MECCANO CONSTRUCTORS GUIDE

Part 5: Rotating Superstructures by Bert Love

BROADLY SPEAKING, rotating superstructures can be placed into one of three categories as follows:

(1) Static balanced structures, such as gun turrets and roundabouts.
(2) Counterweighted structures, such as hammerhead cranes and,
(3) Pivotting structures which swing around a mast, such as tower cranes.

Swing bridges and locomotive turntables fall into the first category which is concerned with rotating structures which are more or less permanently balanced and are therefore fairly simple in design. A large roller path is provided in the form of a ring and a central pivot post is anchored to centralise the rotating structure. In many cases the stability of such turntables is provided purely by gravity from the sheer weight of the revolving mass. A classical case of this is illustrated in the scuttling of the German Grand Fleet in Scapa Flow, after the 1919 Armistice. When the great Battleships and Cruisers were salvaged they were found to be without their heavy guns. When the ships capsized and turned turtle, the gun barbettes simply fell out of their deep circular wells, where they simply rested on roller bearings, and plunged to the bottom of the ocean. Although the fairground roundabout is, generally speaking, a balanced rotating structure, many traditional types did pivot about a central mast and to maintain smooth running, a good fairman, in loading his machine, especially with heavy adults, would see that they were equally distributed round the 'ride'.

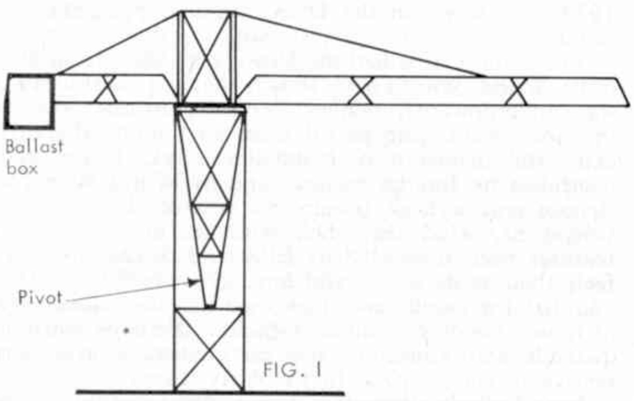


Diagram of a tower crane employing a rotating mast.

The two diagrams Fig. 1 and Fig 1a (not to scale) illustrate cranes that fall into the second two categories. In the first diagram we see the general outlines of a tower crane which represents those types which make use of a central mast for their rotation of the long boom. The tapered mast which runs down through the tower is pivotted in a fixed bearing, as shown, and this often takes the form of a phosphor bronze pad. It is important to realise that, in such a crane, the entire weight of the rotating structure is carried by the bearing at the foot of the mast and a roller ring situated at the break of the tower is a very light-duty affair which supports only the lateral, or sideways 'lean' of the crane when under load. This system has the advantage of being safe; requires no heavy components; can be made up from light-weight lattice components and absorbs both wind displacement and 'whipping' of the crane boom under awkward load conditions or jarring. The tilting moment from the load (or ballast box) is also transmitted to the foot of the mast so that the tower contributes to the general stability of the crane and must be designed and anchored accordingly.

After considerable wear, the phosphor bronze bearing is replaced by 'jacking up' the mast, the upper roller race being designed to allow its rollers to move vertically, and a new bearing inserted. This type of crane is very easy to build in Meccano, the pivot at the foot of the mast being provided by a Meccano Steel Ball, Part No. 168d, trapped in the sockets of a pair of Socket Couplings, Part No. 171, one of which is secured to the foot of the mast and one to the base girders of the tower. The upper roller race to take the lateral thrust can be made from any of the Meccano Circular Strips or Circular Flange Rings, against which six or eight Flanged wheels are set to roll round on the inside. Fig. 1a represents the heavy type of crane which is a familiar sight in ports and dockyards and is well known as a favourite type of modelling by the advanced enthusiast. This type of crane requires quite a massive roller bearing because of the sheer physical weight of the rotating superstructure plus the very heavy loads which these giants can handle. Even larger and heavier turntables are used by the World's largest Draglines which literally 'sit' on their own roller bearings and drag

