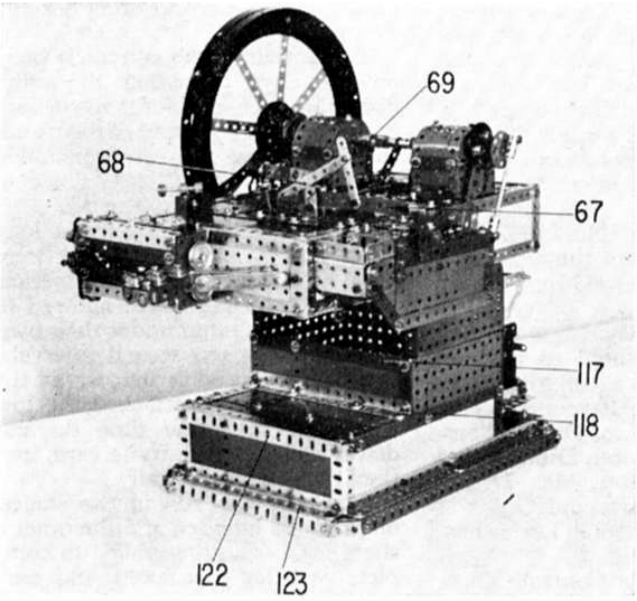


A "Riveting Situation"

—leading up to a Meccano model of an automatic rivet-making machine

Part 1

By P. Blythe

DINKY Toy "Spitfire" wheels, bicycle mudguards, television sets and ladies' handbags may at first sight appear to have little in common. There is a linking factor, however, this being the need for enormous quantities of the products to be manufactured, economically. It is therefore absolutely essential that the components which make up the various products can be put together easily and cheaply and that they do not fall to pieces in use. This is where modern riveting scores over most other fastening systems.

The term "rivet" normally conjures up the vision of a large threadless bolt which is placed by hand into a pre-drilled hole and hammered over to secure the joint. While rivets of this type were used extensively by blacksmiths many years ago, modern automatic riveting bears very little resemblance to such ponderous techniques.

The majority of riveted joints on domestic, electrical and automotive applications require rivets between $\frac{1}{32}$ in. and $\frac{1}{4}$ in. in diameter which are churned out by the million in two basic types—tubular and bifurcated, each having their own particular fields of use.

It is in the riveting of football boot soles, handbags, cardboard and plywood boxes that one normally finds the bifurcated type of rivet which, as its name implies, has a split or slotted shank. These fasteners do not require pre-drilled holes to be provided and are capable of being driven into thin sheet metal and plywood to give an almost indestructible fixing (try taking to pieces a riveted tea chest!). Bifurcated rivets may also be seen reinforcing the pockets of overalls and fixing the metal buttons in place. When a very neat finish is desired on the reverse side of a joint secured by a bifurcated rivet, the turned-back prongs may not be sufficiently smooth. Close inspection of a shopping bag or a dog lead will reveal a small shiny cap into which the rivet is automatically driven during the riveting operation.

So much for bifurcated rivets, but what do we use for securing the pivoting joints of tubular garden furniture and car windscreen wipers? Both of these applications require a very neat and smooth finish with the head and clinch (turned-over end) being similar in size and appearance. The requirement in this case is for a rivet which can be inserted into the work and given a single blow to form the turn-over without any buckling of the shank. In addition to this, for certain applications the joint must pivot with a specified tightness. This rather demanding requirement is very adequately filled by a specially-developed tubular rivet introduced a few years ago and now produced in extremely large quantities.

Further problems are presented when riveting fragile or brittle plastic components of the type commonly employed in the electrical industry. Metal terminals or even additional mouldings are often secured to such components. Joints of this type are further complicated by the material thickness varying greatly from one assembly to the next, while the manufacturers insist upon a tight fixing under all conditions without the bits and pieces becoming broken in the process. Again, continuous research has resulted in a rivet for the job which is a further version of a tubular rivet having a thin tapered wall at the hollow end, to allow the clinch to be formed without undue pressure while remaining sufficiently strong to provide a really secure fixing.

With the increasingly varied and specialised requirements of modern industry the "family" of rivets is being constantly enlarged and now includes shouldered rivets which serve as pivots—have a close look at

Heading, a detailed Riveting Machine built in Meccano by the author. Although it does not actually rivet, it reproduces all the movements of a full-size machine—even down to the realistic clatter!

Left, examples of the many different types of modern rivet, each one designed for its own particular job.

the handle of a one gallon paint can—and electrical terminal pins, the most common application of these being in the channel tuners and printed circuit boards of T.V. sets.

So much for the various types of rivets, but how on earth does one insert a rivet into a pile of components—certain of which have to be correctly positioned—and then form the rivet clinch? The answer here lies in the latest developments of automatic-feed riveting equipment. These machines are usually electrically operated and have a hopper into which the rivets are poured. When the driving motor is switched on, the rivets are sorted to the correct attitude to slide down a track, along which they then travel, finally coming to rest in a pair of spring-loaded jaws which place the rivets one at a time into the stack of components.

The problem of aligning the holes in the parts during assembly is overcome by the use of a device called a "spring centre anvil". The anvil—which forms the clinch of the rivet—has a spring-loaded pilot pin which protrudes sufficiently far to enable the components to be loaded on the pin which then passes through the holes. When the machine foot pedal is depressed by the operator, the rivet is driven through the spring-loaded jaws by a top punch, the hollow shank end of the rivet being located by the domed tip of the anvil pin to guide it down into the pile of components. When the pin is in its fully-down position, the profiled tip forms the clinch of the rivet. This sequence of events takes 1/5th of a second so it will be seen that, with the up-to-date equipment and rivets now available, the system of fastening is well able to cope with modern requirements.

We have discussed briefly the various types of rivets and means for inserting them but what is the best way to go about manufacturing around 100 million rivets in one week—the output of some of the larger producers? A visit to a modern rivet factory is quite a memorable experience due mainly to the terrific noise emitted from the rows of "heading machines" as they are called, munching their way through coils of wire rather like diners eating spaghetti!

There is no better system than Meccano for making your own model heading machine which will faithfully reproduce all the movements of the real thing and with the multiplicity of different movements the completed header is fascinating to watch. The model is not difficult to make and a very large stock of parts is not necessary. Before we plunge into the building details, however, a short description of the construction and operating sequence of the real machine is necessary.

Basically, the original version of the "heading" machine consists of a rectangular frame approximately the size of a small wardrobe laid on its back. This frame is supported on a cast iron stand to provide a conventional working height. Within the frame slides the ram, moving horizontally, this ram being driven by a substantial crankshaft mounted across the frame and running in journals provided towards the rear of the machine. The crank pin carries a connecting rod which, via a toggle linkage, propels the ram back and forth. The linkage is so arranged that the ram makes two strokes per crankshaft rev.

At the front of the ram is superimposed the tool slide which moves up and down, this being driven by a separate mechanism. The tool slide carries two press tools, one mounted above the other. As the rivet is formed in two blows, the sequence of events is that the ram moves forward with the tool slide "down" to partially form the rivet head. The ram then moves back when the tool slide is lifted up ready for the second forward stroke to complete the rivet.

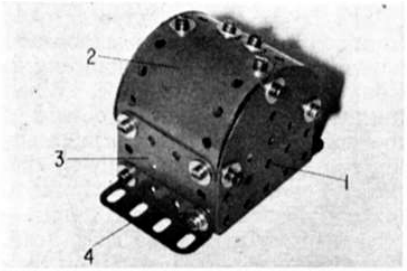
Cams and eccentrics mounted on the outboard ends of the crankshaft drive the ancillary mechanisms while a large flywheel on the left-hand end keeps everything working smoothly. Two cams are fitted to the flywheel side, one for operating the punch mechanism to produce hollow rivets, while the other cam is employed to actuate a "knock-off" linkage which ejects the completed rivet into the catchment tray. Finally, on the left-hand side is an eccentric to operate the wire feed mechanism.

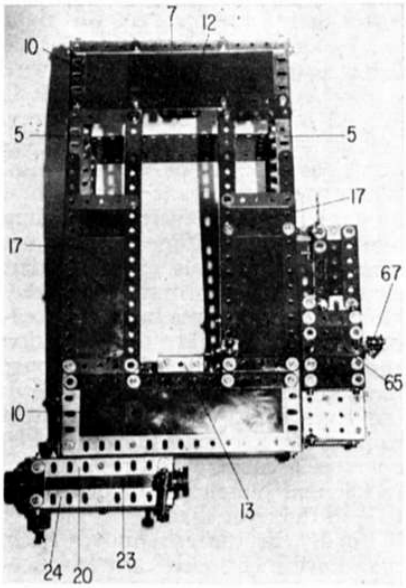
On the right-hand end of the crankshaft is located a cam for the toolslide lift mechanism, while a crank mounted on the extreme end operates the cut-off device, i.e. a mechanism which slices off the slugs of wire from which the rivets are produced. As mentioned above, the crankshaft is mounted towards the rear of the machine, so that long connecting rods extend towards the front to impart the cam and eccentric movements to the various mechanisms which are situated round the actual forging area.

