each made in three widths, ¼", ½" and ¾". The ¼" width Pinion is for ordinary gearing, whilst the wider Pinions are specially designed for use in cases where the shaft on which a Pinion is secured is required to move longitudinally without disengaging the Pinion from its Gear Wheel. This movement is frequently required in Meccano gear boxes.

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Class O: Gears and Toothed Parts *(continued)*

Fig. 87 shows how three different speeds may easily be obtained from a driving shaft with the aid of one intermediate shaft and a ½" diam. ½" width Pinion. Rod 1 is the driving shaft and carries the special Pinion. Rod 2 is the intermediate shaft, and Rod 3 is the driven shaft. Rod 2 may be moved longitudinally in its bearings by means of the sliding hand lever 4, which is connected to Rod 2 by means of the Couplings 5 and 6, the latter being free on the Rod 2. The movement of Rod 2 is so adjusted by Collars 7 that the 57-teeth Gear Wheel 8 remains always in mesh with the ½" width Pinion 9. On sliding the lever 4, the drive may be transmitted to the Rod 3 either by way of (a) the Gear 8 and Pinion 10, (b) the 50-teeth Gear Wheel 11 and ¾" Pinion 12, or (c) by the two 1" Gears 13.

A further example of the adaptability of the ½" width Pinion will be found in Fig. 84. In this case a ½" diam. ½" width Pinion 10 is connected by a Socket Coupling 9 to the male portion of a Dog Clutch 11. The unit so formed is free on the vertical Rod 3, but on operation of a lever which carries a bolt that engages with the groove of the Socket Coupling, it may be raised so that the Dog Clutch section is engaged with the female section 12 that is secured to the Rod 3. When out of engagement the sliding unit rests on the Collar 13. The Pinion 10 is in constant engagement with a Worm on the driving shaft; hence the Rod 3 may be thrown in or out of engagement when desired merely by moving the control lever up or down. The ½" width Pinion is necessary because if an ordinary ½" width Pinion was used it would come out of engagement with the Worm as soon as the lever was raised.

Fig. 86 is another typical Meccano gear box, providing three speeds forward, neutral and reverse gears. This type of gear box is particularly adaptable to model motor cars. The Rod 64 forms the primary driving shaft and the drive is transmitted through the countershaft 71 to the driven shaft 78. The different speeds are obtained by sliding the Rod 71 longitudinally so that the drive is transmitted through different sets of gears. Reverse gear is obtained when the drive passes through the Gears 68, 72, 77, 83 and 81, the speed ratio between the driven shaft 78 and the driving Rod 64 being 1 : 2. First speed forward is obtained when the following Gears are engaged: 68, 72, 75 and 79. This gives a ratio between shafts 78 and 64 of 1 : 4. In the second forward speed the drive is directed via 69, 73, 75 and 79 (ratio 1 : 2) and top forward speed is obtained through the Gears 69, 73, 76 and 80 (ratio 1 : 1). In a certain position of the countershaft 71, the only Gears in engagement are 68, 72, 81 and 83. This represents neutral gear, for the Pinion 83 and the countershaft revolve idly and no power is applied to the shaft 78.

No. 167a, ROLLER RACE, Geared, 192-teeth.
No. 167c, PINION for Roller Bearing, 16-teeth.

For particulars of these parts, see under Class N.

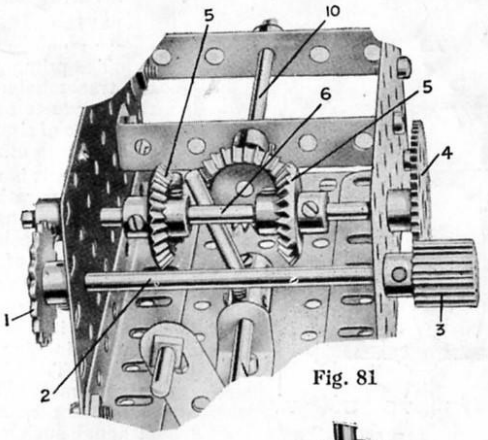
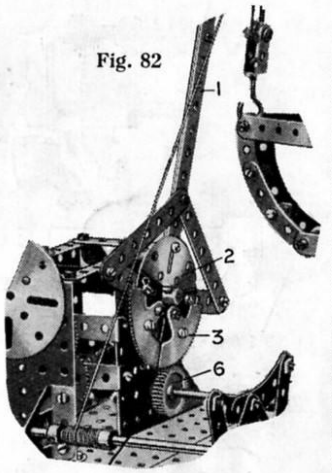


Fig. 81

Fig. 82



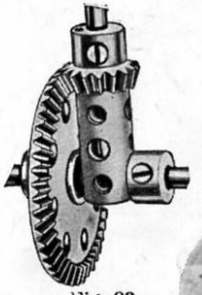


Fig. 83

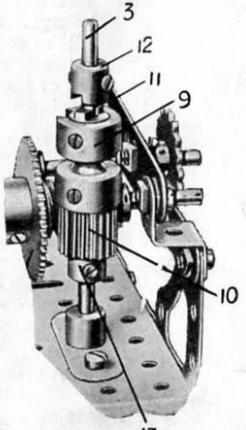
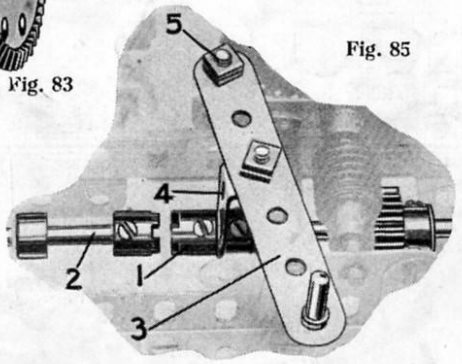


Fig. 84

Fig. 85



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Class O: Gears and Toothed Parts *(continued)*

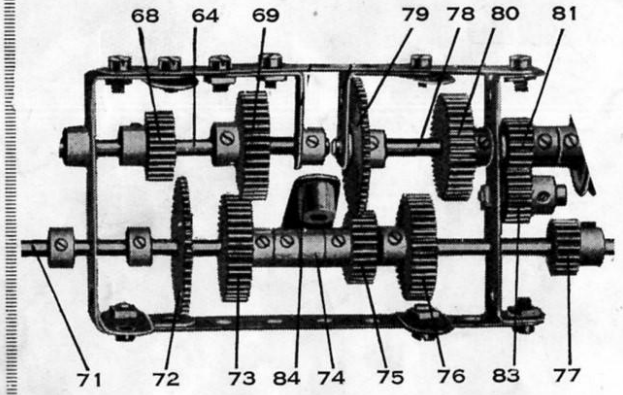

Fig. 86

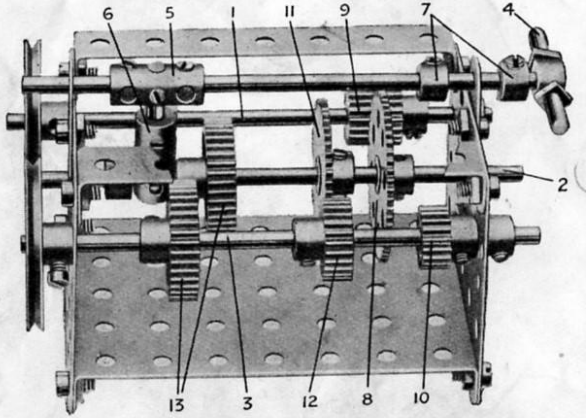

Fig. 87

CONTRATE WHEELS :
No. 28, 1½″ diam., 50-teeth. **No. 29, ¾″ diam., 25-teeth.**

BEVEL GEARS :
No. 30, ⅞″ diam., 26-teeth. **No. 30a, ½″ diam., 16-teeth.** **No. 30c, 1½″ diam., 48-teeth.**

The primary function of the Contrate Wheels is similar to that of the Bevel Gears, i.e., the transmission of driving power at right angles. In certain cases, however, they lend themselves to adaptations that are not possible with the Bevel Gears. For example, two Contrates of similar size mounted face to face on a common axis so that their teeth interlock will form an efficient clutch unit, and one may be thrown in or out of gear with the other.

When it is required to transmit a powerful drive at right angles it is preferable to use Bevel Gears rather than Contrate Wheels since in the former the teeth make contact over a greater area than in the Contrate Wheels. However, those Meccano boys who possess Contrate Wheels but no Bevels will find that they may employ the former in almost every case in place of Bevel Gears, with fairly good results.

In order to reduce friction to a minimum and to obtain a smooth even drive, bevel gearing is always designed so that the surfaces of the teeth of two bevels that mesh with each other lie in planes which, if extended, would all meet in a common point, and this point would coincide with the imaginary point of intersection of the axis of the shafts carrying the bevels. The Meccano Bevels are made with the teeth at such an angle that two ⅞″ Bevels may be meshed together or a ½″ Bevel may be engaged with a 1½″ Bevel. Two 1½″ Bevels should not be meshed together, nor should a ⅞″ Bevel be engaged with a 1½″ Bevel, for although such gearing would work, the teeth would not be properly in line.

Fig. 80 should give a good idea of some of the more important adaptations of the Meccano Bevel Gears. It represents the differential gear incorporated in the Meccano Motor Chassis. The ½″ and 1½″ Bevel Gears are used to transmit the drive from the propeller shaft to the rear wheels, and the series of ⅞″ Bevels 5, 6, and 7 are arranged so that power may be applied to both road wheels under varying working conditions. Normally the Bevels 5, in rotating about the rear axle, carry the Bevels 6 and 7 bodily with them, but should one of the road wheels slow down or stop, as happens when the car turns a corner, etc., one of the Bevels 6 or 7 slows down and the Bevels 5 tend to travel round its teeth, thus causing the opposite Bevel to turn at a greater speed.

In Fig. 81 three ⅞″ Bevels are employed to form a simple and compact reversing gear. The driving power is applied to the shaft 2 and is directed via the ½″ diam. ½″ width Pinion 3 to the Gear Wheel 4, which is secured to the Rod 6 carrying two Bevel Gears 5. The reverse is effected by a hand lever connected to a rocking arm that causes the Rod 6 to move longitudinally in its bearings by striking one of the Collars secured against the faces of the Bevels 5. The direction of rotation of the driven Rod 10 is changed by bringing one or other of the Bevels 5 into engagement with the third Bevel, which is rigidly fastened to the Rod 10. The ½″ width Pinion 3 is used so that the Gear 4 may remain in gear with the driving shaft throughout the longitudinal movement of the Rod 6.

Another very useful adaptation of both Bevel and Contrate Gears is found in the assembly of reduction gearing between two shafts that are mounted in direct line with each other. A specimen gearing of this type, in which Contrates are employed, is shown in Fig. 89. The handle 1 is secured to a 2″ Axle Rod that is journalled in the bearings 2. This Rod is free to rotate in the boss of a 1½″ Contrate Wheel 3, but is secured in one end of the Coupling 4. A further Rod 5, which runs freely in the other end of the Coupling 4, carries the 1½″ Contrate Wheel 7 fixed in the position shown.