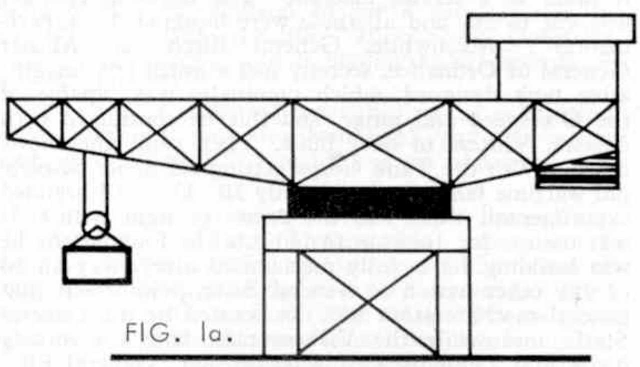
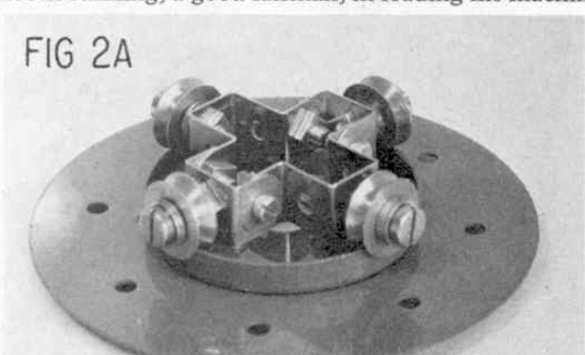


Diagram of a block-setting or hammerhead crane employing a heavy turntable and platform.

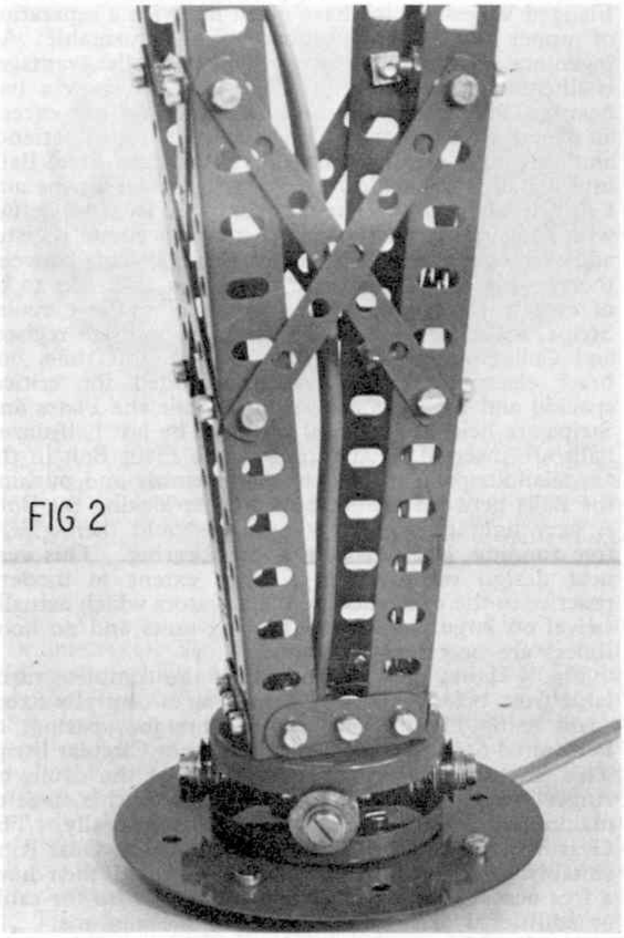


A miniature roller bearing used at the foot of a crane mast.

them across the face of the earth.

In considering the reproduction of the various turntables found in engineering practice, the Meccano Constructor must use his ingenuity to overcome problems within the limits of the parts at his disposal. Referring back to the tower crane, one problem which does arise is the supply of power to the cab controls when it is necessary to pass a cable up through the crane mast. Obviously a hollow pivot bearing is required and Fig. 2 shows how this can be done. One of the neatest and smallest thrust roller bearings which can be built in Meccano is shown in Fig. 2a which has the excellent advantage of being completely self-centring. The lower part of this bearing is a Wheel Flange, Part No. 137, bolted to a Circular Palte. As both of these parts have a substantial hole in the centre, a generous size of multicore cable can be passed right through the

FIG 2

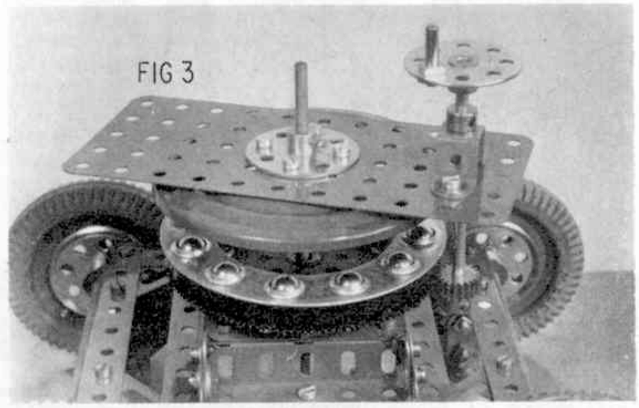


A hollow pedestal-bearing for the foot of a crane mast, through which a power cable is fed.

