A Meccano Gear-Cutting Machine

These constructional details were taken from an article in the March 1972 Meccano Magazine of a model by V. Vollenhoven of Eindhoven, Holland and scanned into computer by T. Edwards.

FEATURED here is a Meccano Gear-cutting Machine which not only demonstrates how gear-cutting is done in real practice, but which is capable of cutting real gear wheels in all standard Meccano sizes, using as a "cutting tool" a 9/16 in. Whitworth (BSW) Tap, obtainable in every toolshop (may be more difficult to find these days – T.Edwards). The gears can be cut from many different materials such as brass, aluminium, PVC, nylon, etc. and the plastic gear wheels thus made are especially recommended in places where "silent" transmissions are required. In any case, it gives the model-builder—after completing the model —a lot of fun in making an extra supply of gear wheels!

The machine demonstrates the great possibilities of standard Meccano parts for the building of really good working "production machines", provided the builder takes care to make the unit strong enough, in the sense of rigidity against bending. Meccano parts practically never break, but at some loads, they occasionally bend, owing to their flexibility.

In the relevant accompanying photographs, the machine is shown at work, cutting a 60-teeth gear wheel from a nylon disc, thus proving its success in operation.

Building the Model

THE FRAME consists of two I-section beams 1, each made from four 12 1/2 in. Angle Girders and one l2 1/2 in. Flat Girder bolted together at regular intervals. At the forward end, the beams are joined together, at the top by two 3 1/2 in. Angle Girders 2 overlaying a 3 x 1 1/2 in. Flat Plate 3, and at the bottom, by a 5 1/2 in. Angle Girder 4, the joins being strengthened by four 1 1/2 in. Corner Brackets. Another 5 1/2 in. Angle Girder 5 is bolted to the spare flange of Girder 4, the securing Bolts helping to fix four diagonal bracing 2 1/2 in. Strips 6 in place between this Girder and nearby Girder 2.

Journalled in Girders 2 are two Axle Rods extended, via Threaded Couplings, by Screwed Rods, as shown, a 1 in. Gear 7 being mounted on the end of each Axle Rod. In mesh with these Gears is a third 1 in. Gear on a centre Rod, an 8-hole Bush Wheel 8, fitted with Threaded Pin, being fixed on the end of the Rod to serve as a hand-wheel. This whole arrangement acts as the horizontal feed for the carriage.

The rear end of the frame consists of five 7 1/2 in. Angle Girders 9, all bolted between beams 1 in the positions shown and extending two holes at one side and six holes at the other. Four 3 in. Strips 10 are also bolted diagonally between the beams to provide further support, while three vertical in. Angle Girders 11, braced by three diagonal 5 1/2 in. Angle Girders 12, give support for the main bearing assembly. The ends of upper and lower rear Girders 9 are connected by two vertical 2 1/2 in. Angle Girders, each of these being connected to nearby Girder 11 by a 4 1/2 in. Braced Girder overlaid by two 4 1/2 in. Angle Girders 13. The frame is then completed by a 7 1/2 in. Braced Girder at the rear and a *2 1/2* in. Braced Girder 14 at the front.

Note that the completed frame must be as perfectly "square" and rigid as possible. The I-section beams must be arranged neatly parallel and all Nuts and Bolts well tightened up for heavy-duty work. Legs for the frame are provided by Sleeve Pieces attached to in. Flanged Wheels.

The model is powered by an El5R Electric Motor, secured to a 3 1/2 x 2 1/2 in. Flanged Plate 15 which, in turn, is bolted to the flanges of another similar Plate fixed between two Girders 12. (I would recommend a more powerful modern type motor like I used rather than the E15R which I did not find very satisfactory – T.Edwards)

The Carriage
Pictured in one of the accompanying illustrations is the carriage as it appears removed from the model. It consists of two U-section girders 16, each supplied by two 4 1/2 in. Angle Girders, the U-section girders being connected by a 3 x 1 1/2 in. Flat Plate 17, a 2 1/2 x 1 1/2 in. Flexible Plate and two 2 1/2 in. Flat Girders, arranged on top of each other as shown, but with the Flat Girders separated by a distance of one hole. Flat Plate 17 must slide with the minimum clearance between beams 1 of the frame, the Flexible Plate giving the carriage a little clearance in the vertical direction.