A 1½″ Rod 8 gripped in the central transverse hole of the Coupling 4 carries a ¾″ Pinion 9, which is free to rotate about the Rod but is retained in position by a Collar 10. The Pinion

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is engaged by the teeth of both Contrate Wheels 3 and 7. The Double Bent Strip forming the bearing 2 for the driving Rod is bolted to the Plate by two ½" Bolts, the shanks of which enter holes in the Contrate Wheel 3 and so prevent the latter from rotating.

It will be found that the secondary shaft 5 rotates twice as fast as the driving Rod carrying the handle 1. Alternatively, by using the Rod 5 as the driving shaft, a 1 : 2 reduction gear will be obtained, for the 2" Rod will revolve once only to every two revolutions of the Rod 5. By repeating the device two or three times in a straight line, a very compact transmission gear may be obtained.

No. 32, WORM.

The Meccano Worm has a pitch of twelve threads to the inch, to enable it to mesh properly with the various Meccano Gears. It is extremely useful for speed reducing purposes, although it should be remembered that it absorbs a good deal of power, owing to friction created by the thrust that is produced through the tendency of the Worm to move longitudinally instead of turning the Gear Wheel. A Worm drive should always be kept thoroughly lubricated.

Owing to the fineness of the pitch the Meccano Worm is irreversible, that is, it cannot be rotated from a Gear Wheel but can only be used to impart motion to the Gear Wheel. This irreversibility of the Worm sometimes proves a great advantage. For example, if a Worm drive is applied to the winding drum of a hoisting gear, the load will remain suspended after the power is withdrawn, and there is no danger of the load over-running.

Each revolution of a Worm results in the Gear Wheel with which it meshes moving through a distance equal to one of its teeth. Hence the number of revolutions that must be made by a Worm in order to complete one revolution of the Gear Wheel or Pinion which it drives, can be ascertained by counting the teeth on the driven wheel.

An idea of the value of the Meccano Worm in speed reduction mechanisms will be obtained when it is remembered that a ratio of 3249 : 1 may be obtained merely by duplicating the gearing shown in Fig. 79, the second Worm being secured to the shaft of the Gear Wheel that is driven by the first Worm.

SPROCKET WHEELS :
No. 95b, 56-teeth, 3" diam.; No. 95, 36-teeth, 2" diam.; No. 95a, 28-teeth, 1½" diam.; No. 96, 18-teeth, 1" diam.; No. 96a, 14-teeth, ¾" diam.

The Meccano Sprocket Wheels and Chain provide an invaluable method for transmitting motion between two shafts where the distance is too great to enable gears to be used conveniently, and where a belt drive would not be sufficiently positive. There are five sizes of Sprocket Wheels, and the following are a few of the many different speed ratios that may be obtained with their aid. Certain of the figures shown are approximate only; the exact ratios can be ascertained by dividing the number of teeth on the smaller wheel into the number of teeth on the larger wheel.

Ratio 4 : 1—¾" and 3" diam. Sprocket Wheels. Ratio 3 : 1—1" and 3" diam. Sprocket Wheels. Ratio 2 : 1—¾" and 1½" diam. Sprocket Wheels. Ratio 1½ : 1—1½" and 2" diam. Sprocket Wheels.

Ratios of 1:1 may, of course, be obtained by using any two Sprocket Wheels of like diameter.

The great advantage of Sprocket gearing is that power may be transmitted through almost any distance with very little loss through friction. Conveyors and caterpillar track, etc., may also be built up with its aid. The method of separating and connecting lengths of Sprocket Chain is dealt with more fully in Class P, in which this part is included.

Meccano boys sometimes use their Sprocket Wheels like ordinary gear wheels, placing them so that their teeth engage. This practice is permissible in the construction of simple models where only a light driving power is transmitted through the gearing, but it should be avoided in more important models, since the teeth are not designed to engage one with the other as in ordinary spur gearing.

The Geared Ball Race (part No. 168b), which forms part of the Meccano Ball Bearing, is provided with standard sprocket teeth, and may therefore be used in chain driving mechanisms. It measures 4" in diameter and has 73 teeth. For further particulars of this part see Class N.

RACK STRIPS : No. 110, 3½". No. 110a, 6½".

The Rack Strips (parts Nos. 110 and 110a) are designed for converting rotary motion to rectiliniar motion, or *vice versa*. They are invaluable for obtaining the traversing movement of lathe saddles or other parts of machine tools. In model No. 6.17 in the 4-7 Instruction Manual two 3½" Rack Strips are used to impart up and down motion to a Meccano jack, while in model No. 7.8 (Steam Shovel) Rack Strips are employed to thrust the shovel arm toward or away from the jib. The 6½" Rack Strip is one of the latest additions to the Meccano system, but it has already found a very large number of uses.

A very ingenious movement produced with the aid of two 3½" Rack Strips is illustrated in Fig. 88. This is a device designed to increase the length of a crank stroke, and is taken from the Standard Mechanisms Manual, where it appears under detail No. 278. For the benefit of boys who are unable to refer to the S.M. Manual, we repeat the description :—

The connecting or piston rod is placed on the end of a ¾" Bolt 1, which passes through an Eye Piece 2 and carries on its shank a ½" Pinion 3. The latter rolls on a 3½" Rack Strip 4 secured by Angle Brackets to the base of the model. A second Rack Strip 5 bolted to two Eye Pieces 6 sliding on a 5½" Strip 7 also engages with the Pinion 3.

At each stroke of the connecting rod the Pinion 3 is caused to rotate, owing to its engagement with the Rack 4, and thereby thrusts the upper Rack Strip in the same direction as that in which the connecting rod moves, but through a distance twice as great. Strip 7 is bolted at each end to 1½" Strips secured to the base by means of 1" Angle Brackets. A second guide Strip 8, secured at either end to a 1"×½" Angle Bracket, forms a support for the Eye Piece 2.

No. 129, RACK SEGMENT.

Intended principally for use where it is required to rotate a mechanism through part of a revolution only. It should be bolted to a Face Plate or other part that is capable of turning about a centre and a 1" Gear Wheel should be engaged with its teeth. The Segment has 28 teeth and a radius of 1½", so if four Segments are placed together to form a circle, the latter will measure 3" in diameter and will have 112 teeth. Great care should be taken when joining the segments together, because unless the adjoining teeth are spaced correctly they will fail to mesh properly with the Gear Wheel.

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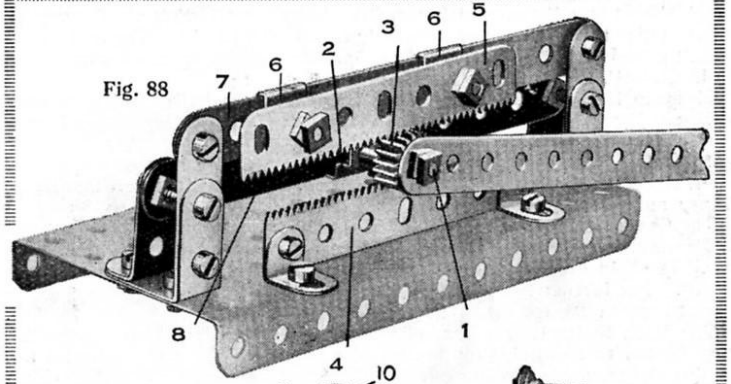
Class O: Gears and Toothed Parts *(continued)*

Fig. 88



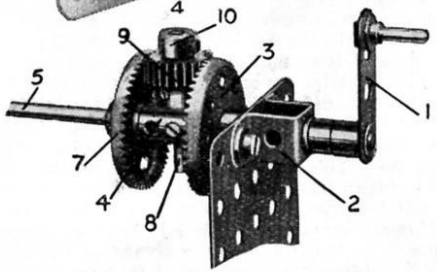


Fig. 89

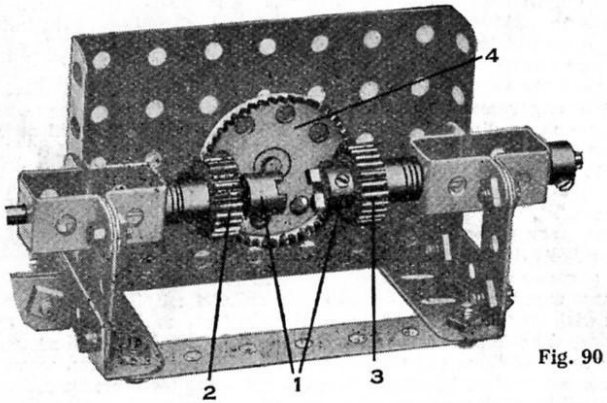


Fig. 90

Fig. 82 shows two Rack Segments secured to the bottom of one of the davit arms of a boat launching gear. This arm is required to move through less than half a circle, hence two Rack Segments joined together provide a sufficient number of teeth to receive the drive from the 1" Gear Wheel 6, a reduction ratio of approximately 3 : 1 being obtained.

No. 144, DOG CLUTCH.

Consists of one male and one female section. The object of this part is to enable two shafts to be engaged with each other or disengaged whenever desired. The shafts must be mounted end to end and one must be slidable in its bearings so that the clutch sections can be thrown in or out of engagement on operation of a suitable lever.

Alternatively, the Dog Clutch may be used, in conjunction with a Socket Coupling, to enable a Gear Wheel or Pinion, etc., to be mounted on a shaft so that it can either be carried round bodily with the shaft or allowed to remain stationary whilst the shaft carrying it turns in its boss. A typical example of the Dog Clutch used in this way has already been described (see Fig. 84).

Another typical Dog Clutch mechanism will be found in Fig. 85. In this case the driving Rod carries the Clutch member 1 and on movement of the lever 3 the secondary Rod 2 may be brought in or out of engagement. The lever is pivoted by a bolt and lock-nuts 5 to an Angle Bracket and also to a Single Bent Strip 4 that is held loosely between the Clutch sections 1 and a Collar with set-screw.

Fig. 90 shows the Dog Clutch employed in the construction of a reversing mechanism. In this mechanism either of the horizontal Rods may be used as a driving shaft. Each carries at its inner end one segment of a Dog Clutch 1, and one ¾" Pinion 2, 3. The left-hand horizontal Rod is slidable in its bearings and is controlled by a suitable hand lever, such as that shown in Fig. 85.

In the first position of the hand lever the ¾" Pinion 2 is caused to engage with a 1½" Contrate Wheel 4 (as in the illustration) whilst in its second position the Pinion is thrown out of engagement and the clutch members are combined. The Pinion 3 remains in constant engagement with the Contrate 4, and in the second position of the lever the Contrate merely revolves idly. Incidentally, this diagram indicates another important use for the 1½" Contrate Wheel.