middle of this neat little roller bearing without impairing its efficiency. The foot of the crane mast is fixed to a second Wheel Flange by Angle Brackets, as shown, and the whole mast can then be rotated by a suitable drive at cab level, or by attaching a 3½ in. Gear Ring, Part No. 180, to the foot of the mast.

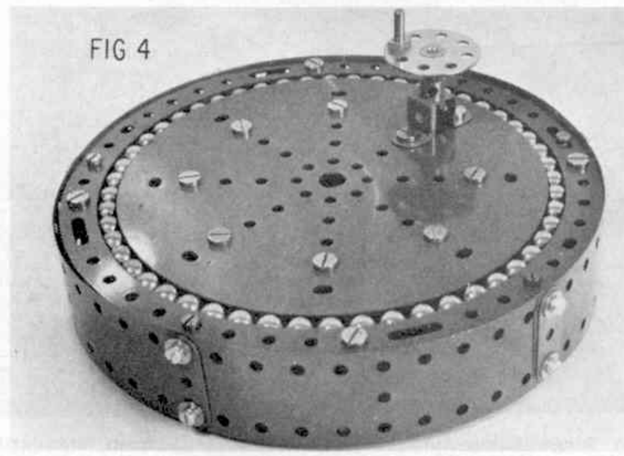
Moving up a little in size, we come to the purpose-made Ball Thrust Bearing, Part No. 168. This is a versatile component as its three parts can be used independently and Fig. 3 shows an exploded view of a built-up Ball Bearing on a model of a mobile crane. Only the top section and actual Ball-race of the bearing are used in this case, the lower flange being replaced by a 3½ in. Gear Wheel. The parts shown in Fig. 3 are separated for clarity but, in action, the top flanged would cover the Balls which, in turn, would ride on the flat surface of the large Gear Wheel. The hand wheel driving the slewing Pinion would be replaced by a mechanism inside the cab of the crane, of course. A Bearing of this nature must have an Axle Rod passing up through

FIG 3



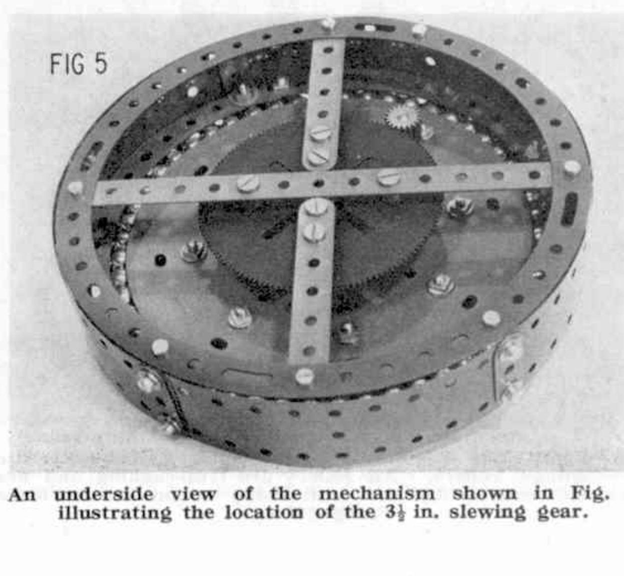
An "exploded" view of a ball bearing for a model mobile crane. All three parts of the bearing are in contact when operating.

FIG 4

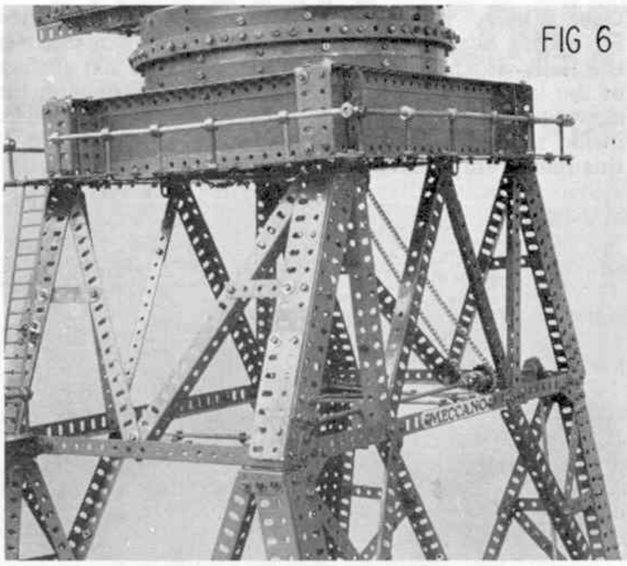


A built-up flush-level multi-ball turntable. Pivot Bolt construction ensures essential concentricity.