The rivets themselves are made from coils of wire which are mounted horizontally upon a reel standing in front of the forging machine. When the machine is operating, the end of the wire passes through straightening rollers and enters a cut-off die, the end projecting sufficiently far to make a rivet of the chosen length—plus a bit extra for the rivet head. The slug of wire is then cut off by a cutter slide, mounted on the right hand side of the machine. This cutter carries a little piece of wire across to the main die where it is pushed in by one of the two press tools moving backwards and forwards on the front of the ram. When the ram advances on its first forward stroke, the vertically sliding toolbox is in its "down" position. The slug of wire is given a smart clout to partially form the rivet head Now, the ram moves back, the toolbox is raised to its "top" position and the ram is driven forward once more on its final stroke to fully form the rivet head. At this instant, a cam on the left hand (flywheel side) operates a rocker, pushrod, second rocker and punch pin to produce a hole in the rivet shank.

Finally, as the ram moves back, the above-mentioned cam advances the punch pin further to eject the finished rivet from the die, where it is knocked off the punch by an extractor mechanism, again cam-operated from the left-hand side of the crankshaft. The wire feed is provided by an eccentric mounted also on the left-hand side of the crankshaft which operates a simple pawl and ratchet arrangement. There are two feed roller shafts, these being geared together and, incidentally, accounting for the only gears in the machine.

Riveting radiator-grille components on a B & TR Co. automatic-feed rivet-setting machine at the British Leyland (Austin Morris) factory at Cowley, Oxford.





Left, one of the two identical crankshaft bearing housings as it appears removed from the machine.

Below, a top view of the main body section without the crankshaft and internal mechanisms.

Model Construction

Turning now to the Meccano model, as already mentioned this is not unusually difficult to assemble although care should of course be taken to ensure framework rigidity and the smooth-running of moving parts. Construction begins with the two crankshaft bearing housings, both of which are identical in construction and may be built up as separate units for subsequent attachment to the machine frame.

Each side plate is made up of a Semi-circular Plate bolted to a $2\frac{1}{2} \times 1\frac{1}{2}$ in. Flanged Plate 1. The pairs of side plates are joined by 2 in. Strips and a built-up flexible plate 2 comprising two $5\frac{1}{2} \times 1\frac{1}{2}$ in. Flexible Plates overlapped two holes at their long edges and extended a further three holes each way by two $2\frac{1}{2} \times 1\frac{1}{2}$ in. Flexible Plates 3. Angle Brackets join the Semi-circular Plates to the Flexible Plates, while mounting flanges are provided by 2 in. Angle Girders 4 bolted as shown.

Body Assembly

In the case of the body, four $12\frac{1}{2}$ in. Angle Girders 5 provide the main side members, these being extended a further three holes forwards by four $5\frac{1}{2}$ in. Angle Girders. The left-hand side panel is filled in by a $12\frac{1}{2} \times 2\frac{1}{2}$ in. Strip Plate 6 and a $2\frac{1}{2} \times 2\frac{1}{2}$ in. Flexible Plate, while a $9\frac{1}{2} \times 2\frac{1}{2}$ in. Strip Plate and a $5\frac{1}{2} \times 2\frac{1}{2}$ in. Flat Plate are used on the right-hand side. Both side panels are joined front and rear by four $7\frac{1}{2}$ in. Angle Girders 7 while the rear corners and the front right-hand corner only are capped by vertical $2\frac{1}{2}$ in. Angle Girders 8. The back of the body is enclosed by $5\frac{1}{2} \times 2\frac{1}{2}$ in. and $2\frac{1}{2} \times 2\frac{1}{2}$ in. Flexible Plates 9, similar Flexible Plates 10 being used to cover the front and rear of the top surface of the body. Plates 10 are fitted beneath the flanges of the frame members.

Two further $7\frac{1}{2}$ in. Angle Girders are bolted across the inside of the body to reinforce the edges of the above-mentioned Flexible Plates, but note that, before fixing these Girders in place, each one has attached to its slotted flange two Flat Trunnions 11 (leave one free hole at each end.) These Trunnions eventually carry the two fore and aft rods on which the ram slides. The rear $7\frac{1}{2}$ in. Girder also carries on its slotted flange a $1\frac{1}{2}$ in. Angle Girder 12, fixed centrally. The forward-facing slotted flange of this short Girder carries at each end, a Hinge.

At the centre of the front $7\frac{1}{2}$ in. Girder is fixed the die block, represented by a Channel Bearing 13 with its sides enclosed by a pair of $1 \times \frac{1}{2}$ in. Angle Brackets. The portion of the Channel Bearing protruding below the Girder has bolted to it the 5-hole side of a Corner Gusset—one hole projecting each end. The downward-facing 4-hole side is on the left and carries a rearward-facing Double Bent Strip 14, the bottom Bolt also retaining an Angle Bracket, its free lug facing towards the front of the machine.

Now the two $7\frac{1}{2}$ in. Girders may be bolted inside the frame, both with their round hole flanges facing the front of the machine. $7\frac{1}{2}$ in. Strips overlay the edges of the Flexible Plates for neatness. The Angle Bracket on the bottom of the Corner Gusset is connected to the main frame by a $2\frac{1}{2}$ in. Strip.

Using its round hole, an Angle Bracket is next bolted through one end hole of each of a pair of $9\frac{1}{2}$ in. Angle Girders 15, a $1\frac{1}{2}$ in. Corner Bracket 16 also being bolted—adjacent to the Angle Bracket—to the right-hand Girder. These Girders, round hole flanges vertical, are now fixed longitudinally within the frame to provide the edges of the ram slideway. Their rear ends are bolted direct to the $7\frac{1}{2}$ in. cross-member Girder, while the front ends are attached by the slotted lugs of the two Angle Brackets to the other $7\frac{1}{2}$ in. Angle Girder cross-member. When correctly adjusted by making full use of the slotted holes, the space between the $9\frac{1}{2}$ in. Girder should be $2\frac{5}{8}$ in., i.e. room for a $2\frac{1}{2}$ in. Strip with $\frac{1}{16}$ in. clearance each side.

A pair of $5\frac{1}{2} \times 2\frac{1}{2}$ in. Flexible Plates 17 are each extended one hole by two $2\frac{1}{2} \times 1\frac{1}{2}$ in. Flexible Plates, these being bolted to partially fill in the space at each side of the ram slideway, the gap being at the rear. Suitable Strips overlay these Flexible Plates and $2\frac{1}{2}$ in. Strips are fixed across each side panel as shown. The rear overlaying $2\frac{1}{2}$ in. Strips serve also as a base upon which to bolt the front of the bearing housings. To support the rear of the housings two further $2\frac{1}{2}$ in. Strips are bolted between Girders 15 and the $12\frac{1}{2}$ in. main side-members.

Fixed to the side of the front left-hand corner of the body is a vertical $2\frac{1}{2}$ in. Angle Girder, secured by its slotted holes. The remaining flange projects outwards and to it is bolted, centrally, a rearwards-facing Double Bent Strip 18.

This now almost completes the body assembly and the bearing housings may be secured by bolting the $2\frac{1}{2}$ in. Perforated Strips to the slotted flanges of the 2 in. Angle Girders. Using an $11\frac{1}{2}$ in. Rod, check that all four bearings are precisely in line. Packing Washers should be added as necessary to bring bearings into line.

At the right-hand side of the front of the body is secured a $4\frac{1}{2} \times 2\frac{1}{2}$ in. Flat Plate 19 fitted inside the frame. Both top and bottom left-hand fixing Bolts also secure, by their round hole flanges, a pair of $4\frac{1}{2}$ in. Angle Girders 20 attached so that their ends project a distance of two holes from the left-hand side of the frame. A vertical $2\frac{1}{2}$ in. Strip 21 joins the end holes of these Girders, thus forming the beginning of the feed roller assembly.

Secured to the forward-facing slotted flanges of the two Girders, at the right-hand end, is a $2\frac{1}{2} \times 1\frac{1}{2}$ in. Flanged Plate 22 and, at the opposite end, are two forward-facing $1\frac{1}{2}$ in. Angle Girders. The space between these parts—at the top only—is filled in by a pair of $2\frac{1}{2} \times 1\frac{1}{2}$ in. Flexible Plates 23, overlapped one hole. Note that the right-hand Bolt also secures an over-

(*continued on page* 457)

Angle Girders overlapped five holes), connected together by three 1½ in. Strips bolted through their third, twenty-third and forty-fourth holes, counting from the top. A 2½ × 1½ in. Triangular Flexible Plate 32 is bolted to each end of each compound girder, then two 18½ in. compound strips 33 are bolted, as shown, between the free corners of the Triangular Plates, at the same time fixing a 1½ × ½ in. Double Angle Strip 34 between the ends of the two compound strips at top and bottom. Each compound strip is built up from two 12½ in. Strips, overlapped thirteen holes. A 6-hole Wheel Disc 35 is bolted between the centres of the compound strip and compound girder at each side of the jib, while Cord is also threaded back and forth between the strip and girder and between the two strips to represent cross-bracing.