No. 147, PAWL, with Pivot Bolt and Nuts. No. 147a, PAWL, without Pivot Bolt and Nuts. No. 148, RATCHET WHEEL.

The Meccano Pawl and Ratchet Wheel may be said to be in partnership, for the one is never used without the other, except on those rare occasions when use can be found for the Pawl only, as in the safety device fitted to the Meccano Warehouse (special instruction leaflet No. 31) where it forms a small catch that engages with the lift guides in the event of accident to the hoisting mechanism. Used in conjunction with each other, the Pawl and Ratchet provide a mechanism that allows the shaft on which the Ratchet Wheel is secured to rotate in one direction only.

A slight pressure should always be applied to the Pawl—by means of a spring or weighted lever—to ensure that it is always in proper engagement with the teeth of the Ratchet Wheel.

The Pawls may be obtained complete with a Pivot Bolt and two nuts. This Bolt forms an ideal pivot for the Pawl; it should of course be clamped to a Meccano part by the two nuts so that the Pawl is allowed plenty of freedom.

No. 159, CIRCULAR SAW.

Although a toothed part, No. 159 is included under Class P since it is for use as a saw only and has nothing to do with gearing.

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No. 41, PROPELLER BLADE.

The Propeller Blades have recently been improved in design and now conform closely to an actual aeroplane propeller, or airscrew.

Fig. 100 shows two of the three engines incorporated in the Meccano Biplane (Instruction Leaflet No. 34). Each airscrew is formed from two Propeller Blades, and each pair of blades is bolted to a Double Arm Crank, the boss of which serves to secure the complete airscrew to the engine shaft.

The hub end of each blade is rounded so that it partially encloses the boss of the Double Arm Crank; hence one bolt is sufficient to hold the blade perfectly rigid. If a Double Arm Crank is not available the blades may, of course, be bolted to a Bush Wheel or similar part.

The broader parts of the blades are turned at an angle to the plane of rotation so that a considerable current of air is created by the airscrew when in motion. As a matter of fact the Propeller Blades have been employed successfully in a Meccano Electric Fan, although for such a purpose it is better to shape the fan itself from a sheet of tin so that the blades may be as broad as possible.

A very interesting small model making use of the Propeller Blades is the Helicopter Toy described under Model No. 5.24 in the new 4-7 Instruction Manual.

No. 61, WINDMILL SAIL.

Like the Propeller Blade, the Windmill Sail has its hub end cut out so that it will fit round the boss of a wheel, or round the raised lip on the wheel on the reverse side to the boss. Amongst other adaptations of the Windmill Sail may be mentioned its use to represent cabin sides in model ships (complete with windows!) and wings for small aeroplanes.

WEIGHTS: No. 66, 50-gramme. No. 67, 25-gramme.

Supplied specially for use in scientific experiments, where perfectly accurate weights are essential. They also find numerous other applications in ordinary model-building. Fig. 95 shows a portion of a device for measuring the movement of a beam that is subjected to a bending stress. In order to measure the strength of the beam correctly, the exact amount of the weight applied must be known.

In the illustration five 50-gramme weights 3 are attached to the centre of the beam by means of a Scientific Hook.

The 25-gramme Weight 4 serves as a counterbalance to the weight of the Pointer, so that the latter always returns to the zero position when the load is removed from the beam. In Fig. 94 a 25-gramme Weight is used for a similar purpose, i.e., for returning a Pointer to "zero" or neutral, after deflection. Of course, in these two last-mentioned cases it is not essential that the weights should be of great accuracy or even of any particular amount, and if a Meccano boy does not already possess these parts he can use home-made weights, or a Meccano Wheel or two, in their place. This remark applies to several models shown in the Meccano literature.

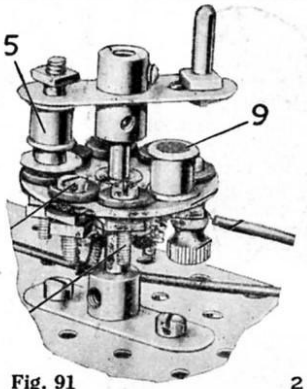

Fig. 91

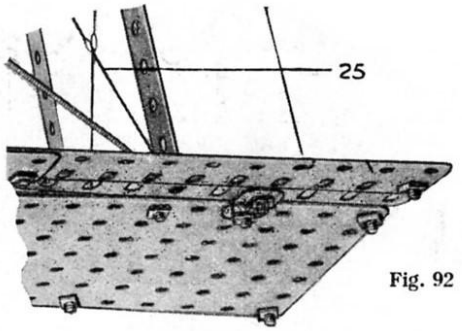

Fig. 92

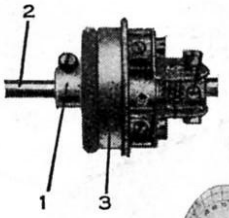

Fig. 93

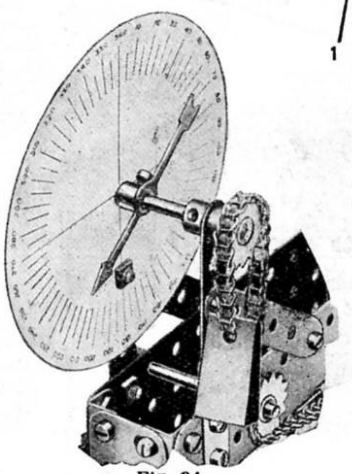
Fig. 94

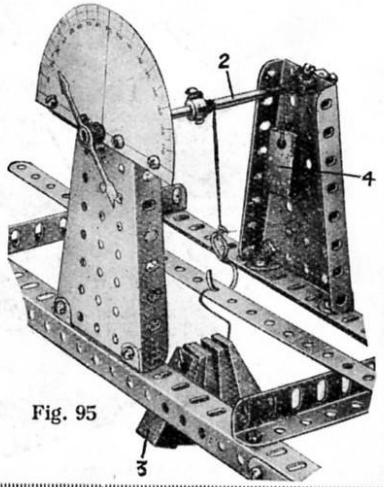

Fig. 95

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Class P: Special Accessories *(continued)*

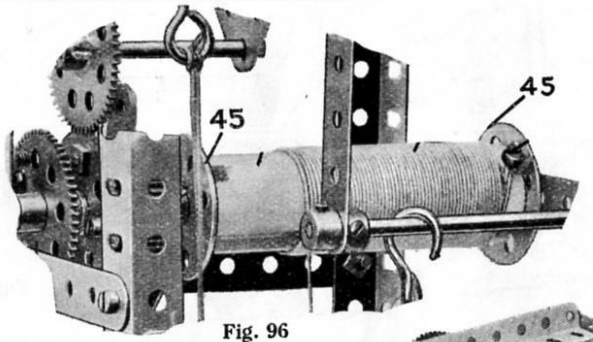

Fig. 96

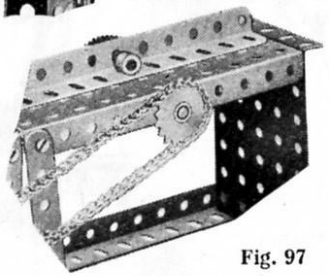

Fig. 97

Fig. 98

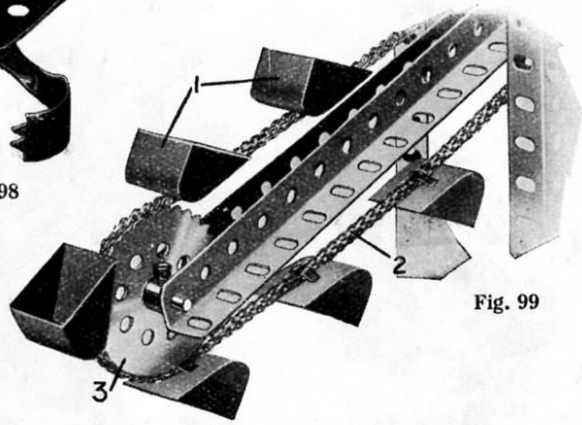

Fig. 99

No. 101, HEALD FOR LOOM.

In addition to the use for which it is specially designed, i.e., as a heald in the Meccano Loom (see Instruction Leaflet No. 16), part No. 101 is frequently employed as a tie in bracing various Meccano Structures. In the Meccano Biplane (Instruction Leaflet No. 34) Healds are used as the diagonal ties between each pair of upright wing supports. A portion of a pair of these supports, with the Healds in position at 25, can be seen in Fig. 92. Another important use for Healds is found in the Meccano Motor Chassis, where they are employed as the means of connection between the hand brake lever and the brake mechanism on the rear wheels.

A further example of the use of Part No. 101, occurs in the model Racing Seaplane, which is described under Model No. 7.18 in the Manual of Instructions. In the model referred to, Healds are employed as bracing wires for the wings and floats.

No. 104, SHUTTLE.

Produced specially for use in the Meccano Loom. It is illustrated and its functions fully explained in Instruction Leaflet No. 16.

No. 106, WOOD ROLLER. No. 106a, SAND ROLLER.

In addition to their functions as the take-up rollers in the Meccano Loom, the Wood and Sand Rollers are frequently used as winding drums in cranes, etc. Both Rollers are provided at each end with a circular recess, to receive a Collar or wheel boss, and with a slot to receive the set-screw inserted in the boss. Each is supplied complete with two Collars secured to a 4½" Axle Rod. The Wood Roller also has a groove along one side, the object of which is to enable the woven material in the Loom to be secured by gripping it under a short Rod dropped into this slot. An ideal winding drum may be formed from the Wood Roller by adding a Bush Wheel at either end as shown at 45 in Fig. 96. A drum so formed has a large capacity. The Sand Roller differs from the Wood Roller in that it is encircled by a sheet of tin that is specially burred so as to grip the woven material in the Loom as it passes beneath it and is wound on to the Wood Roller.

No. 107, TABLE FOR DESIGNING MACHINE.

Supplied specially for use with the Meccanograph (see Instruction Leaflet No. 13) wherein it is used to hold the paper whilst the design is being drawn by the writing arm. It is 6½" square, of smooth polished wood, and is supplied complete with a Bush Wheel screwed to its under side, by means of which it is secured to the vertical rotating spindle in the model. The part is also very useful as a fixed base for small models.

No. 114, HINGE

A Meccano Hinge is shown in Fig. 92 connecting one end of the aileron to the main wing in the Meccano Biplane. This part is invaluable for mounting doors and similar hinged parts in Meccano models. It is also frequently used in place of lock-nutted bolts, etc., in making pivotal connections between any two parts of a model.

No. 117, STEEL BALLS, ½" diam.