Spindle 18, vertical when the carriage is mounted in the frame, carries the "leading" Gear Wheel and the disc to be cut. It is journalled in two bearings supplied by Double Arm Cranks, the top bearing being bolted to a 1 1/2 in. Flat Girder which, in turn, is bolted to a 4 1/2 in. Angle Girder 19. Girder 19 is attached to the carriage by 1/2 in. Bolts and extra Nuts, thus allowing for easy dismantling when setting up for cutting a new gear wheel.

Vertical feed of spindle 18 is controlled by a lever system attached to the underside of the carriage. On the spindle, a Coupling 20 is freely mounted, being held in place by two Collars, one each side of the Coupling, with the spindle passing through the centre transverse bore of the Coupling. Two 3 1/2 in. Strips 21, free to pivot, are held by Collars on two 1 in. Rods fixed in the ends of the Coupling. Bolted to the Flat Girders and Plates underneath the Carriage are two Handrail Supports 22 in the heads of which is fixed another 1 in. Rod, this carrying a Crank 23, five Washers and a Double Arm Crank 24, all free on the Rod. The Rod passes through the boss of the Crank and the circular hole in the arm of the Double Arm Crank.

The swivel for the lever is a short Rod 25**,** passed through the second holes of the Strips 21, the boss of Double Arm Crank 24 and the circular hole in the arm of Crank 23. The Rod is free to rotate, being held in place by Collars.

Loosely mounted on two Bolts between the opposite ends of Strips 21 is a Coupling 26, the centre tapped bore of which carries a 6 in. Screwed Rod 27. This Rod actuates the lever, but excessive movement is prevented by two "stops" 28, each provided by two Nuts locked against a Washer between them. The upper end of the Screwed Rod passes through the centre *smooth* bore of another Coupling, held in the carriage by two short Rods in two 1 in. Corner Brackets 29 bolted to a 2 1/2 in. U-section girder secured, along with a Flat Trunnion, to one girder 16. Fixed on the end of the Rod is a 7/16 in. Pinion and vertical feed is accomplished by turning this Pinion by hand. However, as vibrations during cutting tend to cause the Screwed Rod to revolve involuntarily, the Rod can be secured for two or three cutting revs, at a time by a second 7/16 in. Pinion 30, fixed on a Pivot Bolt screwed into one tapped centre bore of Coupling 26.

Fixed between the flanges of U-section girders 16 by short Bolts, each fitted with two Washers, are four Threaded Bosses 31. Screwed into these Bosses under operating conditions are four swing-bolts 32, each made up of a Threaded Boss in which a short Screwed Rod is locked by a Nut. A 3/4 in. Washer is mounted on the Rod, the "wings" of the bolt being provided by two 1/2 in. Bolts. These swing-bolts must be firmly tightened during the final vertical cutting so as to obtain the best results. Construction of the remaining carriage framework is clear from the illustrations, but it should be mentioned that the two Screwed Rods providing horizontal feed for the carriage locate in the transverse bores of two further Threaded Bosses 33 secured between the flanges of lower girder 16.

Main Bearing Assembly
Moving to the main bearing assembly, two 7 1/2 in. Angle Girders 34 are connected together by four 1 1/2 in. Angle Girders and two 3 1/2 x 1 1/2 in. Flat Plates 35, then two further 7 1/2 in. Angle Girders 36 are bolted, one to each Girder 34 to form reversed angle girders. Seven Threaded Pins are mounted in the positions shown, four in one Plate 35 and three in the other Plate, each Pin carrying three Washers and a Coupling. The upper transverse bores in the Couplings provide fine and easily lubricated bearings for Rods carrying the cutting equipment and relevant gearing.