Held by Spring Clips in the upper end holes of compound girders 31 is a 2 in. Rod, on which two 1 in. Pulleys with boss 36 are freely mounted. A 3½ in. Rod carrying a fixed 1 in. Pulley 37 is journalled in the nineteenth holes of the girders, then the tower is pivotally connected to the body by a 2 in. Rod passed through the lower end holes of the girders and through the vertical lugs of two Angle Brackets bolted to the forward edge of Flat Plate 8. A ½ in. Pulley without boss 38 is mounted on the Rod, which is held in place by Spring Clips. A "stop" to prevent the tower from pivoting backwards onto the body is provided by a 2½ in. Strip bolted to the free lugs of two 2½ × ½ in. Double Angle Strips 39 which are in turn bolted to the underside of the cab roof in such a position that they project three holes forward.

Pivotally attached to the tower is the jib which consists quite simply of two 12½ in. Strips 40, lock-nutted through the seventh holes of compound strips 33. Strips 40 are themselves connected together through their ninth holes from the tower by a 1½ in. Strip, attached by Angle Brackets, while a 1 in. Rod, carrying two 1 in. Pulleys without boss 41, is held by Collars in the end holes of the Strips.

This leaves only the cording arrangements to be completed and the model is finished. The load cord attached to Crank 20 and projecting from the front of the body is passed round Pulley 38 in the base of the tower, is taken upwards and over left-hand Pulley 36, down and around left-hand Pulley 41 in the jib and is then completed with a Loaded Hook, tied to the end. The jib control cord projecting from the top of the body is taken up and over right-hand Pulley 36; down and around right-hand Pulley 41 and is then brought back up and tied to upper Double Angle Strip 34. The remaining tower attitude control cord is simply taken up and around Pulley 37, then is brought back and tied through the rearmost centre hole in Flat Plate 22 to finally complete the model.

PARTS REQUIRED

6—1	1—18a	2—48	4—187
6—2	1—18b	2—48a	4—188
2—3	2—19b	1—48b	3—189
2—4	1—19h	1—52	2—190
13—5	3—22	2—53	1—191
4—6a	2—22a	2—53a	2—192
4—8	1—23	2—54	2—194
2—10	1—23a	1—57c	1—199
1—11	2—24	4—59	1—200
16—12	2—24c	6—111c	1—213
2—12a	1—27a	1—115	4—215
2—15	7—35	4—125	4—221
1—15a	133—37a	4—126a	
3—16	129—37b	1—147b	
2—17	28—38	1—176	

Riveting (*continued from page* 434)

laying 1½ in. Strip and an Angle Bracket. The forward ends of the short Angle Girders and the flanges of the 2½ × 1½ in. Flanged Plates are now joined by a further pair of 4½ in. Angle Girders 24, the upper right-hand Bolt fixing a second Angle Bracket in place. The vertical flanges of Girders 24 are connected by two 2½ in. Strips, one each end.

The left-hand bearings for the feed roller shafts are provided by two 1½ in. Flat Girders 25 bolted by their slotted holes to the vertical flanges of the 1½ in. Angle Girders. These should be adjusted to give correct meshing of two 1 in. Gear Wheels.

Bolted between the vertical slotted lugs of the two Angle Brackets is a Stepped Bent Strip 26 which simulates the device which applies pressure to the wire feed rollers. An inverted ¾ in. Bolt projects from the Bent Strip and is secured by Nuts so that a Collar 27 can be attached by one tapped hole. The "tommy bar" is provided by a 1 in. Rod passed through the Collar with two further Collars fixed one each end.

Fixed to the centre of a 4½ in. Strip is a 1 × ½ in. Angle Bracket 28, the slotted hole of which carries a Threaded Pin. On this Pin is mounted the rivet punch and extracting rocker which is made up from a stack of five 4½ in. Strips bolted together. These are secured to the Threaded Pin by a Collar and the assembly is then bolted to the vertical 2½ in. Strips at the front of the wire feed housing, inside the housing, the left-hand Bolt also securing in place a Double Bent Strip 29 fitted with a ¾ in. Bolt and Nuts to regulate the movement of the punch rocker. Finally, a further 4½ in. Strip is secured across the housing to complete this part of the assembly.

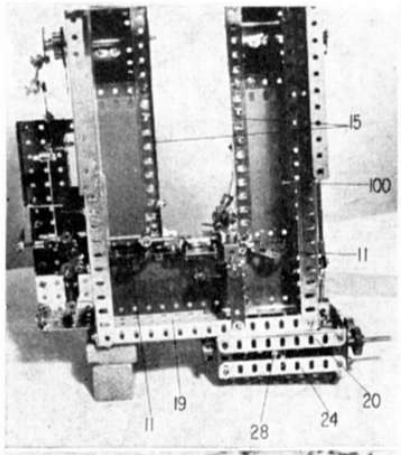
Crankshaft

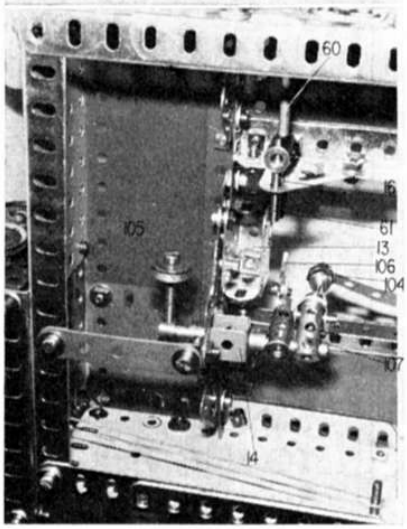
Next we come to the crankshaft, the left-hand half of which is provided by a 5 in. Rod and the right-hand side by a 4 in. Rod. Two Cranks 30 form each web, these being mounted upon the Rods with bosses outwards and securely locked in place. A Collar 31 and two Washers fill the space between each pair of crank arms, these being retained by Pivot Bolts passing through the slotted holes of the Cranks and screwed into the tapped holes of Adaptors for Screwed Rod 32. Two 3 in. Strips 33, which form the connecting rod, are fitted on to the plain shanks of the Adaptors which are then locked together by a Coupling 34 to provide a rigid crank pin, additional packing Washers being added to ensure a good fit.

Ram

In the case of the ram, a 2½ × 2½ in. Flat Plate 35 forms the top of the unit, this being overlaid each side by 3½ in. Strips. The four fixing Bolts—one at each corner—also retain (attached by their round hole flanges) a pair of 2½ in. Angle Girders 36 bolted across the assembly.

Two 2½ × 1½ in. Flanged Plates 37 form the front and back of the ram, but before these are fixed into place, both are fitted with a 5½ in. Angle Girder 38 centrally attached by the round hole flanges, these forming the runners upon which the ram slides. To the centre of the front Flanged Plate, is fixed a Coupling 39 with its longitudinal bore vertically disposed. The two fixing Bolts must carry Washers to ensure that, when the Coupling is secured, a Rod can slide freely up and down. This Coupling forms the bearing to carry the tool slide. The front and rear 2½ × 1½ in. Flanged Plates may now be bolted to the vertical slotted flanges of the 2½ in. Angle Girders, the two Bolts fixing the rear Plate in place also securing in position a 1½ × ½ in. Double Angle Strip 40, to which the toggle links are subsequently pivotally attached. Finally, the ends of the two 5½ in. Girders are connected by a pair of 3 in. Strips 41, bolted one each side. (*To be continued*)





Top, An underside view of the forward part of the main body section, from which the ram has been removed.

Above, the die-block and part of the rivet ejection mechanism in close-up—viewed from beneath.

Below, the left-hand end of the feed roller assembly with the actuating connecting rods removed.

Automatic Rivet-making Machine

Part 2 of an advanced model requiring relatively few parts

By P. Blythe

Toggle Links

The toggle links themselves are next to be built, each flap of the toggle being provided by a $1\frac{1}{2} \times 1\frac{1}{2}$ in. Flat Plate 42. Bolted to the front plate and to one end only of the rear Plate are three $1\frac{1}{2}$ in. Angle Girders, the forward Girder on the front flap carrying on its slotted flange a pair of Angle Brackets adjusted so that their round hole lugs fit neatly within the lugs of Double Angle Strip 40. A $2\frac{1}{2}$ in. Rod 43, held in place by Spring Clips, pivotally attaches the flap to the ram. The two remaining $1\frac{1}{2}$ in. Angle Girders on the toggle flaps each carry a $1\frac{1}{2} \times \frac{1}{2}$ in. Double Angle Strip 44, the lugs of which are pivotally fixed together by a $2\frac{1}{2}$ in. Rod. The lower ends of Strips 33 are slipped on to this Rod and secured in place by Collars. It will be necessary to crank Strips 33 slightly to obtain a good fit.