The Steel Balls are intended for use in building up ball bearings for swivelling structures. A typical built-up ball bearing unit is described in the Standard

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Mechanisms Manual (see detail No. 134), and on reference to this it will be found that twenty-one steel Balls are placed round the circumference of a Wheel Flange that is bolted to a 3" Pulley Wheel, while a further 3" Pulley, which is bolted to the swivelling superstructure, rests upon the Balls. With this arrangement it is possible to rotate heavy structures easily and smoothly about a central pivot. The Steel Balls are also used in model-building for ballast purposes and for driving "gravity wheels." In the latter case the Balls are arranged to drop one at a time on to the blades of a kind of water-wheel, and the weight of the Balls causes the wheel to rotate, just as the force of the impingeing water operates the actual water-wheel.

No. 120, BUFFER. **No. 120a, SPRING BUFFER.**

Designed for use in models of railway vehicles. Both types are mounted on threaded shanks and fitted with standard nuts. No. 120 measures ½" in length, excluding the shank, and is cut from the solid, while No. 120a, which measures ⅝" in length minus shank, is provided with a separate sleeve that encloses a compression spring, and thus acts as a shock absorber.

The Spring Buffer may also be employed for other very different purposes. In Fig. 102 part No. 120a serves as a spring catch to hold a hand lever in position after the latter has been moved from one side to the other. The lever passes through the centre hole of a Coupling 19 and carries a second Coupling 20, which presses upon the Spring Buffer 21 and is provided with two 7/32" Bolts inserted on opposite sides. These bolts act as stops to prevent the lever moving too far in either direction.

One of the most interesting adaptations of the Spring Buffer is included in Standard Mechanisms No. 115 (Meccano Electric Controller). This mechanism is reproduced at Fig. 91 and it will be seen that the Spring Buffer 5 acts as a spring-controlled contact, which ensures good contact being made with the studs of the resistance. The sleeve portion of another Spring Buffer is bolted at 9 to act as a stop.

No. 122, MINIATURE LOADED SACK.

This accessory adds a very realistic touch to Meccano models of cranes, lorries, conveyors and other types of goods-handling machinery. It may also be used with advantage in connection with Hornby goods trains. It is filled with sawdust and provided with a small loop of wire by means of which the crane hook may be attached.

The use of a number of Miniature Sacks will also add considerably to the realism and pleasure of operating the lifts in the Meccano Electric Goods Warehouse (Special Instruction Leaflet No. 31).

No. 131, DREDGER BUCKET.

Intended for use in models of excavating machinery and conveyors. Is provided with a clip which may be pushed through one of the links in a length of Sprocket Chain, the ends of the clip then being bent back as shown in Fig. 99. Great care should be exercised in bending the clips to ensure that sufficient space is left between their ends to admit the teeth of the Sprocket Wheel round which the Chain passes. The Chain 2 on which the Buckets 1 are mounted should be kept taut or it will twist when the buckets are loaded.

No. 150, CRANE GRAB.

Useful in model cranes, for picking up and depositing loads. It consists of two jaws fitted with arms that are pivoted together and connected at their upper ends by short chains to a hook, which may be attached to the main crane hook. It is illustrated in Fig. 98.

No. 169, DIGGER BUCKET.

This part is shown in Fig. 101. Designed principally for use in Meccano steam shovels, or mechanical navvies. The mouth of the Bucket measures about $1\frac{7}{8}" \times 2\frac{1}{4}"$, while the depth (over cutting teeth) is $2\frac{1}{2}"$. The bottom of the Bucket is mounted on hinged levers and normally is held in place by a sliding catch that engages with a slot in the front of the bucket. A cord may be attached to the catch and on pulling this the floor falls open and so discharges the contents of the bucket. If a small quantity of gravel or grain is available a model excavator fitted with the Digger Bucket can be used to load Hornby Railway Wagons, etc.

No. 135, THEODOLITE PROTRACTOR.

The Protractor consists of a sheet of superfine ivory card on which are printed circular and semi-circular scales, marked out in degrees. These two scales are for use in the Meccano Theodolite (Model No. 6.17), the former for indicating the extent of rotation of the model in a horizontal plane and the latter for indicating the angle of the sighting arm. The scales are also very useful in a number of other models. In Fig. 95 the semi-circular scale is used to register the movement of a beam under stress, while in Fig. 94 the circular scale acts as a measure of the extent of vertical rise or fall of a lift.

No. 138, SHIP'S FUNNEL. **No. 138a-z, RAKED SHIP'S FUNNEL.**

Part No. 138 is placed vertically on its base while No. 138a is raked, i.e., when secured to a model, it lies at an angle to the vertical. Both are provided with two perforated lugs by means of which they may be bolted to any Meccano Strip or Plate. No. 138 is enamelled red and is designed for use in models of tramp steamers, etc. No. 138a is obtainable in twenty-six different colour-combinations to represent the principal shipping companies. It is also provided with a miniature steampipe attached to the front of the funnel.

No. 141, WIRE LINE.

For suspending the 18 lb. weight required to drive the Meccano Grandfather Clock (Instruction Leaflet No. 14). Can be used in any model where a very heavy load is to be raised, but is not suitable for small model cranes, owing to stiffness.

DUNLOP TYRES :

No. 142b, to fit 3" diam. Pulleys. **No. 142d, to fit 1½" diam. Pulleys.**
No. 142a, to fit 2" diam. Pulleys. **No. 142c, to fit 1" diam. Pulleys.**

The 3" and 2" sizes of the Dunlop tyres will be familiar to the majority of Meccano boys, but the 1½" and 1" are recent additions to the system. These solid rubber tyres are perfect miniature reproductions of the real thing and are specially made for Meccano Limited by the Dunlop Rubber Company Limited. They are suitable for use in all models of motor vehicles, etc. The dimensions given represent their inside diameters and therefore the four tyres fit the 3", 2", 1½" and 1" Pulleys respectively.

No. 142, RUBBER RINGS, 3". **No. 155, ⅝".**

No. 142 is designed to fit round the groove of a 3" Pulley Wheel and thus represent a pneumatic tyre in models of road vehicles. Also employed to provide the frictional surface in Meccano clutch mechanisms and frictional driving apparatus. The ⅝" Rubber Ring is incorporated in the clutch of the

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Class P: Special Accessories *(continued)*

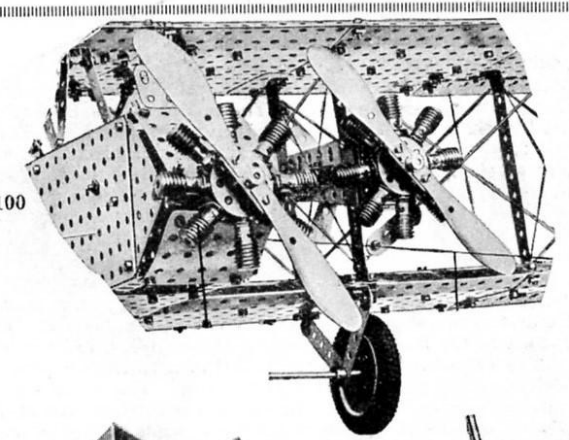

Fig. 100

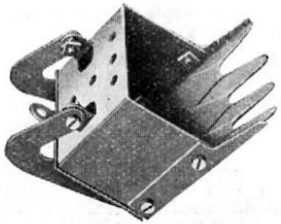

Fig. 101

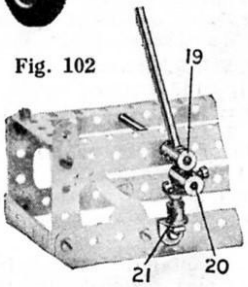

Fig. 102

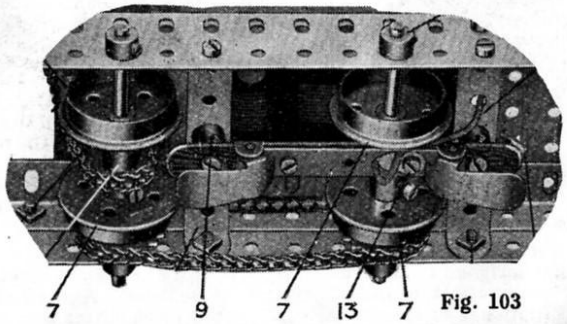

Fig. 103

Motor Chassis (Instruction Leaflet No. 1). In Fig. 93 the Ring is placed round the groove of a 1" Pulley 1, which is secured to the Rod 2 and forms one portion of the clutch. On operation of the clutch pedal the other clutch member 3—a 1⅛" Flanged Wheel—may be moved to and fro and thus brought in or out of frictional contact with the Rubber Ring, which is driven continuously from the engine.

No. 149, COLLECTING SHOE.

Intended for use in models of electric locomotives, tramway cars, and other vehicles designed to run on the three-rails system. It consists of a fibre strip 4" long on which are mounted the hinged metal contact pieces that press upon the centre or "live" rail. The Shoe is shown in Fig. 103 secured to the underside of a model electric loco. An insulated wire is led from one of the Motor terminals through the loco undercarriage and is secured by the bolt 13, which also helps to secure the metal part of the Shoe to the fibre strip. The current is picked up from the centre rail by the Shoe and is directed to the Motor by the wire attached to the Bolt 13. It returns to the Accumulator by way of the framework of the model, the running wheels 7, and the outer rails.

No. 156, POINTER.

No. 156 measures 2½" overall and is provided with a boss that is set slightly off centre so that if the part is mounted loosely on an axle the Pointer will tend always to remain in a vertical position, with the point uppermost. Examples of its use are provided in Figs. 94 and 95.

No. 157, FAN.

The Meccano Fan may be used as a radiator cooling fan in model motor cars, etc. It also adds realism to model workshops.

SIGNAL ARMS: No. 158a, "Home" type. No. 158b, "Distant" type.

The difference between the two types of Signal Arms is the "fish-tail" on the "Distant" Signal. Each type measures 3" in overall length. Transparent red and green "glasses" are attached and if a light is placed behind them a realistic effect is obtained.

A very fine model of a signal gantry may be built with the aid of these parts and ordinary Meccano Accessories.

No. 159, CIRCULAR SAW.

Made of fine tempered steel, is 1½" in diameter, and provided with a boss and set-screw. If driven at a high rate of speed from a Meccano Electric Motor, it will cut through thin pieces of wood. In Fig. 97 the Circular Saw is used in conjunction with the 5½" × 2½" Flanged Plate to form a saw bench. The Circular Saw is secured to the Sprocket Wheel shaft, and its blade, which can just be seen above the Angle Girder that forms the guide piece, protrudes through the slot in the Plate. The Girder is held in place by the Collar shown, and the latter is secured on the shank of a bolt passed through the elongated hole in the Plate. This hole allows the guide or "fence" to be adjusted.

No. 172, PENDULUM CONNECTION.

No. 172 is a short length of special springy brass strip and is primarily intended, as its name implies, to be used as a means of suspending the pendulum in the Meccano Grandfather Clock (see Instruction Leaflet No. 14). It also forms an excellent "brush" contact in model electric motors and engines.