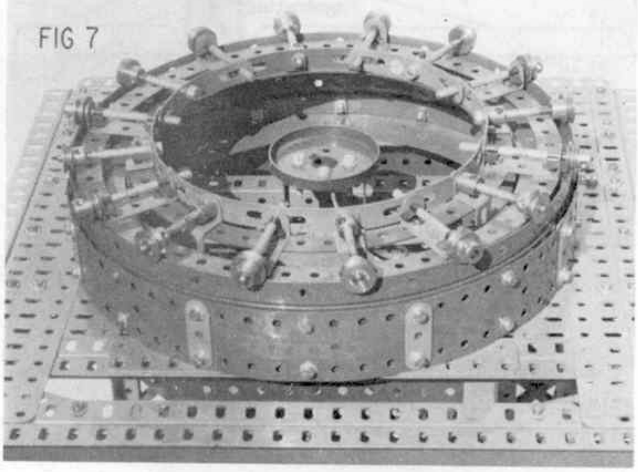
FIG 5



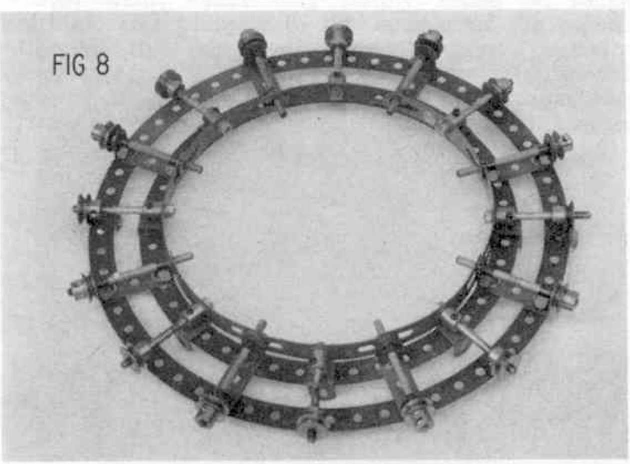
An underside view of the mechanism shown in Fig. 4 illustrating the location of the 3½ in. slewing gear.



A good example of a tower design to support a heavy crane turntable.



A large heavy-duty roller bearing built from standard Meccano Parts. The centre Wheel Flange is used as a current collector.



A lightweight "hollow" centre spider with alternate "floating" rollers. All rollers are free-running and are located entirely by the centralising action of the large Flanged Rings.

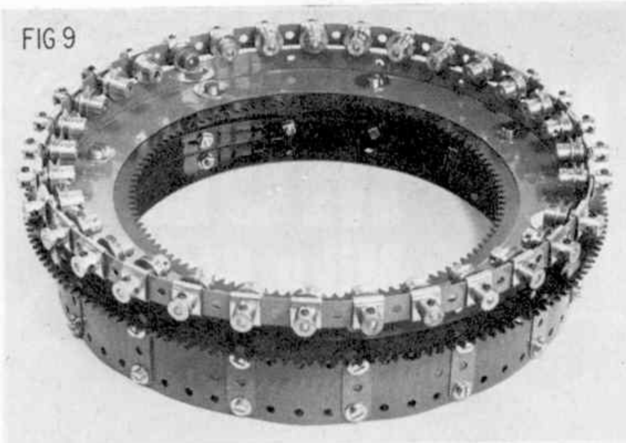
its centre to centralise the whole bearing and a suitable locking device, such as Collars or Bush Wheels, must be added to prevent the bearing from lifting apart under load conditions. This can be quite a serious disadvantage to the model builder who takes his turntable design seriously and he would aim to fit ' hook rollers ' to his model, as is frequently done in full-size prototypes. Hook rollers are often fitted to excavators and similar machines which have a natural tendency to tilt when they are removing stubborn soils and rocks. The purpose of such rollers is to hook underneath the bottom of the turntable ring and to ' pick up ' the turntable bodily if the machine starts to tilt.