The rear toggle flap is now attached to the pair of hinges already bolted to Girder 12 of the frame. Two $11\frac{1}{2}$ in. Rods 45 are slid through the end holes of Girders 38 on the ram and are then located in Flat Trunnions 11 inside the frame, the Rods being finally held in place by Spring Clips. The Trunnions may require slight adjustment to ensure that the ram is centrally located and slides freely.

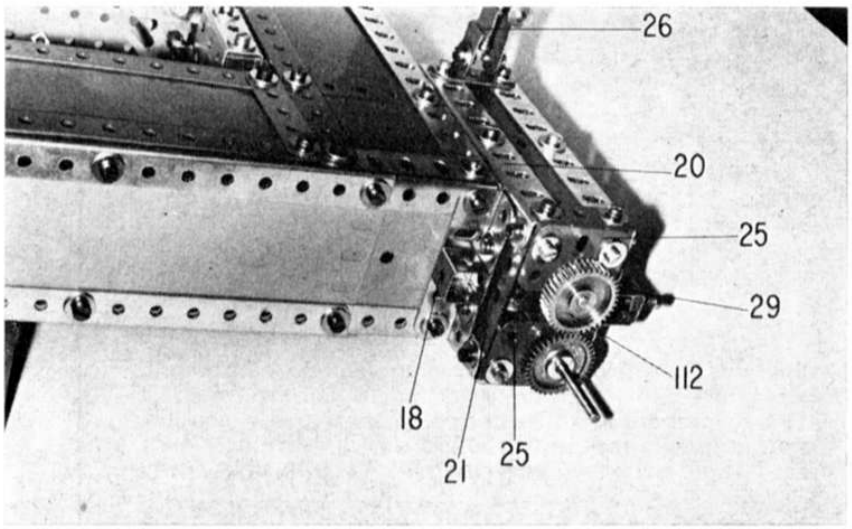
Tool Box Slide

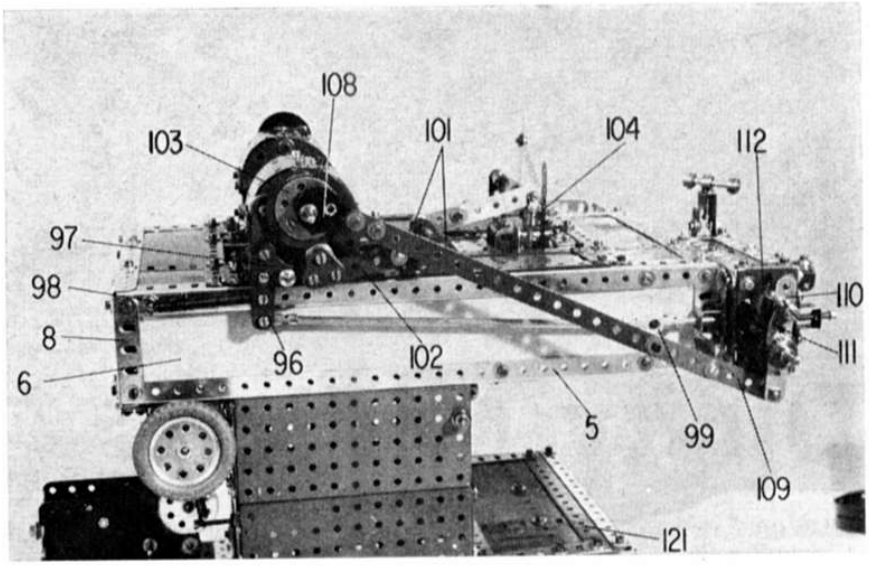
Next in line is the tool box slide, for which the round hole flanges of a pair of $2\frac{1}{2}$ in. Angle Girders are joined together by a $2\frac{1}{2}$ in. Flat Girder 46, the lower pair of Bolts also securing in place a 1 in. Triangular Plate 47—stood off by two pairs of Washers—the third hole of which has a Collar bolted through it to represent the bottom heading tool. A further Triangular Plate 48 with Collar is bolted in a similar manner to the slide, one hole down from the top to serve as the upper heading tool. The $2\frac{1}{2}$ in. long "channel" is enclosed at the top by two Angle Brackets 49 secured by their round holes. To the slotted ends of these Angle Brackets inside the channel is fixed a Coupling with its centre smooth transverse bore vertically disposed and carrying a 4 in. Rod 50 secured firmly by the Grub Screw. This Rod is slid into Coupling 39 fixed on the front of the ram, care being taken to ensure that the tool box assembly can move freely up and down. To the bottom end of the Rod is fitted a Rod Socket 51, carrying a rearwards-facing 2 in. Strip 52.

Lift Mechanism

Coming to the lift mechanism, two $5\frac{1}{2} \times 2\frac{1}{2}$ in. Flanged Plates 53 are bolted (one each side) to the underside of the body to leave five free holes at the rear. An $8\frac{1}{2}$ in. Rod 54 is fitted with a pair of Cranks 55, reinforced with $1\frac{1}{2}$ in. Strips, then two Threaded Pins are screwed into the boss of a Slide Piece 56 and the shanks located in the ends of the Cranks and $1\frac{1}{2}$ in. Strips. Collars secure the Slide Piece assembly in position. The $8\frac{1}{2}$ in. Rod is journalled in the $5\frac{1}{2} \times 2\frac{1}{2}$ in. Flanged Plates, as shown, with the Slide Piece fitted on to a 2 in. Strip 52 fixed to the bottom of the tool slide. The Rod is retained by a Collar on the left-hand side and a Crank—with a Threaded Pin 57 attached to its slotted hole—on the right-hand side.

A $5\frac{1}{2}$ in. Strip 58 is next bolted to a Triple-throw Eccentric 59, which is mounted by the $\frac{3}{4}$ in. stroke boss





A close-up view of the left-hand side of the model with the flywheel removed to show the connecting linkages.

on the right-hand side of the crankshaft. This Strip is secured through its lowest hole on the shank of Threaded Pin 57 by a Collar. If all is well, when the crankshaft is rotated, the ram will move backwards and forwards and the tool slide up and down. It will be necessary to position the Eccentric correctly so that the 2 in. Strip on the tool slide does not strike the $8\frac{1}{2}$ in. cross-shaft.

Wire Cutting Mechanism

Turning, now, to the mechanism which simulates the wire-cutting action, a $4\frac{1}{2}$ in. Rod 60 represents the cutter slide, this being journalled in the right-hand Flat Plate of the body side with the inner end of the Rod sliding in the centre hole of $1\frac{1}{2}$ in. Corner Bracket 16 inside the body. The Rod must be prevented from rotating, but must slide freely from side to side. On the Rod is fitted a Coupling which carries in its lower bore a 1 in. Rod 61, this Rod passing through the lower hole in the Corner Bracket. On the end of Rod 60, where it emerges from the side of the machine, a further Coupling 62, vertically disposed, is secured by its centre traverse bore, a $1\frac{1}{2}$ in. Rod 63 projecting from the lower end of its longitudinal bore.

To the extreme end of Rod 60 is secured a Threaded Coupling 64 mounted by its longitudinal bore and locked by a $1\frac{1}{8}$ in. Bolt projecting vertically upwards. Secured by a Nut under the head of this Bolt is a $1\frac{1}{2}$ in. Strip 65 facing "across" the machine, the Bolt passing through its central hole. A Rod and Strip Connector is fitted on the inboard end of the cutter slide-rod to represent the cutter and, when moved from side to side, should just clear the die block.

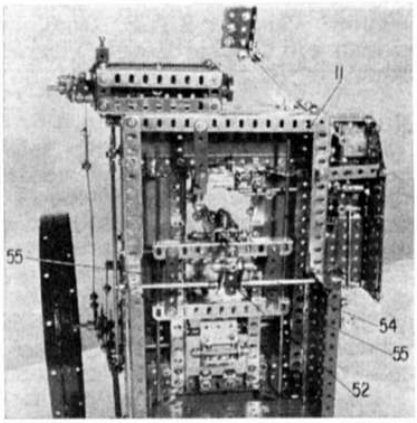
Into the longitudinal tapped bore of Threaded Coupling 64 is screwed a $\frac{3}{4}$ in. Bolt which is secured by a lock-nut. Also locked, through its end hole, beneath the bolt head, is a 2 in. Strip 66, projecting vertically upwards. Attached by its boss to the upper end of this Strip is an End Bearing 67, the lugs of which carry the "Fiddle Bow"—the device which carries the slug of wire across from the cut-off die to the main forging die. The assembly is made up simply by a $5\frac{1}{2}$ in. Perforated Strip 67, the inboard end of which carries a vertical $2\frac{1}{2}$ in. Strip, fixed by its centre hole. The fixing Bolt also holds a $3\frac{1}{2}$ in. Narrow Strip 68, the free end of which is attached to a $2\frac{1}{2}$ in. Narrow Strip, as shown, to complete the roughly triangular shape of the assembly.