No. 173, RAIL ADAPTOR.

This part is intended for use in models where it is necessary to attach a length of Meccano built-up track to Hornby Rails. It forms a neat joint, which cannot otherwise be obtained with ordinary parts, and adds to the smooth running of rolling stock.

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No. 35, SPRING CLIP.

Part No. 35 is designed to hold Axle Rods in position in their bearings or to maintain loose parts in place on the Rods. It can only be used for light work, however, and in every case where considerable stresses are met with a Collar should be used.

In the mechanism shown in Fig. 111 it was required to mount the Rod 5 so that it could be moved longitudinally in its bearings, but not rotated. Consequently two Spring Clips were placed upon it with their arms towards the Double Angle Strip in which the Rod is mounted, with the result that, should the Rod start to turn, they strike against the Strip and prevent further movement.

No. 38, WASHER.

The Washers are designed principally, of course, to decrease friction between moving parts. They are also invaluable for spacing purposes. A single Washer frequently proves invaluable for obtaining correct spacing when building various Meccano structures. If two enamelled parts are connected pivotally by bolt and nut, Washers should be placed against the parts to prevent the bolt head and nuts wearing away the enamel.

No 40, MECCANO CORD, Coloured.

The Meccano Cord is red in colour and may be used for hoisting mechanisms, pulley and belt gear, or for bracing Meccano structures and any other similar purposes.

No. 43, SPRING (Tension).

The tension Spring measures 2" in length contracted and is fitted with a loop at each end to facilitate its connection to other Meccano parts. Its functions as a spring will be apparent to every Meccano boy. The Spring is frequently used in models of petrol and steam engines to represent a pipe.

No 120b, COMPRESSION SPRING.

The Compression Spring normally measures ½" in length, and is used to control movement and as a shock absorber, etc. In Fig. 110 a Compression Spring 3 is placed on a Crank Handle so that normally a Collar 2 having an ordinary bolt inserted in its set-screw hole, is held against the bearing and the Crank Handle is prevented from rotating by the stop 5. The Handle can only be turned by compressing the Spring; hence an efficient safety device is provided. The Compression Spring 4 in Fig. 109 is placed over the shanks of two opposite ⅜" Bolts and acts as a shock absorber for both axles attached to the 2½" Strip.

A Compression Spring does important service in the clutch of the Meccano Motor Chassis (see Fig. 93, Class P). If reference is made to this illustration it will be seen that the Spring holds the clutch member 3 in engagement with the member 1 until the operating pedal is pressed. In this case, however, the ordinary Compression Spring would be too large to go in the small space available; it is therefore cut in two and a portion only used.

[No. 50a, EYE PIECE, WITH BOSS.

The Eye Piece is particularly useful as a guide for sliding mechanisms, such as an engine crosshead. The slotted portion will fit over any Meccano Strip, which thus becomes a guide rail. Fig. 105 shows the crosshead of a Meccano horizontal steam engine, in which the two Eye Pieces 4 act as "slippers" sliding on the "guide bars" 3.

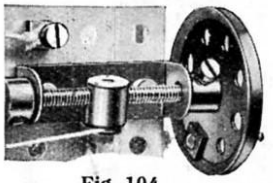

Fig. 104

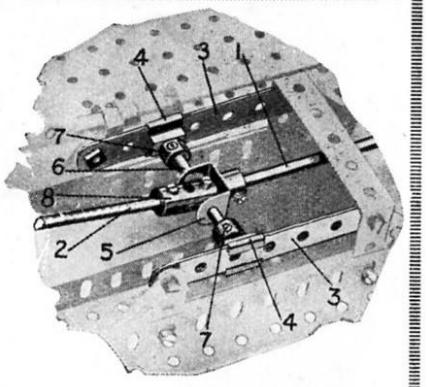

Fig. 105

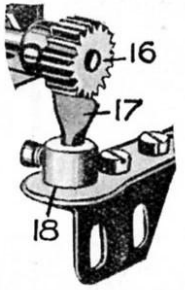

Fig. 106

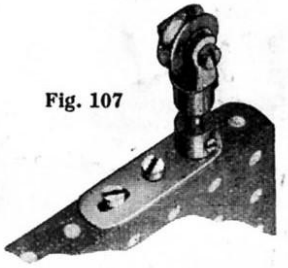

Fig. 107

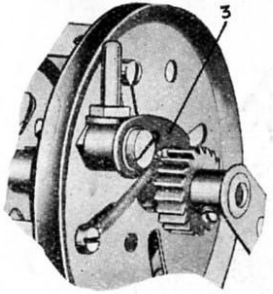

Fig. 108

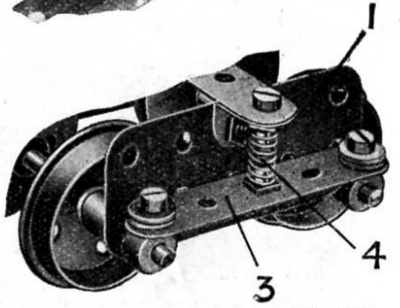

Fig. 109

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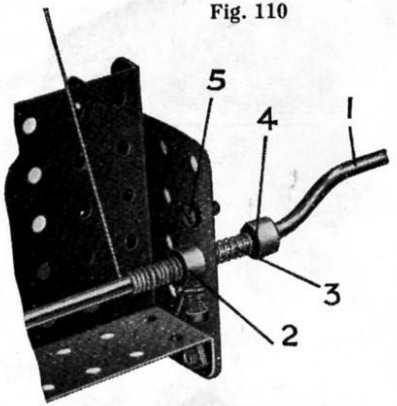
Class Q: Miscellaneous Mechanical Parts *(continued)*

Fig. 110



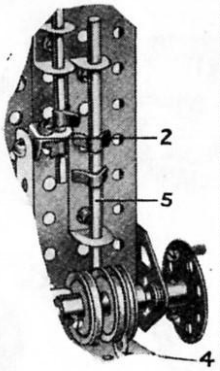


Fig. 111

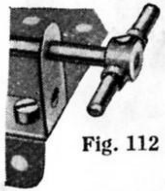


Fig. 112

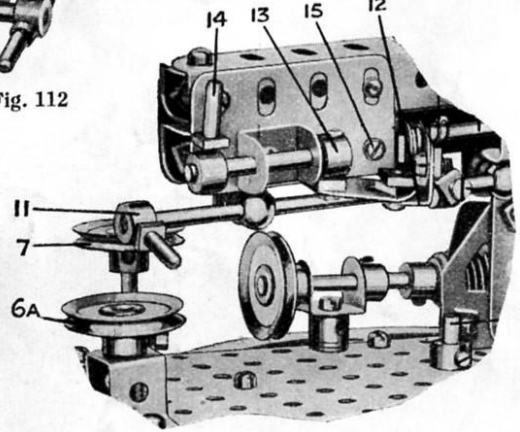


Fig. 113

HOOKS : No. 57, ordinary. No. 57a, Scientific. No. 57b, Loaded.

The ordinary Meccano Hooks are of a suitable size for use as the load hooks in the majority of Meccano cranes. The Scientific Hooks are provided for the benefit of those boys who wish to carry out scientific experiments. The lower portion of the hook is straight and long so that three or four Meccano Weights (parts Nos. 66 and 67) may be added at one time.

The Loaded Hook is of much more massive construction than part No. 57 and is complete with a lead ball, the weight of which is intended to keep the hoisting cord of a crane taut round the circumference of the guide Pulley when no load is attached to the hook, and when lowering, etc.

No. 58, SPRING CORD, 40" length.
No. 58a, COUPLING SCREW .or Spring Cord.

The Spring Cord has many varied uses. First, of course, is its function as a driving belt between two Pulleys. To make an endless driving belt, the necessary length of Spring Cord should be measured and cut off and the two ends then connected together by means of the special Coupling Screw (part No. 58a). The screw should be inserted half-way into one end of the Spring Cord, and the other end then screwed upon it.

Where it is required to attach Spring Cord to a Meccano bolt or other part, its end should be heated in a lighted match so as to take the springiness out of the metal. It may then be twisted round the bolt as easily as a piece of thread.

Occasionally the Spring Cord is used as a kind of Bowden wire or cable to encase an operating wire or string. In Class D is illustrated a Meccano siphon lubricator, in which the " wicks " used to conduct the oil to the journal bearings are encased in short lengths of Spring Cord.

Yet another example of the adaptability of the Spring Cord is reproduced at Fig. 91 (Class P). In this case the Spring Cord is used as resistance wire, and short lengths of it are connected between the studs on the switch. Portions of the Spring Cord may also be used as tension springs for light purposes. Small springs so formed are used frequently, for example, for holding Pawls in engagement with Ratchet Wheels (see Fig. 108). Again, in the internal-expanding brakes fitted to the Meccano Motor Chassis (see Fig. 114) short pieces of Spring Cord serve to return the brake shoes to the " off " position when the lever is released.

No. 59, COLLAR, WITH SET-SCREW.

The Collars with Set-screws, like the Spring Clips, are intended for holding shafts in place in their bearings, or for holding Strips, etc., loosely on Axle Rods. There are, however, many other novel uses for them. For instance, as mentioned above, they form the brake shoes of the internal expanding brake shown in Fig. 114, whilst in Fig. 109 Collars secured to the 2½" Strip 3 form journal bearings for axles. The bolts holding the Collars are spaced by Washers so that they do not grip the axles. In Fig. 116 a series of Collars are employed to form a hinge, the Collars 1 and 2 being secured to the door 3 whilst two other Collars are secured to the jamb and to the Rod 4. The remaining three Collars are inserted for spacing purposes.

No. 64, THREADED BOSS.

The Threaded Boss is of the same diameter as the Collar but measures ⅜" in length and is perforated longitudinally and transversely with threaded bores. Hence the part is particularly valuable in Meccano screw gearing. In Fig. 104 a Threaded Boss is shown mounted on a short Screwed Rod. It is prevented from rotating with the Rod ; consequently, when the hand wheel is turned, the Boss travels longitudinally, and in the example illustrated this movement is utilised to control a simple brake mechanism.

The Threaded Boss is also useful for connecting Strips, etc., to Screwed Rods.

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No. 65, CENTRE FORK.

The Centre Fork may be used as a small pointer in certain Meccano indicating appliances, etc. Perhaps its most important function, however, is its use in intermittent motion, where it engages at intervals with the teeth of a Meccano Gear or Sprocket Wheel. It is shown used in this way in a Meccano distance indicator in Fig. 115. Here the Centre Fork is secured by a Coupling to a vertical rotating Rod, in such a way that once in each revolution of this Rod it engages with and partially turns a Sprocket secured to a second vertical Rod.