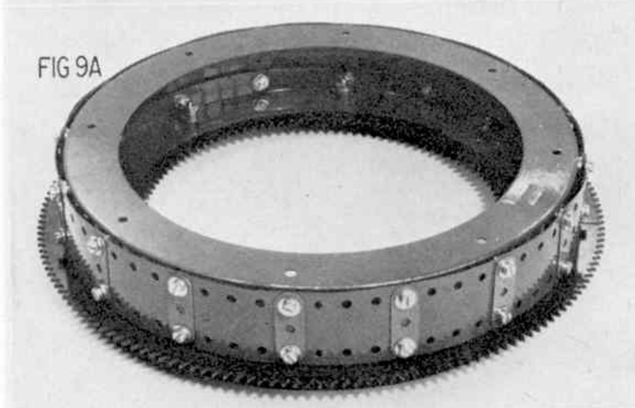
Many average-size turntables for models have been published in Meccano Magazine from time to time, utilising the 5½ in. Circular parts as roller rings or flanges but few have employed hook rollers, if any, and many have been out of proportion due to the use of Flanged Wheels which have given too wide a separation of upper and lower portions of the turntable. An ingenious method of overcoming these disadvantages is illustrated in Fig. 4 and Fig. 5 which show a ball bearing, the essential features of which do not exceed an overall depth of ⅜ in. Construction requires patience and care and the insertion of 52 Meccano Steel Balls into a Ball Race made from 7½ in. Circular Strips and 6 in. Circular Plates. The two Plates are locked together with Pivot Bolts, as shown, to ensure accurate register and each one carries a Collar for critical spacing between the two Plates. Collars *must* be chosen with care to be of exactly the same length. In spacing the Circular Strips, Pivot Bolts are again used for accurate register and Collars are used for spacing, but, this time, one brass electrical Thin Washer is added for critical spacing and the Balls are inserted while the Plates and Strips are held in a vertical plane. The last half dozen balls are inserted by slacking off one Pivot Bolt in the Circular Strips at the top of the assembly and pushing the Balls between the Strips before re-locking the Bolt. A very light greasing (not oiling) should then give a free running, but not sloppy, ball bearing. This very neat design conforms to a large extent to modern practice in the construction of excavators which actually swivel on large, sealed ball bearing units and no hook rollers are necessary of course.

Fig. 5 shows the construction of the complete turntable from below. A 3½ in. Gear ring is centrally fixed, again using Pivot Bolts and Collars for spacing, to Perforated Strips attached to the bottom Circular Strip. This, in turn, is secured to the wall of the drum by Angle Brackets and care must be taken at this stage to maintain the 3½ in. Gear Wheel quite centrally. The Gear Wheel could be replaced with a 3½ in. Gear Ring suitably attached, when the bearing would then have a free access hole right up through its centre for cable or additional drive shafts to upper mechanisms.

As the Meccano turntables get larger, substantial bases are required to support them and Fig. 6 shows an excellent type of structure for this purpose in which heavy-section built-up girders are put to good use in providing a strong platform for the turntable.

A typical basic construction for the larger roller bearing is shown in Fig. 7. Three 9½ in. Flanged Rings are used, two of them forming supports for the drum wall, made of three layers of 5½ in. × 1½ in. Flexible Plates. These are stood off from the Rings by double washers and overlaid with 1½ in. Perforated Strips. The Wheel flange mounted in the centre of the bearing is stood off by electrical Insulating Bushes to provide an electrical slip ring feed to the revolving superstructure. Fig. 8 shows how simply the ' spider ' is made. The outer ring is made of eight 4½ in. Stepped





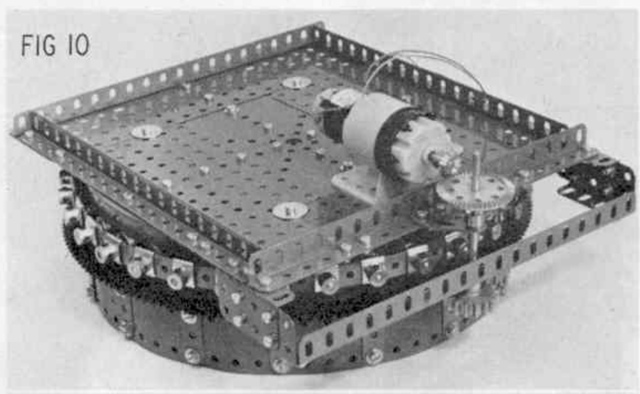
Above: A roller race carrying 32 ½ in. "rollers" and a complete ring of Large-Toothed Quadrants. No Nuts and Bolts are required for the roller ring. Below: An underside view of the roller race appearing in Fig. 9 showing how the ring of Quadrants is sandwiched between the top pair of Flanged Rings and accurately located by Pivot Bolts spaced with Washers.