The cutting tool itself is a 9/16 in. Whitworth (BSW) Tap 37, centred between short and long pointed Rods, the long Rod carrying an 8-hole Bush Wheel 38, to the face of which four Threaded Bosses are fixed by their longitudinal bores. Screwed through their transverse bores are four in. Bolts which hold the squared end of the Tap. The same Rod also holds a 1/2 in. Pinion 39, a Collar 40, two pairs of two 13- in. Strips 41 and two 57-teeth Gear Wheels 42, the last face to face for heavy-duty driving.

Running parallel to the cutting tool and shaft is a 5 in. Rod carrying the "leading" Worm 43 and the other end of one pair of Strips 41, being fixed part way in the bore of a 1/2 x 1/2 in. Pinion 44. Running free in the other half of the bore of the Pinion is a shorter input-drive Rod, carrying the other pair of Strips 41, a 1/2 in. Pinion 45 and, on my model, a Meccano Flywheel 46. This last very fine, but long-since obsolete, Meccano part can be replaced by two 3 in. Pulleys with Tyres, if desired. Pinion 45 meshes with Gear Wheels 42.

In mesh with Pinions 44 and 39 is an "idler" 1/2 in. Pinion 47 on a 1 1/2 in. Rod, held by a Collar in the centre holes of Strips 41. Here, and at all other points double Grub Screws should be used. (Double grub screws are not a particular secure fastening – much better is filing a small flat on the axle rod – T.Edwards)

When completed, the main bearing assembly is bolted to the frame at a somewhat inclined angle, as shown, this being necessary as the tangent to the Worm (and the cutting tool) must be exactly vertical. With Girders 36 bolted to outside vertical Girders 11, there must be *one* hole clear in left-hand Girder 11 and two holes clear in right-hand Girder 11, counting from the top. In other words, upper Girder 36 must be bolted through the second hole of left-hand Girder 11 (furthest in photographs) and the third hole of right-hand Girder 11 (nearest in photographs). With the unit in place, Flywheel 46, or its substitute, is connected by a suitable Driving Band to a 1/2 in. Pulley fixed on the Motor output shaft.

Gear-cutting

With a fine hack-saw, a disc of equal diameter to the corresponding Meccano Gear Wheel is sawn out of the chosen sheet material. A centre-hole of standard shaft diameter is drilled in this and also two holes at 1/8 in. or 1/2 in. distance from the centre in order to Bolt the disc to a 1 in., or 1 3/8 in. Bush Wheel. For cutting in brass, *two* Bush Wheels are recommended, one each side of the disc, and, when cutting a 133-teeth Gear Wheel (the largest possible in the carriage), the largest Sprocket Wheel should be used as a bush wheel.