A somewhat novel use for the Centre Fork is illustrated in Fig. 106. Here it forms the " knife edge " in a Meccano knife-edge bearing. Fig. 106 is a section of the Meccano Harmonograph (see Special Instruction Leaflet No. 26) the Pinion 16 being secured to the pendulum. This Pinion rests upon the edge of the Centre Fork 17, the teeth of which lie between two of the teeth in the Pinion, and the Centre Fork is secured in the boss of a Crank 18 that is bolted to the fixed part of the model. The pendulum rocks about the extreme edge of the Centre Fork.

No. 94, SPROCKET CHAIN.

The primary function of the Sprocket Chain is, of course, to provide a means of transmitting power between any two shafts where ordinary gearing would be impracticable and belt or cord drive insufficiently positive. It engages with the Meccano Sprocket Wheels, and the different speed ratios that are obtainable with their aid, are described at length in Class O (Gears and Toothed Parts).

The Chain is supplied in lengths of 40 ins., and comprises 6 links to the inch. It may easily be separated and joined again when the requisite length has been measured off. To separate, the ends of one of the links should be gently prised up with the blade of a screwdriver so that the adjacent link may be slipped out. After rejoining, the ends should be bent back again carefully so that they do not grip the next link too tightly. The Chain should be passed round the wheels so that the turned-over ends of the links face outward or away from the wheel, as this will result in smoother running.

No. 115, THREADED PIN.

The smooth portion of the Threaded Pin terminates in a squared shoulder and short threaded shank. The shoulder permits of the Pin being secured rigidly with the aid of a spanner. The part is intended principally for use as a handle or as a fixed pivot for a ½" or 1" loose Pulley. In Fig. 113 two Threaded Pins 11 and 14 are used as handles for operating sliding Axle Rods, the Pins being secured to the Rods with the aid of Collars. Another kind of handle formed from two Threaded Pins and a Collar, is shown in Fig. 112, whilst in Fig. 108 a Threaded Pin is seen inserted in the set-screw hole of a Pawl, to serve as a handle by which the Pawl may be lifted clear of the Ratchet Wheel.

FORK PIECES : No. 116, large. No. 116a, small.

Fork Pieces are designed for pivotal connections between Rods and Strips or between two Rods meeting at right angles. In Fig. 105 a Large Fork Piece forms a connection between the piston rod 1 and the cross piece 6, whilst in Fig. 113 the same part may be seen employed as a neat journal bearing for a short horizontal Rod. In Fig. 107 this part is used as a bearing for a ½" loose Pulley, which runs on a ½" Bolt passed through its arms.

ECCENTRICS : No. 130, Triple Throw. No. 170, Single Throw.

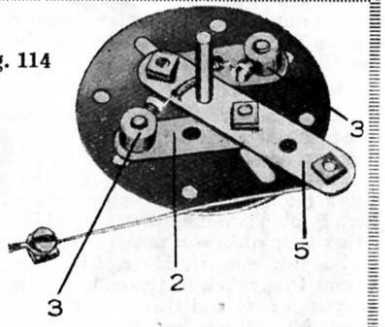
There are two kinds of Meccano Eccentrics, part No. 130 giving three different throws (¼", ⅜" and ½") and No. 170 one throw only (¼"). The term " throw " means the radius of eccentricity, so that the total rectilinear movements obtained for the three throws of No. 130 are ½", ¾", and 1" respectively, while that of No. 170 is ½". The great advantage of an eccentric is the fact that it permits reciprocating movements being obtained from a rotating shaft without breaking the line of the latter. On the other hand a disadvantage lies in the fact that unlike the crank, it can only transform rotary movement to reciprocating and cannot be used to produce rotary motion. In Meccano model-building, as in actual engineering, the most common use for the eccentric is found in the operation of valve mechanism for reciprocating engines. An Eccentric requires ample lubrication.

No. 136, HANDRAIL SUPPORT.

The Handrail Support, in addition to the function indicated by its name, may be employed as a journal bearing for rotating shafts. In Fig. 113 the part is seen employed as a bearing for the sliding Rod carrying the handle 11.

In addition, the Handrail Support may of course be used in innumerable cases where it is required to secure an Axle Rod to a Strip or other part. It is used also to a large extent as an ornamental top for a column.

Fig. 114



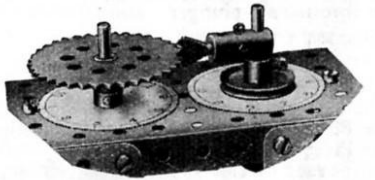


Fig. 115

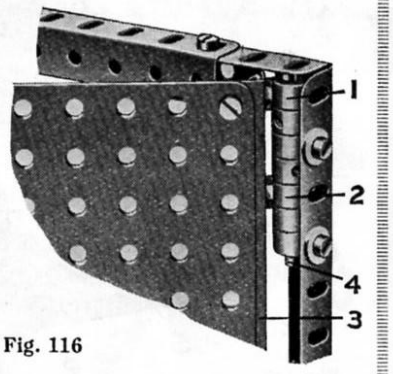


Fig. 116

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Class T: Electrical Parts

It will be noted that each part in this Class is numbered over 300, although the last number in the regular accessories is 173. The object of this is to make a more marked division between the regular and electrical components of the Meccano system.

No. 301, BOBBIN.

Designed for use in the construction of small electro-magnets and solenoids. It is about 1" in length and its centre, which is of brass, is bored to fit round a Meccano Axle Rod. The ends are of fibre and are ¾" in diameter. Fig. 120 shows two solenoids, formed from Meccano Bobbins, used to impart reciprocating motion to the "piston rods" 3 and 4 of a small horizontal engine. Each Bobbin is wound with several layers of No. 26 S.C.C. Wire and is covered with a strip of brown paper as extra protection. The Rods 3 and 4 are free to slide in the centre bores of the Bobbins, and matters are so arranged that current is supplied to the coils of wire alternately, thus imparting motion to the piston rods and thence to the crankshaft of the engine. Solenoids constructed in this way can be used for innumerable purposes in Meccano model-building. For example, an electric railway signal may be brought to the "off" position by supplying current to a solenoid that operates the signal arm through a "plunger" and suitable lever mechanism, as shown in Fig. 121.

No. 308, CORE OR POLE PIECE.

Consists of soft iron and may be secured in position by the nuts supplied with it. A very useful electro-magnet may easily be formed by winding a Bobbin to capacity with 26 S.C.C. Wire and inserting in its centre a Core or Pole Piece. A great advantage of the electro-magnet lies in the fact that the Pole Piece is magnetised only whilst current flows through the coils. Hence, if a magnet of this type is attached to the lifting hook of a model crane, metal objects can be picked up or dropped merely by closing or opening a switch. Other obvious adaptations for the electro-magnet—such as in bells, buzzers, relay switches and electric indicators, etc.—will immediately suggest themselves to Meccano boys. The special Pole Pieces should always be used for the magnet core, for if the ordinary Meccano steel Rods are employed they will be found to retain the magnetism after the current has ceased to flow through the coils.

Fig. 122 shows a Meccano electro-magnet incorporated in a buzzer. The magnet is seen at 1, with the end of the Pole Piece at 2 just beneath the vibrating lever or "armature" 3.

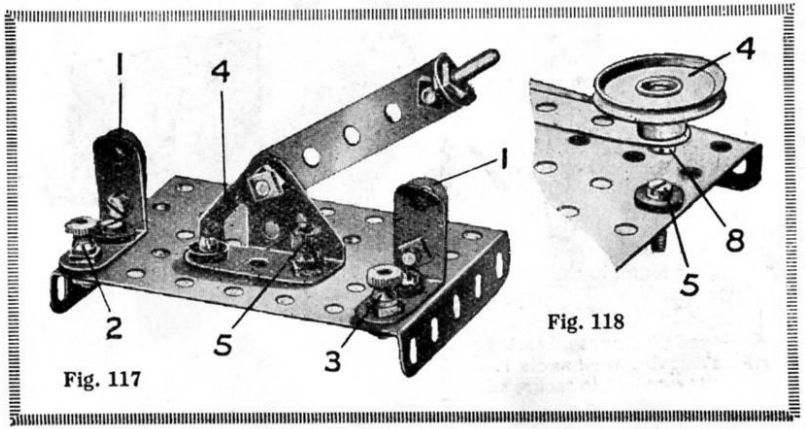

Fig. 117

Fig. 118

No. 307, SILVER TIPPED CONTACT SCREW.

These screws are cut with 6 B.A. Thread and are ½" in length overall. They are shown at 4 and 5 in Fig. 122 and should always be used where a rapid make-and-break is required, for they ensure perfect contact and do not burn away or "soot-up" under the heat of the sparks like ordinary screws. The gap between the contact points may easily be adjusted by turning one of the screws.

No. 304, 6 B.A. SCREW.
No. 302, INSULATING BUSH.
No. 305, 6 B.A. NUT.
No. 303, INSULATING WASHER.

The 6 B.A. Bolts and Nuts are supplied so that Meccano parts can be bolted together and yet insulated from each other by using these bolts in conjunction with the special Insulating Bushes and Washers. These latter parts are of fibre and are similar except that the Insulating Bush has a small "shoulder" which fits inside a standard Meccano hole. Whenever it is necessary to insulate a bolt from a Meccano Strip, an Insulating Bush should be placed on one side of the Strip, with its shoulder inside a hole in the Strip, and an Insulating Washer on the other side; a 6 B.A. Bolt should then be passed through the two and secured by its nuts in the ordinary way. In this manner the bolt is prevented from making contact with the metal of the Strip. This simple means of insulation is of course, invaluable in Meccano model-building.

No. 306, TERMINAL.

The Terminal consists of a milled brass knob bored and tapped to fit the 6 B.A. Bolts. Fig. 122 shows two Terminals mounted on the shanks of bolts at 6 and 8. It will be noted that an Insulating Washer is placed under the Terminal 6; an Insulating Bush is used on the other side of the plate, so that this Terminal is insulated from the model. Terminal 8 is in metallic contact with the model.

Fig. 117 shows a Meccano two-way switch. In this the switch arm is attached pivotally to a Trunnion that is insulated from the base plate in the manner described above, and the two contact pieces 1 carrying the Terminals 2 and 3 are also insulated. Hence, by engaging one or other of the latter with the switch arm the electric circuit can be led from Terminal 5 to Terminal 3 or, alternatively, from Terminal 5 to Terminal 2.

Fig. 118 shows a 6 B.A. Bolt 5 used as the contact stud in a Meccano Morse tapping key. The bolt is insulated from the base plate, but the key 4 is in metallic contact with it. One wire is attached to the bolt 5 and another to the plate, so that the circuit is completed whenever the bolt 8 of the key touches bolt 5.

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No. 309, COIL CHEEK.