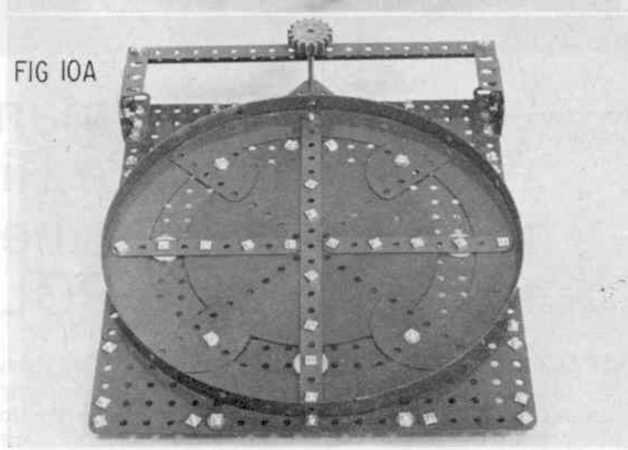
Curved Strips bolted at their joins to 1½ in. × ½ in. Double Angle Strips. These in turn are bolted to the inner ring which is a 7½ in. Circular Strip. Each Double Angle Strip carries a 2 in. Axle Rod held in place by Spring Clips to provide spindles for eight of the 16 'rollers'. Interwoven between each pair of fixed rollers is a 'floating' roller mounted in a Rod Socket attached to a Formed Slotted Strip held in Place by a ½ in. Reversed Angle Bracket which simply clips over the Circular Strip, but allows the 1½ in. Axle Rod to move up and down to allow for any unevenness in the rim of the Flanged Ring.

The choice of ½ in. Fixed Pulleys has three advantages. First of all, they prevent unsightly spacing of the roller rings. The bosses (though completely free to revolve and not secured in any way) give lateral stability to the 'rollers' and prevent any wobble, and, finally, the whole roller bearing is once again completely self-centring with all the advantages of plenty of central space to bring up wiring or other mechanisms to the superstructure. This bearing is very simple to build and works beautifully with a heavy block-setting crane. The more weight on this turntable, the better are its self-centring properties. Slewing is carried out by the simple expedient of a 1 in. Pulley fitted with a Rubber Ring which bears against the lower roller ring from the outside and is driven from a mechanism in the superstructure.

Finally, Figs. 9, 9a, 10 and 10a show a further development of the same roller bearing for the advanced constructor. Fig. 9 shows the 32 rollers employed and the way in which they are mounted. All of them are carried in Slide Pieces, Part No. 50 which does the dual job of holding the 1 in. Axle Rods forming spindles for the rollers and also of securing the lapped ends of the eight 5½ in. Perforated Strips which form the external roller ring. Each pair of 5½ in. Strips are lapped over three holes and locked simply by the jaws of the two Slide Pieces in that vicinity. The first and last 5½ in. Strips are tucked back into their own 'tails', the two final Slide Pieces having been slipped on previously.

Fig. 9a shows how the new Large-Toothed Quadrants are sandwiched between the two top 9½ in. Flanged Rings and located by Pivot Bolts spaced underneath with Collars. The upper 'deck' of the turntable is shown from below in Fig. 10a where it is seen to be perfectly symmetrical and is suitable for either of the last two turntables described. Fig. 10 shows the completed heavy-duty turntable fitted with an outrigger girder frame which carries the new 167c Pinion to mesh with the complete circle of Large Toothed Quadrants. Hook rollers may be mounted on this outrigger to engage below the toothed rack. With the Power Unit mounted as shown, set in the lowest ratio, one further stage of reduction via Bevel Gears, Part Nos. 30a and 30c, a nice scale speed of rotation is achieved with 6 volts which gives adequate power for a heavy crane. The Slide Piece method of construction is quite suitable for a lesser number of rollers or for internal mounting.





Above: A heavy-duty crane turntable for the advanced modeller employing the latest Meccano components. Powerful slewing at scale speed is achieved with only six volts fed to the power unit. Below: The upper "deck" of the turntable suitable for either of the large turntables described in the text.