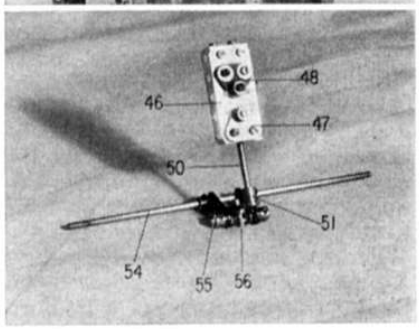
The "Fiddle Bow" guide is provided by a Single Bent Strip 69 fixed by its centre hole to the right-hand side of the ram slideway. A $\frac{1}{2}$ in. Bolt with suitably-placed Washers and lock-nuts, provides the location for the $5\frac{1}{2}$ in. sliding Strip.

A 3 in. Angle Girder 70 is bolted to the side of the frame by its round hole flange, four holes back from the front of the body, with its projecting flange uppermost. To the front end of this Girder, and projecting out to the right to form part of the Cutter Slide housing, is a 2 in. Angle Girder, to the downward-facing slotted flange of which a forward-projecting Girder Bracket 71 is bolted. This is extended further by a second Girder Bracket, the wide flanges being overlapped one hole. These latter parts make up the tool tray, the right-hand side of which is enclosed by a $1\frac{1}{2}$ in. Angle Girder 72, the front fixing Bolt also securing in place an Angle Bracket with its slotted lug facing downwards. Another Girder Bracket 73, attached by its narrow flange, is bolted to the underside of the tool tray to enclose the front of the Cutter Slide housing, the lower right-hand hole of this latter Girder Bracket carrying an Angle Bracket, its free lug facing rearwards.

The top of the Cutter Slide housing is now further enclosed by a pair of 2 in. Strips 74, bolted—one hole apart—to the 3 in. Girder. Moving further back still, another 2 in. Angle Girder 75 is bolted to Girder 70 through its second hole, while bolted in the end hole of Girder 70 is an Angle Bracket, to the slotted lug of which is secured a second rearward-projecting 3 in. Angle Girder 76 which is secured at its rear end to the body by a Double Bracket. (This latter 3 in. Girder is therefore spaced one hole away from the side of the body.) To the horizontal flange of the Girder is bolted a $3 \times 1\frac{1}{2}$ in. Flat Plate 77, edged by two $1\frac{1}{2}$ in. Angle Girders and a 3 in. Angle Girder 78.

(*continued on page* 499)





Top right, this picture shows the interior of the body assembly, viewed from beneath. It is complete except for the base motor drive.

Right, a close-up view of the tool box slide as it appears removed from the model.

Lunar Rover Kit

Dinky's final release this month should be to the liking of the do-it-yourself fraternity—being a kit version of the existing Lunar Roving Vehicle—the moon buggy that has already proved very popular as a "ready-made" model.

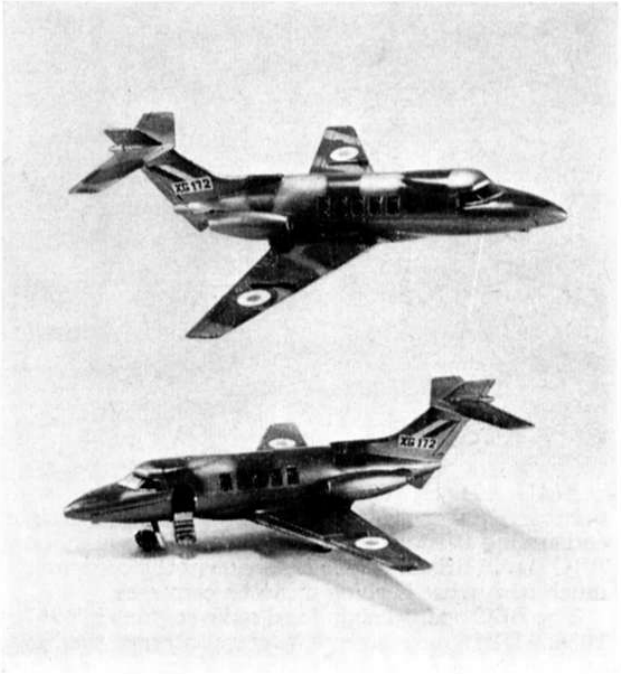
Dinky Kits have established themselves as a highly successful line, and Meccano are now regularly increasing the range as promised when the Kits were first introduced. At the time of writing the figure stands at fourteen models including the Lunar Rover. The popularity of the Dinky Kits has undoubtedly been greatly influenced by the very competitive price at which they are sold. All the Kits include die-cast components, and if one was to compare Dinky's Kits with other metal kits on the market, the value would immediately be apparent, bearing in mind that they are not aimed at the adult kit enthusiast who might be willing to spend several pounds for one of the specialist advanced kits sometimes found on the "expert's" market.

Apart from the twenty-eight components required to build up into the Lunar Rover, the kit comes complete with two model astronauts, and a sample phial of Humbrol enamel. Identified by No. 1027, it retails at only 69p which represents an excellent buy.

Opposite, left, two views of Dinky Toy No. 410 Bedford Van "Royal Mail" clearly portraying its outstanding realism and impeccable overall finish.

Opposite, right, a close-up rear-quarter view of the Bedford Van clearly showing the wealth of fine, realistic detail present on this good solid Dinky.

Right, up, up and away . . . ! No. 728 R.A.F. Dominie is a valuable addition to the Dinky aircraft range.



Pirate Models

Mention "pirates" to most people and you are likely to conjure up visions of black-bearded, cutlass-swinging demons swarming down from heavily-armed ships to loot and pillage among law-abiding citizens. This image, however, would be totally false if applied to a particular brand of 20th Century pirates to be found in London—Pirate Models, of 6 Manor Hall Drive, London, N.W.4—for this oddly-named Company is in fact in business to assist the public, not to harm it. They specialise in providing spare parts such as radiators, windscreens, wheels, etc. for obsolete models, particularly old and rare Dinky Toys, and, to my knowledge, they are the only organisation in the Country who do so.

All the spare parts available are replica components, newly made, and of special interest is a selection of different-sized tyres—both black and white—reproduced from the early Dinky period when plain, treadless tyres were fitted to models. These could prove particularly valuable as missing tyres probably present by far the biggest problem to serious collectors, intent on renovating old Dinky Toys to their original condition. Further information on available items can be obtained direct from Pirate Models.

RIVETING

(*continued from page* 497)

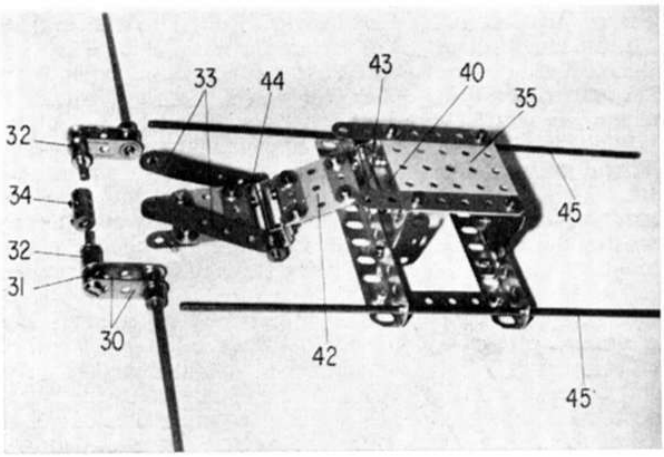
The free ends of the 2 in. Girders and 2 in. Strips are connected by a $2\frac{1}{2}$ in. Angle Girder, the downward projecting flange of which is extended by a pair of $1\frac{1}{2}$ in. Flat Girders 79.

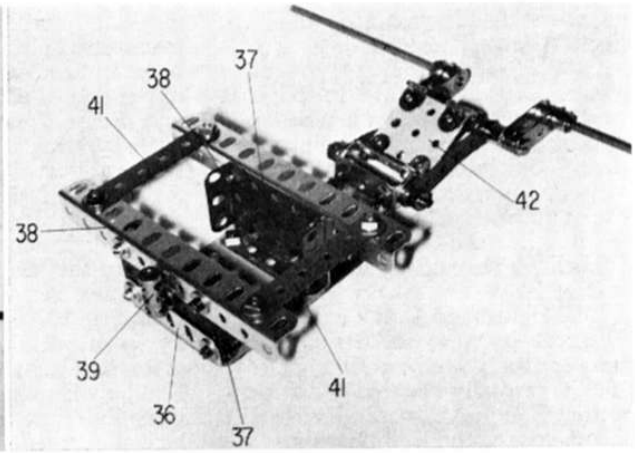
To the underside of the tool tray is bolted a 1×1 in. Angle Bracket 80, spaced one hole away from the side of the body. This carries a 4 in. Rod which slides also in a further 1×1 in. Angle Bracket 81 bolted to the $5\frac{1}{2} \times 2\frac{1}{2}$ in. Flat Plate on the side of the body. As this Rod also must not rotate, it carries towards the forward end a Coupling 82, in the opposite transverse plain bore of which is secured a $1\frac{1}{2}$ in. Rod which also slides in front Angle Bracket 80. Two further Couplings 83 and 84 are secured to the 4 in. Rod, Coupling 83 being mounted by its central transverse bore with its vertical longitudinal bore carrying a downward-projecting 1 in. Rod 85. The rear Coupling is also vertically disposed and carries in its lowest transverse bore a Threaded Pin 86.