This part is cut from $\frac{1}{8}$" fibre sheet and measures $1\frac{1}{4}$" square. An oblong perforation is cut in its centre, so that Meccano Strips can be passed through it, and four small holes are provided to admit wire. The object of the part is, of course, to facilitate the construction of large magnetic coils.

No. 310, LAMP HOLDER. No. 311, METAL FILAMENT LAMP (6-volt).

The Lamp Holder is designed to form a screw socket for the Meccano 6-volt Lamp. Its end is of fibre and it should be secured to Meccano models as follows. A 6 B.A. Bolt is passed through the small perforation in its end, and then through a hole in a Meccano Strip, and an Insulating Bush is placed on the shank of the bolt so that its shoulder fits into the hole in the Strip. The bolt can then be secured by a nut or Terminal. When the latter is screwed up tight, the metal of the Lamp Holder will be in contact with the Strip, so that the electric current may be conducted to the lamp by attaching one wire to the 6 B.A. Bolt (the head of which presses against the contact in the end of the lamp itself), and another wire to the Meccano Strip.

Fig. 119 shows a Lamp and Holder mounted in the front of a model electric locomotive, the Holder 14 being bolted to an Angle Bracket. Current is led to the Lamp by an insulated wire slipped under the nut on the 6 B.A. Bolt by which the holder is secured, and returned to the source of supply through the Holder itself and through the frame of the model.

No. 312, 27 GAUGE, BARE IRON WIRE. No. 314, 23 GAUGE, S.C.C. COPPER WIRE.
No. 313, 26 GAUGE, S.C.C. COPPER WIRE. No. 315, No. 22 GAUGE, BARE COPPER WIRE.

The 27 gauge Bare Iron Wire is intended for use when it is required to insert a resistance in an electric circuit, such as in the construction of electric speed controllers, etc. The 26 gauge Single Cotton Covered Copper Wire is usually employed in constructing electro-magnets, bobbins, etc., although it can be used for ordinary connecting purposes. The 23 gauge Copper Wire is intended for making all kinds of electrical connections in Meccano models, and the 22 gauge Bare Copper Wire is supplied for use where a conductor wire is required, such as in electric locomotives and similar models.

It is scarcely necessary to give Meccano boys detailed instructions on the subject of wiring their models, but it may be well to mention one or two important points. All connections should be made as tight as possible—that is, when connecting a wire to some part of a model it should not be merely twisted round a Strip, but secured by a nut and bolt. Insulated wire should never be allowed to rub against metal, else short circuits will quickly occur.

Another point to remember is the fact that wire exerts a certain resistance against the flow of the electric current, just as a water pipe resists the flow of water through it by the friction created between its walls and the moving liquid. In ordinary Meccano model-building, the resistance likely to be exerted by the wiring is negligible, especially if the Meccano 23 gauge wire is used, but in exceptional cases where the current is directed over considerable distances, such as in Morse Telegraph instruments, electric signals and indicators, etc., a considerable loss of current will result if thin conductor wire is used, and the Motor, bell or whatever it is required to energise, will fail to function properly. The resistance in the conductor can, however, be decreased by increasing the diameter of the wire or, if a larger wire is not obtainable, by connecting additional lengths of wire in parallel with the first.

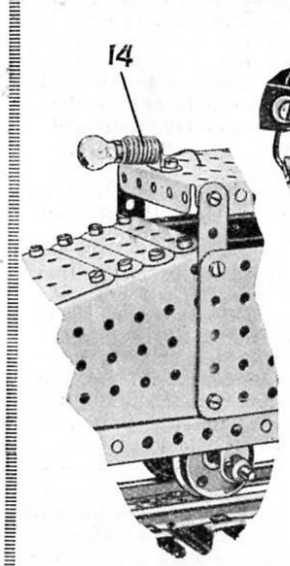

Fig. 119

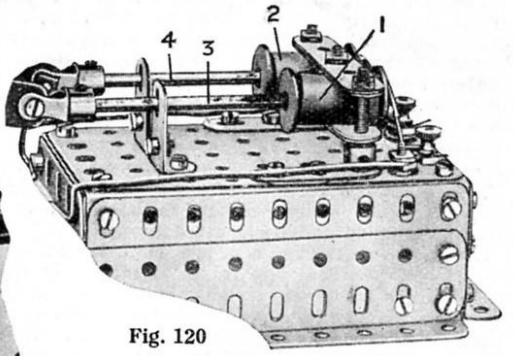

Fig. 120

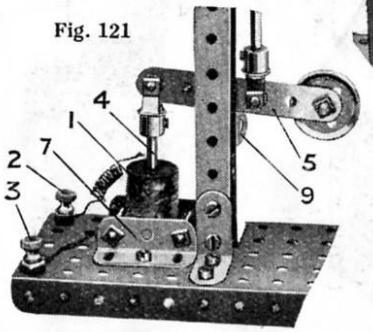

Fig. 121

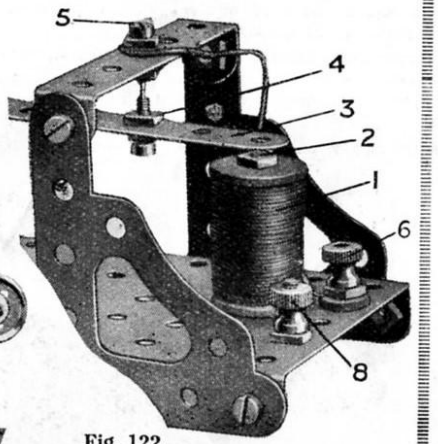

Fig. 122

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Class X: Power Units and Accessories

For setting his model in motion, the Meccano boy has a choice of " prime movers " employing the three principal sources of power used by the model engineer—electricity, steam and clockwork. Many boys find it very difficult to decide which of these three methods to adopt. Of course, the ideal plan is to use all three methods, so that when building, say, a model electric train the Electric Motor can be employed, whilst if it is desired to represent a steam shovel or similar machine, the Steam Engine can be used, and so on, but very few boys are in a position to collect the necessary equipment!

ELECTRIC MOTOR, No. 6, 6-volt.
STEAM ENGINE, complete with Boiler, Burner, 6.5 : 1 gearing, etc.

The Meccano Electric Motor and Steam Engine are each capable of driving practically every Meccano model, provided that the intermediate gearing is designed and constructed properly.

No matter what type of model is to be driven, the Motor or Engine should always be allowed to rotate at maximum speed. This means that if it is required to operate a slow-moving model, a gear that will provide a considerable reduction in speed must be employed. The simplest means of obtaining the necessary reduction is provided by the ordinary Meccano toothed gearing (see Section 1, Standard Mechanisms Manual). If gears are not available the drive from the Motor can be transmitted through belt mechanism, and the speed can be reduced at the same time by taking the drive from a small Pulley to one of much larger diameter (see Section 2, Standard Mechanisms Manual). Sprocket Wheel and Chain gearing may, of course, be used equally well in place of belts. Meccano gearing is dealt with fully in Class O.

Fig. 123

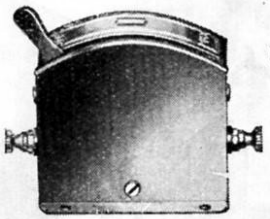

Fig. 124

Fig. 125

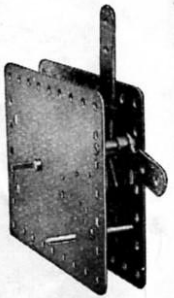

Fig. 126

Whatever type of gearing is employed it is important to remember that, if the driven shaft moves more slowly than the driving shaft, a mechanical advantage is obtained and increased loads may be overcome, the apparent gain in power being roughly in proportion to the loss in speed. If the drive is led through 1 : 1 gearing (i.e., two Gears of equal size meshing together or two Pulleys of equal diameter connected by a belt), there is no gain in power to counteract the loss through friction. Such gearing should therefore be avoided as far as possible, and when it is necessary to transmit the power from one point to another, the gearing should always result in some reduction in speed in the driven shaft, unless it happens that speed is a more important consideration than power.

Another very important means by which the Engine or Motor may be used to overcome increased loads, consists of pulley blocks. By incorporating a cord and pulley system in a model, a reduction in speed is obtained, the reduction increasing in proportion to the number of pulleys or "sheaves," to give them their correct term, employed. For example, if a crane can lift a load of 10 lbs. coupled directly to the hoisting cord, then by using a single-sheave pulley block, so that the load is raised in just twice the time formerly taken, the model should be capable of lifting 20 lbs. (not allowing for loss through friction). Similarly, if a two-sheave pulley block is used so that the crane hook is raised in four times the period occupied originally, then a load of nearly 40 lb. could be raised. Therefore the mechanical advantage is "2" and "4" respectively in these examples.

Of course, the same mechanical advantage could be obtained by using extra gearing and retaining the single hoisting cord, but the use of the pulley blocks is the better method, for it is more economical and it has the very important advantage of distributing the load over several lengths of cord instead of one only, with the result that a lighter and more flexible cord can safely be used.

Fig. 129 shows the Steam Engine applied to the Meccano Stiff Leg Derrick (see Special Instruction Leaflet No. 6). In this case the gearing mounted between the side plates of the Engine gives a ratio of 58.5 : 1, that is, the crankshaft of the Engine turns 58½ times to each revolution of the winding shaft. This ratio is obtained as follows: Engine crankshaft to secondary shaft, 6.5 : 1 (the Pinion and Gear Wheel giving this ratio are supplied with the Steam Engine); secondary shaft to intermediate shaft, 3 : 1 (½" Pinion driving on to a 57-teeth Gear Wheel); intermediate shaft to winding shaft, 3 : 1 (½" Pinion and 57-teeth Gear).

Now, if we apply a load direct to the end of the hoisting cord, we shall find that the Engine can lift 9 lb. 13 oz. If we decrease still further the speed at which the load is raised by adding pulley blocks, then the amount of the load that can be raised should increase proportionately for, as already stated, power is gained in porportion to the loss in speed. In Fig. 129 a three-sheave pulley block is used, and the hoisting cord is passed between this and the jib head six times, so that the load is raised six times as slowly as it would be if attached direct to the cord. Hence it should now be possible to lift a load of nearly 59 lb. The load illustrated actually weighs 56 lb., and this the engine will raise easily, the difference between 56 and 59 representing the amount of power lost through the increased friction now existing in the various working parts of the model.

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Meccano boys who have built the model Motor Chassis (Special Instruction Leaflet No. 1) will readily appreciate the importance of gear ratios when fitting motors to Meccano models. The chassis has three forward speeds, and the very great difference in the load that can be carried at the different speeds is obvious.

A striking illustration of the power of the Meccano 6-volt Electric Motor is afforded by the Traction Engine (Special Instruction Leaflet No. 22). This model has two forward speeds. In the first a total ratio between the Motor armature and back axle of 283.5 : 1 is obtained, but the second provides the big ratio of 567 : 1, and with this gearing truly great loads can be overcome. The Traction Engine has been made to pull over a hard, smooth surface a load of no less than 10 stone, excluding its own weight and that of the Accumulator and ballast. The latter, which was necessary to obtain sufficient adhesion on the ground, consisted of lead blocks fitted inside the boiler. Fig. 128 shows the Traction Engine hauling its driver.