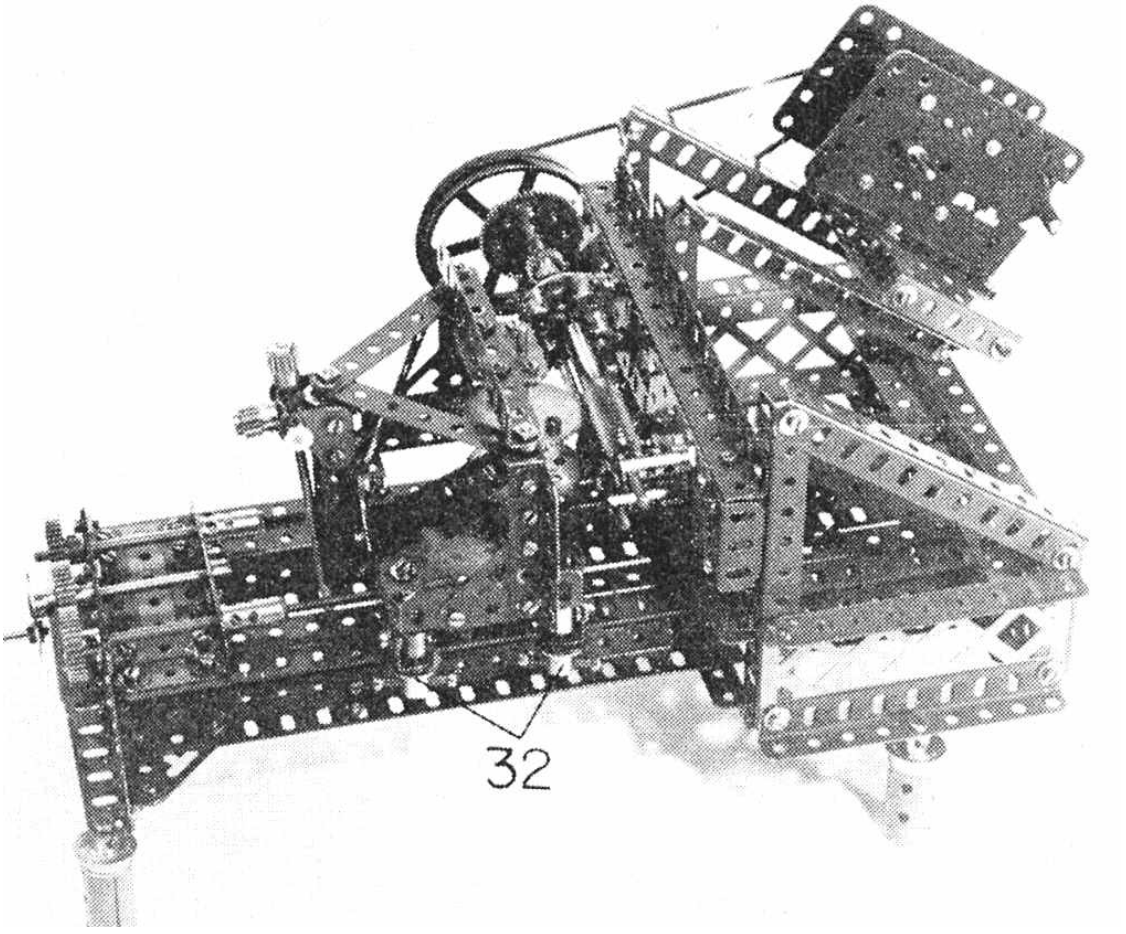
The leading Meccano Gear Wheel should be located at the centre of Worm 43, but the disc to be cut must be positioned somewhat below the middle of the Tap to allow the Worm and leading Gear to make contact first when feeding horizontally. The horizontal feed must be stopped when the leading Gear cannot be moved further into the Worm, then the swing-bolts are tightened and the vertical feed is begun, moving the spindle in an upwards direction.

Cutting in thick materials would also require "thick" leading Gear Wheels, but it can also be done by repositioning the leading Gear Wheel after reaching half of the vertical feed!