This assembly, which slides backwards and forwards, must now drive the cutter slide which moves at 90° to it. To achieve this, the two vertically projecting 1 in. Rods 63 and 85 engage in the slotted holes of a small bell crank 87, made up from a pair of Fishplates secured by their round holes to a Rod Socket. Another 1 in. Rod is fixed to the boss of the Socket, this Rod swivelling freely in a Handrail Support 88 fixed to the lower frame member. To the underside of the $3 \times 1\frac{1}{2}$ in. Flat Plate is bolted a $1 \times \frac{1}{2}$ in. Double Bracket 89 which carries a Bell Crank fitted with one arm projecting downwards, the other rearwards. The latter arm is extended a further two holes by a $2\frac{1}{2}$ in. Strip 90, the outer hole of which carries a Pivot Bolt upon which a Coupling 91 swivels freely. A Threaded Pin is secured to the vertical arm of the bell crank, the plain shank carrying a $3\frac{1}{2}$ in. Strip 92 which is retained by a Collar. The forward end of the Strip fits on to Threaded Pin 86, where it is secured by a further Collar. To drive the cutter arm mechanism a Bush Wheel 93 is secured to the end of the right-hand side of the crankshaft. A Coupling is pivotally fixed to the Bush Wheel by a Pivot Bolt, this Coupling then being joined to Coupling 91 by a 3 in. Rod.

Finally, the side of the Cutter Slide housing is enclosed by Flexible Plates, Perforated Strips, and a Flat Girder 94. This side panel is fixed to the side of the frame by a $2\frac{1}{2} \times \frac{1}{2}$ in. Double Angle Strip.

(*to be continued*)





Automatic Rivet-making Machine

Above, top and underside views respectively of the ram, toggle links and crankshaft in "exploded" form.

Part three of an advanced model requiring relatively few parts By P. Blythe

Punch and Extract Mechanism

In the case of the punch and extract mechanism, this section is operated by a cam, built up from a Fishplate (forming the lobe) bolted by its round hole to a Bush Wheel 95. The lift should be approximately ¼ in. The Fishplate is trailing when the crankshaft is rotated in the correct direction, i.e. clockwise when the shaft is viewed from the left-hand end. A Grub Screw locks the Bush Wheel to the shaft, the boss being spaced by a Washer from the left-hand bearing housing.

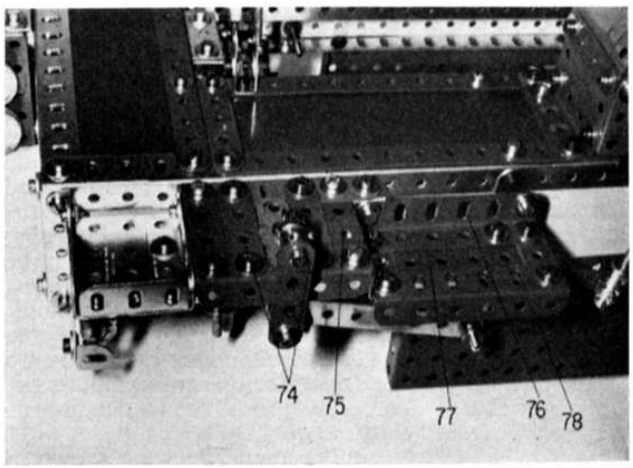
The cam follower and "rocker" are made up from a pair of 3 in. Strips 96 secured together by five ½ in. Bolts, the Strips being spaced by lock-nuts. A ½ in. Pulley rotates freely on the upper Bolt, while the lower Bolt carries a pivoting Rod and Strip Connector. The centre pair of Bolts retain two forward-facing 1 in. Corner Brackets 97 and the remaining Bolt forms an anchor for a rearward-facing Tension Spring 98, the opposite end of which is secured to the rear of the body by a 1⅛ in. Bolt.

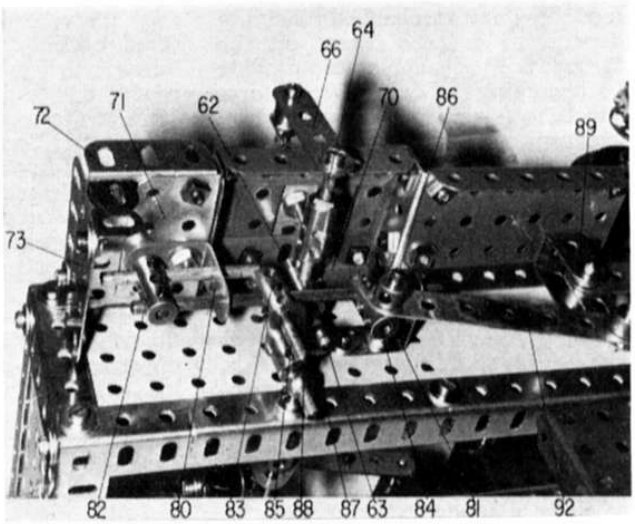
The rocker pivots upon a 3½ in. Rod, journalled in the left-hand bearing housing and retained by a pair of Collars. Lock-nutted together are a pair of Rod and Strip Connectors 99, one of them being fitted with a 2 in. Rod and the other, with a 8½ in. Rod. This latter Rod is pushed into the Rod and Strip Connector on the cam follower, while the shorter Rod is slid into Double Bent Strip 18 with its end pushing against the front horizontal rocker inside the feed roller assembly at the front of the body. This front rocker is held against the end of the Rod by a rubber band slipped over one arm and hooked on to a Bolt 100 within the frame.

Rivet Ejection Mechanism

Having been formed (in real life) the rivets are ejected and in the model the simulated ejection mechanism is supplied by a pair of Trunnions 101 bolted to the top of the left-hand side of the body. Journalled in these Trunnions is a 3 in. Rod, on each end of which a Crank is fixed, the left-hand Crank facing rearwards and the right-hand Crank forwards. The former Crank is extended by a 3 in. Strip 102, to the rear end of which two 1 in. Triangular Plates, separated by lock-

Below, the cutter slide housing and tool tray, viewed from above. Right, an underside view of the tool tray and cutter slide housing, with the cutter slide equipment.





nuts, are fixed by a pair of ½ in. Bolts. A third Bolt retains a freely-rotating ½ in. Pulley, acting as a roller. Actuating this roller is a cam comprised of a Bush Wheel 103 to which is bolted a Paxolin or metal disc 1¾ in. in diameter which has a "dwell" approximately ⅝ in. long, the radius of this portion being 11/16 in., i.e. the same as the Bush Wheel. The cam is secured by a pair of Bolts.

The right hand Crank is extended forwards by a 3½ in. Strip, to the free end of which an End Bearing 104 is pivotally secured by a lock-nutted Bolt. A 2 in. Rod is carried in the boss of the End Bearing.

Now journalled in Double Bent Strip 14 fixed below the die block is a 2½ in. Rod, retained by two Collars. The forward end of this Rod carries a further Collar secured by a 1⅛ in. Bolt projecting horizontally towards the right-hand side of the machine. Under the head of this Bolt a ½ in. Pulley 105 is secured to serve as a counterweight to keep the cam roller in contact with the cam. Adjacent to the rear Collar of the 2½ in. Rod is mounted a Coupling arranged vertically and secured by its end transverse hole. In the longitudinal bore is fixed a 1 in. Rod, on the upper end of which is carried a Rod and Strip Connector, to which is bolted by its "middle" hole a Pawl without Boss 106, the pointed end facing to the right. This serves as the "knock off arm" which gives a quick flick across the die at each cycle of the machine.

It now remains to fit a further Coupling 107 on the rear end of the 2½ in. Rod, the upper transverse plain hole of this carrying a 1 in. Rod upon which pivots a Small Fork Piece, in the boss of which is held the lower end of the 2 in. Rod projecting down from End Bearing 104. The timing of the cam must be adjusted so that the arm quickly whips across the die and returns while the Ram is at the back of its stroke—thus avoiding a collision!

Wire Feed Mechanism

The mechanism which actually feeds the wire to the forming and cutting units is built up from an Eccentric 108, mounted boss outwards on the left-hand side of the Crankshaft. Bolted to the arm of this Eccentric is a 9½ in. Strip extended a further three holes by a 3 in. Strip 109. A Pawl carrier is supplied by a 3 in. Strip 110, to one end of which is fixed a Threaded Pin. One hole down from the opposite end is a Pawl with boss 111 (boss outward) pivotally attached by a Pivot Bolt, the Threaded Pin and Pawl being situated on opposite sides of the Strip.