The side plates of the Electric Motor measure 5″×2½″ and are perforated with the Meccano standard holes. Hence the Motors may actually form parts of the models that they are required to drive, and they can be bolted in any position. In the Traction Engine the Motor is secured on end at the rear of the boiler, in the position occupied by the fire box in the prototype, and the holes in its plates form bearings for the engine crankshaft and other parts. Fig. 127 shows an Electric Motor fitted with typical reduction gear giving a ratio of 171 : 1, the bearings for the various shafts being provided by a Channel Bearing and two 1″×1″ Angle Brackets bolted to one of the Motor side plates.

The Motor may be run from a 6-volt accumulator or from a suitable transformer connected to the main electric house supply, provided that the latter is alternating current. The Motor takes about 0.8 amperes when running free, but on load this increases up to 2.5 amps.

ACCUMULATOR, 6-volt 20 ampere-hours.
TRANSFORMER, suitable for all standard supply voltages.

Fig. 123 shows the Meccano 6-volt 20 ampere-hour Accumulator, and Fig. 125 the special Meccano Transformer designed for running the 6-volt Motor from the house supply. This transformer is available for all standard supply voltages from 100 to 250 inclusive at all standard frequencies, and is supplied complete with a length of flex and adapter for connection to an ordinary lamp socket.

The question is often asked whether the No. 6 Motor can be run from Leclanché or dry cells. For several technical reasons it is not possible to run satisfactorily any electric motor from such a source of supply, the principal reason being that these cells are not capable of delivering for any appreciable period the constant heavy current required to run even the smallest motor.

With regard to the rival merits of the two methods of running the 6-volt Motor—by accumulator or transformer—the following points should be noted. In models that are required to travel along, such as motor cars, traction engines, etc., an accumulator can be incorporated in the model or carried on a trailer behind it, and the model then becomes a self-contained power unit. The accumulator, however, will require charging at intervals. A transformer can be neatly stored in a model, but the radius of movement will always be limited by the length of the flex to the lamp socket. When using a transformer with normal loads on the Motor, the consumption of current will be something like one unit per 20 hours.

Meccano Accumulators are rated as regards their current-giving capacity in "ampere-hours." For example, the Meccano Accumulator will give a current of five amperes for four hours, or of two amperes for ten hours, and is said to have a capacity of twenty ampere-hours. It will drive the Motor continuously for 10 or 15 hours, so it will be seen that whichever method is adopted, the running of Meccano Electric Motors is not expensive.

In handling the Accumulator care should be taken to ensure that the cells are not subjected to severe knocks. Rough usage will cause particles of the chemicals of which the plates are formed to become dislodged from the lead "grids" in which they are held, and drop to the bottom of the container, where they are liable to cause short circuiting, with the result that the Accumulator will become "run down" even though not in actual use.

The Accumulator must not be used after the voltage has fallen below 1.8 volts. When this stage is reached the Accumulator should be recharged. A small voltmeter for testing the cells is very useful. These are not expensive and save a great deal of trouble and annoyance which might arise if the Accumulator is never tested, but allowed to remain at work until no further

Fig. 127

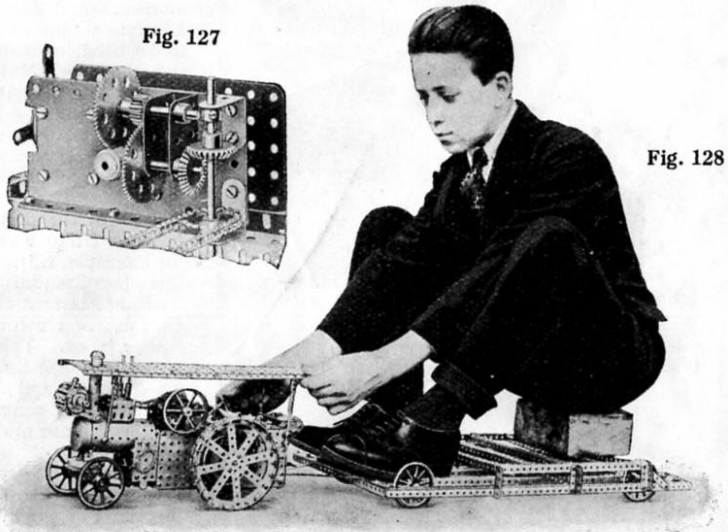

Fig. 128

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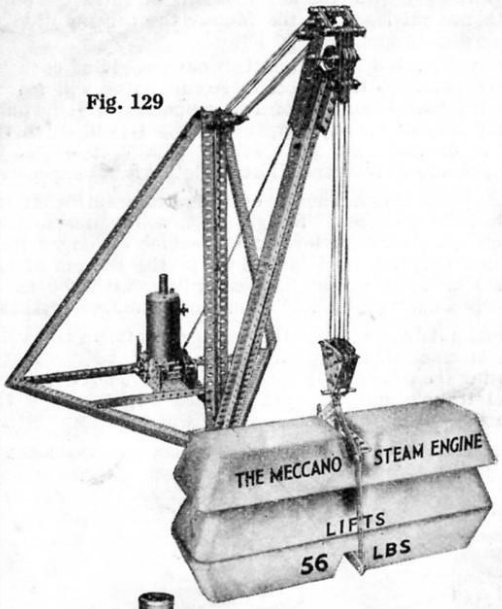
Fig. 129



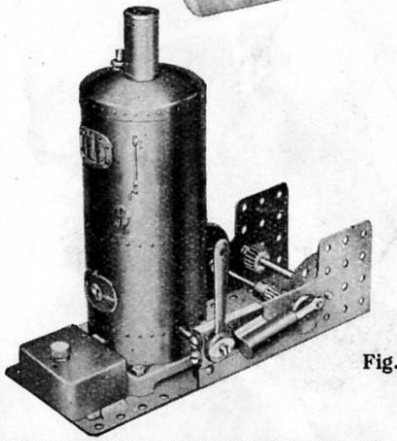


Fig. 130

current can be obtained from it before it is recharged.

It is decidedly detrimental to the Accumulator to "spark" or "flash" the cells to see if they are charged—it should never be done. A handy method of roughly testing if the cells are charged or not is to connect an ordinary 2-volt pocket-lamp bulb across the terminals of each cell in turn. If the cell is fully charged the lamp will glow very brightly, but if the cell requires charging, the lamp will be somewhat dim.

Care should be exercised to prevent the acid spilling, as it is very corrosive and will burn severely if it gets on the skin. If acid does get on the hands, however, it is a good plan to wash the skin with water in which some ordinary washing soda has been dissolved. This will prevent the skin smarting and peeling.

If an Accumulator is permitted to stand idle for a lengthy period a white deposit of lead sulphate forms on the plates. This greatly increases the resistance of the cells and might result in complete ruin of the plates. These ill effects can be prevented by always making sure that the plates are well covered with acid. If these become uncovered owing to evaporation a little distilled water should be added, but on no account should tap water be used for this purpose. If any of the acid has been spilled, the level should be brought up by adding dilute sulphuric acid of specific gravity 1.125. This may be obtained at the charging station at a small cost. Always keep the Accumulator in an upright position.

RESISTANCE CONTROLLER.

A very useful gadget for use in connection with the 6-volt Electric Motor. The Controller is shown in Fig. 124. By connecting it in series with the Motor the speed of the latter can be varied.

CLOCKWORK MOTOR.

The Clockwork Motor (Fig. 126) is the cheapest form of power, barring "gravity" and "wind" motors, which the Meccano boy sometimes fixes up for himself. It is strong, easily built into almost any model, and of course, is entirely self-contained. The remarks already given regarding the gearing to be used in connection with the Meccano Electric Motors and Steam Engine refer equally well to the Clockwork Motor, but if considerable loads are to be overcome, one must expect to have to wind the Motor frequently.

Where only a light driving power is required, the period during which the Motor will run for each winding can be increased enormously by using a suitable governing device. One of the simplest of such devices consists of a fan wheel driven by the Motor, the resistance of the atmosphere against the blades of the fan being used to prevent the Motor exceeding a certain speed. with the result that it will run for 10 minutes or more at a single winding. The fan wheel can easily be built up from Meccano parts, but the actual blades should consist of stout cardboard, or Meccano Strips covered with cardboard. Other ways to regulate the speed of the Motor are to employ some form of governing device, for example, a friction brake that is applied by the action of weights flying outward under centrifugal force (see Standard Mechanism No. 107), or a clock escapement mechanism (S.M.'s Nos. 108 and 108a). The applications of the latter are limited, however, for on referring to the S.M. Manual it will be seen that as one tooth only of the pallet wheel is released for each swing of the pendulum the movement is rather jerky. This can be overcome to a certain extent by conveying the drive through a fairly long length of loose Sprocket Chain.

The size and shape of the Clockwork Motor enable it to be incorporated in almost any model and it is often found convenient to arrange the Motor as part of the framework or the base. In small travelling models such as motor lorries and tractors, etc., it may be used to advantage as a part of the main frame or chassis.

Where a very powerful drive is required and in cases where reduction gearing cannot easily be arranged, the drive may be taken direct from the gear on the winding spindle by means of a 1" Gear, the shaft of which may be journalled in the holes in the Motor side plates directly above the winding shaft. A tractor (Model No. 7.17 in the Instruction Manual) fitted with this gearing and a reduction of approximately 1 in 3 between the rear axle has been tested to haul a load exceeding seven stone!

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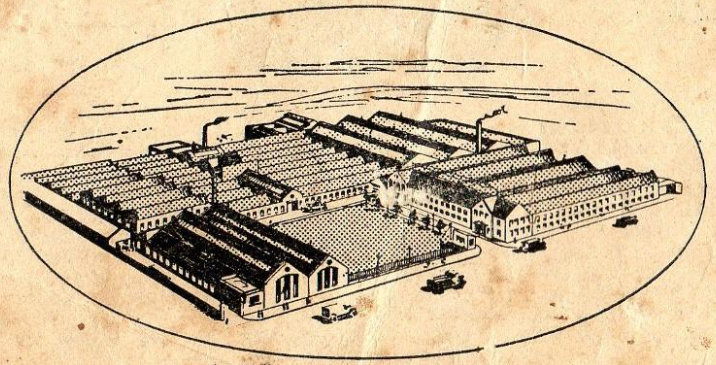

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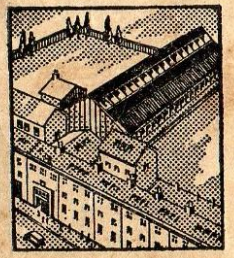

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