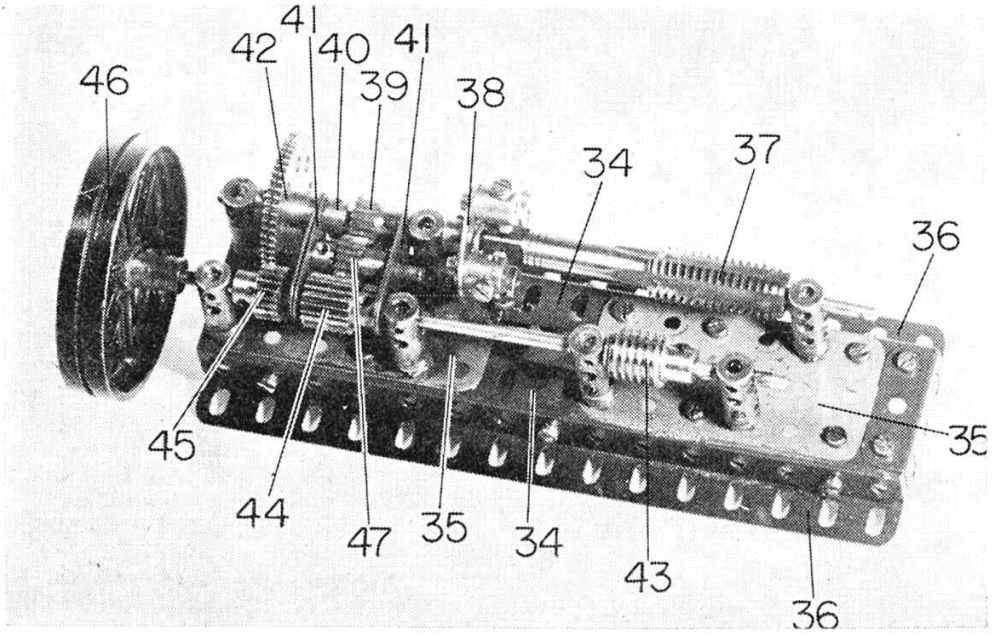
Further developments

By some modifications to the model, it must be possible not only to cut gear wheels of standard Meccano tooth numbers, but also gear wheels of special tooth numbers—say 75-teeth, for example. In this case, a 60-teeth Meccano Gear could still act as the leading gear wheel on the spindle, as before, but the cutting tool (the Tap) must be placed somewhat behind, i.e. not in the same vertical plane as the Worm. The gear-ratio between the shaft carrying Worm 43 and the Tap must be changed from 1 : 1 to 60 : 75 (4 : 5). Whatever is done, however, the model will give good service—provided every care is taken to ensure strong, rigid and correctly aligned construction.

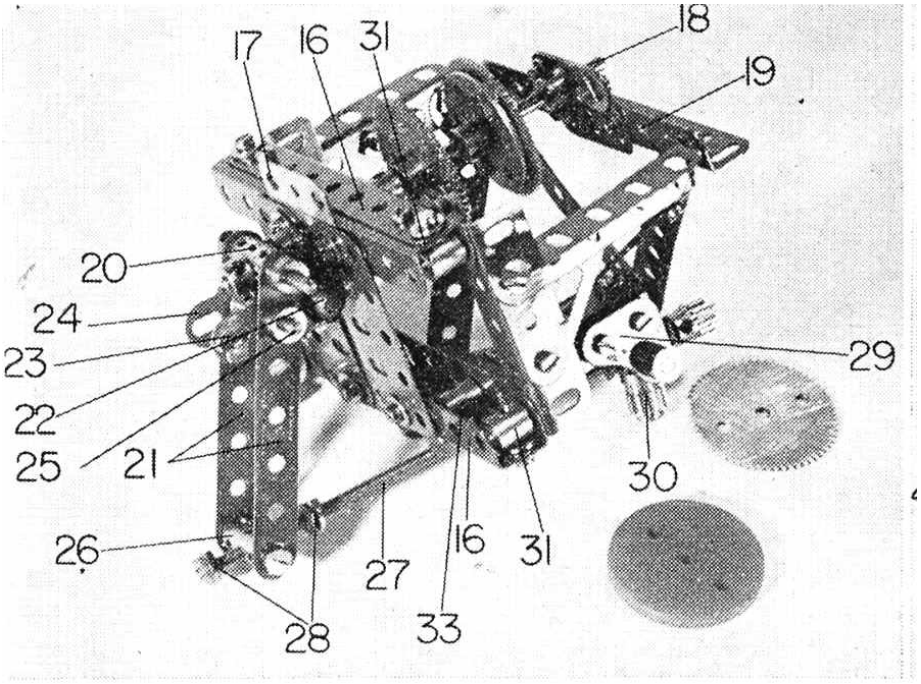
There is no parts list is available for this model.