The upper feed roller shaft is a 5½ in. Rod, to the left-hand end of which is fixed a 1 in. Gear 112. The right-hand end carries a 1 in. Pulley 113 representing a feed roller. The shaft is, of course, journalled in the Flat Girder and Flanged Plate at each end of the feed roller housing.

The lower Rod is 6½ in. long and similarly journalled and also carries a 1 in. Gear and Pulley. Fixed on the left-hand end of this lower Rod, next to the Gear, are three Washers, the Pawl carrier assembly (Pawl outwards) and a Ratchet Wheel, also mounted boss outwards. Finally, Strip 110 is secured to the Threaded Pin on the bottom of the pawl carrier by a Collar. *(to be concluded)*

Meccano Parts and How to Use Them

PART II — SOME MISCELLANEOUS PARTS

By B. N. Love

ALTHOUGH competitors of the Meccano system have been numerous over the years, the majority of them have failed for one simple reason: they could never compete with the wide range of additional parts which the Meccano system offers.

Once the basic construction of a model has been completed, detailed modelling and mechanical reliability depend to a large extent on the "brassware" available to provide both working and decorative features Meccano is rich in brassware, but, because of the very wide range available, it is only possible to feature here a few of the more popular and perhaps most useful of the miscellaneous parts.

Every serious constructor is familiar with the Collar, Part No. 59, as being a basic holding device for keeping Axle Rods in place. It is very much more versatile than this, however, and some additional applications are shown in Figs 1 and 2. In Fig. 1, a working pantograph is shown which will pick up current from a bare conductor wire overhead to drive a model train or tramcar. Although this particular design is well known to older readers, the introduction of the Meccano electrical parts of the 1960's enables an insulated fibre baseplate to be used for the pantograph anchorage, effectively insulating it from the metal framework of the electric locomotive. The use of a pair of Hinges, Part No. 114, can be seen in Fig. 1 and this allows the pantograph to be tilted back for wiring connections below. Collars are used extensively in this design and in their simplest form at the base of the pantograph, where they locate the two 2½ in. Axle Rods forming the lower pivots for the Screwed Rod framework. Again, we see an unorthodox use for another part – Sprocket Chain, short lengths of which are attached to the Screwed Rods entered into the Collar bosses as shown. Note that the two lengths of chain are rigged in opposite slope on the two sides of the loco roof and this ensures that, as the whole framework of the pantograph moves in concertina fashion to keep its tension against the overhead conductor, it does not topple fore and aft.

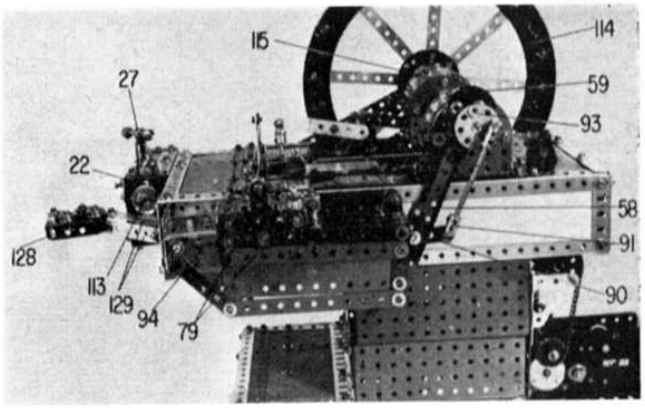
The middle joints of the pantograph can just be seen in the illustration of Fig. 1 and these require six Collars on each Axle Rod. The outside Collars are locked in place by their Screwed Rods and a lock-nut, but the Collars immediately inboard are free to turn on the Axle Rod, the second set of Screwed Rods being entered into the tapped hole of the Collars sufficient to make a firm hold, but not enough to bind against the Axle Rod. Finally, the inside Collars are locked to the Axle Rod to keep the middle free-turning Collars in place.

A development of the Collar is Part No. 63, the Coupling, and this also appears in Fig. 1. A pair of Couplings are locked to the lower Axle Rods of the pantograph as shown and linked by Tension Springs, Part No. 43, the Springs being held in place by 1 in. Axle Rods and Spring Clips. This ensures that the pantograph maintains an upper thrust towards the overhead conductor. The top of the pantograph is a 2½ in. Double Angle Strip, joined by an Axle Rod and more Collars to the upper set of Screwed Rods. A length of Meccano Cord, attached to the centre of the Double Angle Strip and passing down into the driver's compartment, allows the pantograph to be drawn downwards for stowage.

Similar applications are shown in

Automatic Rivet-Making Machine

Last of a four-part series by Paul Blythe



Flywheel

We now come to the flywheel which is built up from a pair of $9\frac{7}{8}$ in. Flanged Rings 114, sandwiched between which are eight spokes formed by $4\frac{1}{2}$ in. Strips. The inner ends of the Strips are neatly arranged and bolted to the outer circle of holes in a pair of Face Plates 115. Spacing Washers will be required to ensure neat assembly and note that the sixteen securing Bolts should not be tightened until the wheel is found to be running true. The wheel is mounted on the left-hand end of the crankshaft where it is held in place by the set screws in *both* Face Plates.

Base Assembly

Turning to the base of the machine, the two $5\frac{1}{2} \times 2\frac{1}{2}$ in. Flanged Plates 53 at each side of the body are extended down by two further similar Plates 116, their long flanges being bolted together. This second pair of Plates are joined across the machine by a $7\frac{1}{2}$ in. Strip 117 which overlays a $5\frac{1}{2} \times 2\frac{1}{2}$ in. and a $2\frac{1}{2} \times 2\frac{1}{2}$ in. Flexible Plate, these Plates being reinforced four holes down by a $7\frac{1}{2}$ in. Angle Girder 118, slotted flange forwards.

Bolted through the lower row of holes in each Plate 116 is a $9\frac{1}{2}$ in. Strip Plate 119 extending the assembly forwards by a further eight holes. These Plates at each side are overlaid by $9\frac{1}{2}$ in. Strips with the front and rear edges being capped by vertical $2\frac{1}{2}$ in. Angle Girders. The bottom edges are reinforced by $12\frac{1}{2}$ in. Angle Girders 120 extending six holes rearwards. Further Flexible Plates and a $7\frac{1}{2}$ in. Flat Girder 121 fill in the horizontal shelf which is edged at the front by a $7\frac{1}{2}$ in. Angle Girder 122. The front panel of the shelf is also enclosed by Flexible Plates and strengthened at the bottom by a further $7\frac{1}{2}$ in. Girder 123, slotted flange outwards.

Dealing now with the rear of the base, this is completely panelled with Flat Plates reinforced at the lower edge by a $7\frac{1}{2}$ in. Angle Girder 124. Two $3\frac{1}{2} \times 2\frac{1}{2}$ in. Flanged Plates 125 and a $3 \times 1\frac{1}{2}$ in. Flat Plate complete the rear horizontal panel which, again, is strengthened by a $7\frac{1}{2}$ in. Angle Girder 126, slotted Flange outwards and fixed by three Angle Brackets. The base itself is edged by additional Girders, these being bolted with the flanges projecting downwards. The four corners are completed by diagonally-fixed $1\frac{1}{2}$ in. Strips, the vertical flanges being enclosed by Obtuse Angle Brackets and Fishplates 127.

Above, a general view of the right-hand side of the finished Riveting Machine. Below right, the completed machine as it appears when viewed from above. Below left, a rear view of the completed model showing construction of the base and the motor drive system.