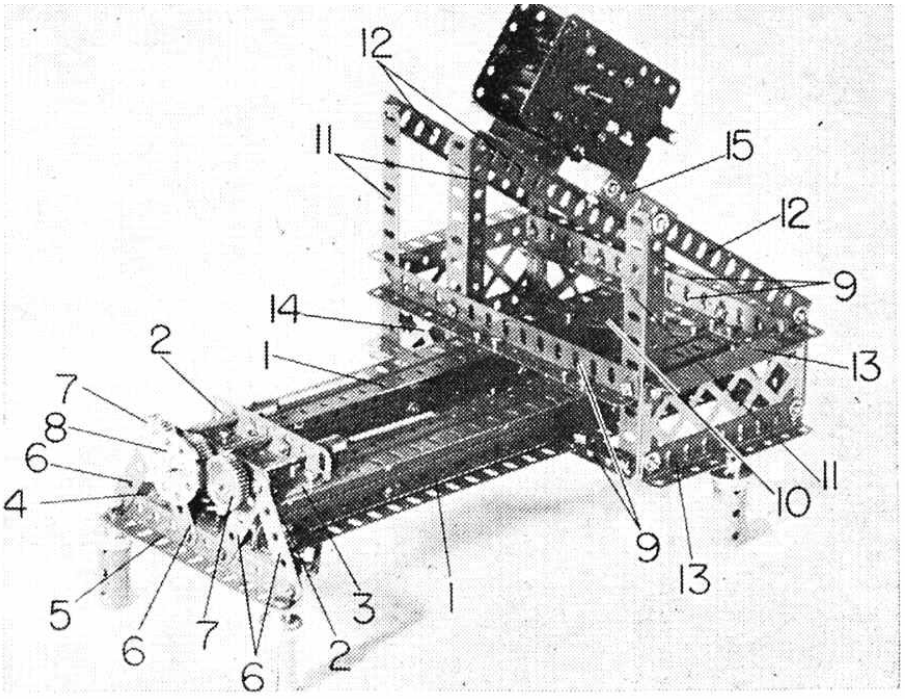
A detailed view of gear-cutting in operation. As the lower Meccano Gear Wheel makes contact with the Worm, when fed in horizontally (from left to right), the Tap begins cutting the upper disc. The Worm and Tap drive are coupled in a 1 :(1) : 1 ratio.



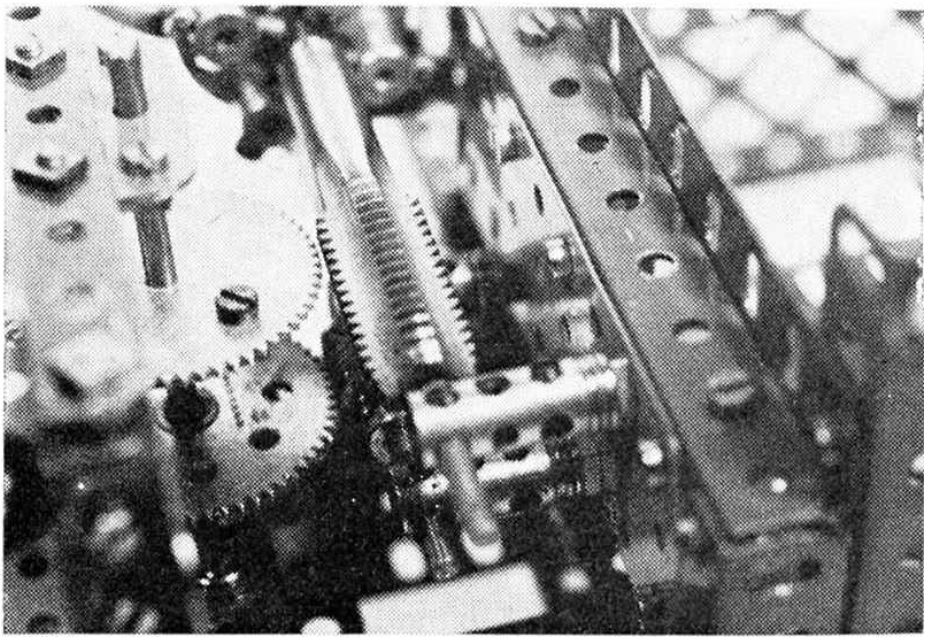
Top, a “working” Meccano model in the true sense of the word is this Gear-cutting Machine, designed and built by the author. It will produce real gears from a variety of materials.



Left, a close-up view of the main bearing assembly, removed from the model, The cutting tool (37) is a 9/16 in. Whitworth (BSW) Tap.



The cutting carriage as it appears removed from the Machine. In the right foreground is a P.V.C. disc prepared ready for cutting and a completed gear cut from brass.



A view of the main frame without the cutting carriage and main bearing assembly. The horizontal feed for the carriage appears at the near end of the frame.