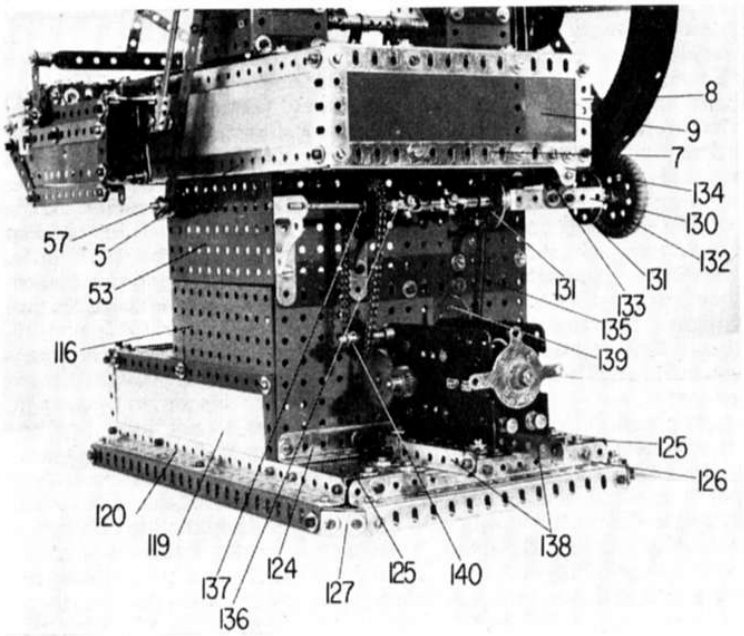
Wire Straightener

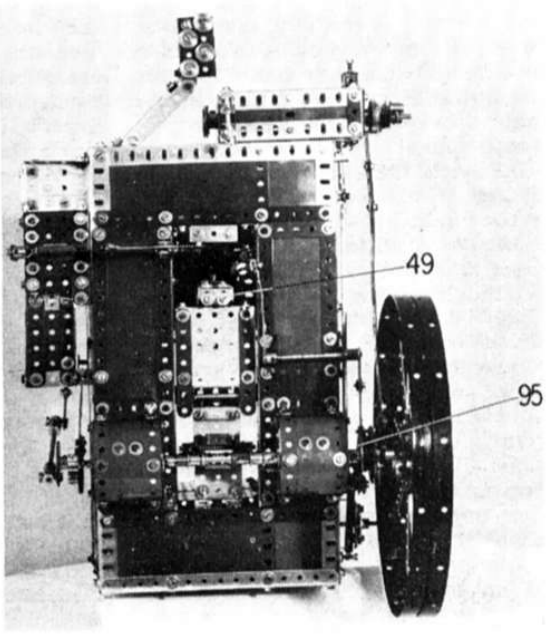
Moving upwards from the base to the wire-straightening mechanism, two Girder Brackets 128, with their wide flanges overlapped, are secured together by four $\frac{1}{2}$ in. Bolts, a $\frac{1}{2}$ in. Pulley being fitted under the head of each Bolt. The front end of the assembly is enclosed by two Angle Brackets, then the unit is attached to the front of the body by a pair of 3 in. Strips 129, connected by Fishplates and Obtuse and "ordinary" Angle Brackets.

Motor Drive Assembly

Finally, we have the drive system. Although the real machine is driven by rear-mounted motor and "vee" belt on the flywheel, it is more convenient to drive our model by a friction wheel bearing on the fly-

(*continued opposite*)





torches to their legs and set these alight. Flying in panic, the birds set fire to the houses and in the confusion the Vikings attacked and demolished the village.

Naturally fear exaggerated tales of their exploits. In time legends grew up around these dreaded fighters. One told how the 'Skibladnir', a well known long-boat, had been built by dwarfs and was so large all their weapons and equipment could be carried in her. In actual fact, the biggest ships with 100 oars were mainly used to terrify the enemy while smaller 12 oared boats were used for fighting. Each captain, or local King, commanded his own fleet of armoured vessels, sometimes as many as 700. Armoury ranged from cables used to capsize the enemy's boats to bows and arrows and stone-slings.

The Vikings knew the power of psychological warfare. To see a fleet of black boats approaching was enough to scare anyone but when these boats had terrifying figures fore and aft, demoralisation increased. Usually a serpent's head or dragon-like beast was carved, head at the bow, tail astern. When later in their era most Vikings exchanged paganism for Christianity, they kept their fearsome carved figureheads as examples of evil. Conversion was not always from the heart. Olaf Tryggrason was only too pleased to 'convert' his fellows by battle. If they refused to turn Christian, he had a fool-proof excuse for a fight, keeping any boats and plunder to swell the Church funds through his own possessions.

For a Viking to become a Christian meant a great change. Vikings believed that to be killed in battle ensured a place with the Gods in Valhalla where fighting lasted all day, and the wounded were treated by night to fight again on the morrow. To die in bed meant damnation in the land of Hela, the Norse equivalent for Hell. No wonder Olaf found physical persuasion necessary to increase his converts.

Fortunately they had a burial custom which enables us to gain a true picture of what these Viking boats were like. When a chief died, his boat was buried with him. In the Viking ship hall at Oslo, the Oseberg Ship, the Gokstad Ship and the Tune Ship, all carefully restored, can be seen. The names refer to the site of burial. Denmark has two Viking ships and the Isle of Man also has a couple.

As shipbuilders they were superb. Planks were thinned to the precise degree required. Animal hair twisted and rubbed together formed the caulking. Pine floorboards made the deck. With a striped red and yellow sail and demoniac figureheads, no wonder they terrified all whom they met.

The Oseberg ship, dug out of the mud in 1904, had a 19.8 metres long keel made of oak, and boasted 30 oarsmen who buried their oars with their chief. Naturally the figurehead at the bow, a serpent's head, was well carved with gaily painted fierce eyes. It is interesting to find that the mast, 13 metres high, was of pinewood, the anchor of iron, while the rudder, really an outsized oar, could be steered by a tiller. Probably the Oseberg ship never crossed the ocean but was used in coastal work.

Whether you dislike their warlike habits or admire their courage, there is no doubt that this race of fighting seamen had a remarkable record of discovery, trade and settlement to their credit. There was no room for the weakling in their way of life and without their enterprise, much nautical knowledge would have been lost to succeeding navigators and shipbuilders. We owe them a debt, for in the Dark Ages, tribes united into nations to repel them and eventually, on settling in our land, they brought their trades and skills with them to our lasting benefit.

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wheel. To achieve this a pair of 3 × 1½ in. Double Angle Strips 130 are bolted together with the lugs overlapping, the fixing Bolts also securing two Bush Wheels 131 in place, one each end with bosses outwards. A 5 in. Rod is mounted in the bosses of the Bush Wheels and this should be positioned before the Bolts are tightened to ensure that the Bush Wheels are exactly in line so that the Rod runs perfectly freely. This Rod carries a 1½ in. Pulley with Tyre 132 at one end and a Universal Coupling at the opposite end, allowing the Rod an essential half-inch end float.

Two 1 in. Corner Brackets 133 are bolted to the centre of Double Angle Strips 130 to complete the friction wheel carrier which is pivotally attached to the machine by a 3½ in. Rod passed through the Corner Brackets and located in an upper hole of the rear panel. The outer end of this Rod is supported by a further 1 in. Corner Bracket 134 bolted to the rear of the body. Collars retain the Rod, Washers being employed to space the carrier away from the body.

To keep the friction wheel firmly in contact with the flywheel, the carrier is spring-loaded by a Tension Spring 135 retained on the inboard Bushwheel by a lock-nutted ½ in. Bolt. A 1 in. Bolt lock-nutted to the rear panel of the machine secures the lower end of the Spring. The Universal joint on the end of the friction wheel Rod is connected by a 1 in. Rod to a further Universal Coupling 136 which also carries a 2½ in. Rod, this latter Rod being journalled in a pair of Flanged Brackets bolted to the rear panel of the machine base. A 1½ in. Sprocket 137 is locked on this Rod.

Bolted to each flange of an E15R Motor are four downward-projecting Angle Brackets, these being fixed to a pair of 3½ in. Angle Girders 138 which are in turn bolted to the rear of the machine. The output shaft carries a ¾ in. Pinion which drives a 50-teeth Gear Wheel on a 2½ in. Rod journalled in the Motor side plates. On the opposite end of this Rod is mounted a ½ in. Pinion, meshing with a 57-teeth Gear Wheel 139 immediately above it. This latter Gear is fixed on a 3½ in. Rod located by a Collar, a 1 in. Sprocket Wheel 140 also being mounted on the right-hand end of the Rod. This Sprocket is connected by Chain to Sprocket Wheel 137 on the driving shaft.

This completes the assembly and it remains only to "time" the two cams, two Eccentrics and the crank to give the sequence of operation detailed at the beginning of these articles. It is essential of course, to ensure that each mechanism turns freely and is lubricated to give a good and reliable operation of the finished model—which, it is guaranteed, will even rattle in a similar manner to its full-size counterpart!

PARTS REQUIRED

5—1b	1—15	9—62	1—136
15—2a	1—15b	8—63	1—139
6—3	4—16a	1—63c	1—139a
7—4	3—17	6—70	2—140
9—5	3—18a	2—72	1 | 142
8—6	5—18b	2—73	1—147a
9—6a	1—21	2—74	5—147b
8—8	2—22	4—77	1—147c
4—8a	7—23b	1—94	1—148
13—8b	5—24	1—95a	1—160
6—9	1—25	1—96	3—161
4—9a	1—26	1—102	2—166
3—9c	1—27	1—103f	2—167b
12—9d	1—27a	4—103h	1—179
6—9e	2—31	2—103k	8—188
7—10	6—35	1—108	5—189
1—11	310—37	2—114	12—190
1—11a	2—43	6—115	14—193
13—12	1—44	1—116a	3—196
2—12a	2—45	2—126	1—197
3—12b	2—47a	4—126a	4—212
10—12c	3—48	1—128	4—214
2—13	1—50	1—130	1—222
2—13a	4—53	1—130a	1—235
1—14	2—53a	2—133	1—235b
1—14a	19—59	5—133a	1—E15R Motor
		1 Paxolin or metal disc 1¾ in. diameter	