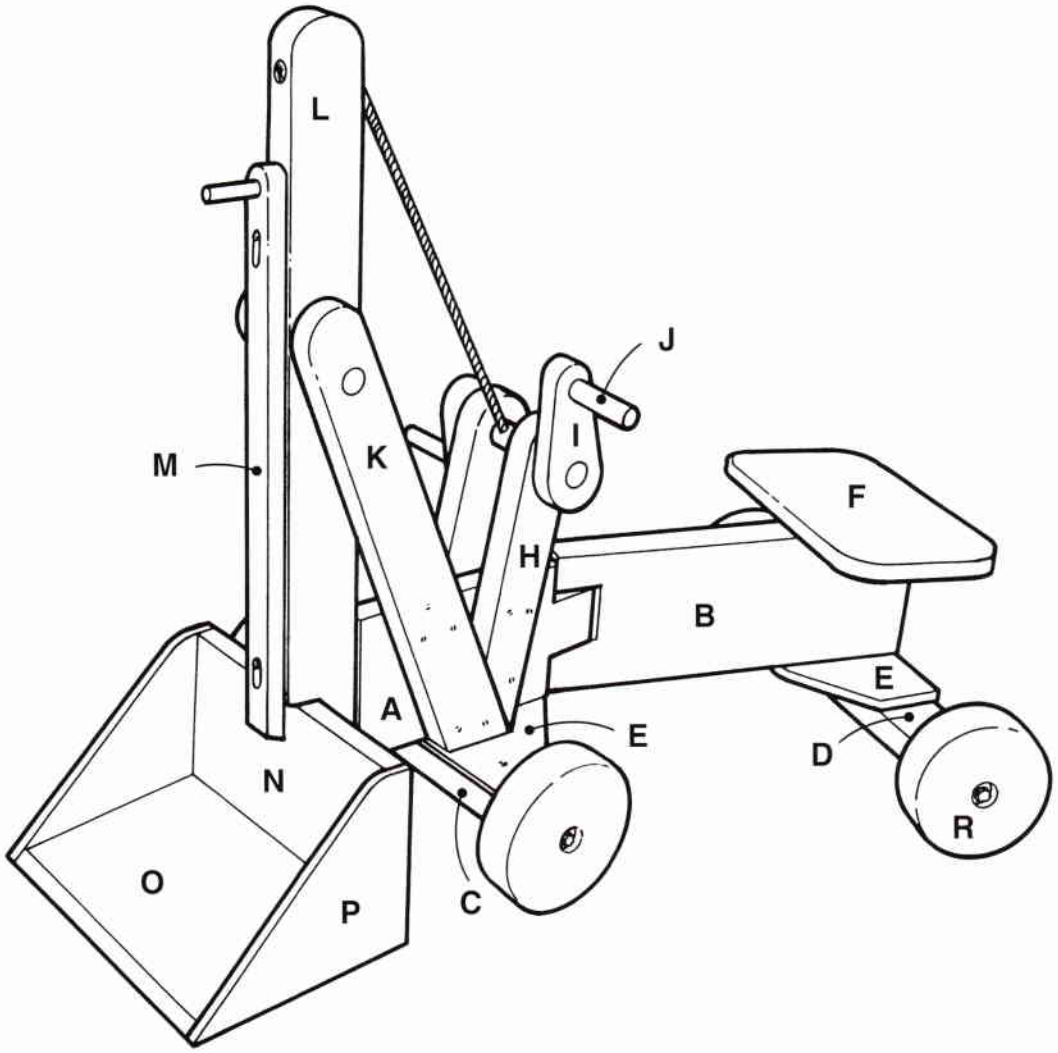
ADVANCED
PROJECT NO. 6

Front End Loader

Designed to give hours of fun in the sandpit for the 3 to 6 year olds, this robust toy is based on a popular kindergarten model. Its articulated steering and simple mechanisms appeal even to adults, and most workshops would have sufficient scraps and offcuts to make material purchases unnecessary.

A good quality jigsaw, and a Triton Sanding Disc to suit your circular saw are necessary for the project. A simple jig for making wheels is described. A router will save hours of rounding over edges by hand.

The project is an advanced one, and familiarity with cutting and shaping procedures is presumed.



Tool Requirements

1. ESSENTIAL Triton Workcentre and your power saw; Triton Router and Jigsaw Table and your router; router bits as follows: 6.5mm straight bit, rounding-over bit; drill press or electric drill with stand; Triton Woodbit set, 13mm Triton Woodbit (suit 1/2"/12.7mm dowel), 19mm spade bit (suit 3/4"/19mm dowel), expansive or adjustable auger bit (suit 29mm dowel); countersink; Triton Sanding Disc; jigsaw; G-clamps; hammer; screwdriver; socket spanner to suit coach screws; measuring tape; square; compass; pencil; sandpaper.

2. USEFUL Taper ripping jig (see Jig Guide); round file or rasp.

Issue No.1, December 1991

Construction Details

Component Specifications

All dimensions are in mm.

Part	*Description*	*Quantity*	*Width*	*Thickness*	*Length*
A	Front Body	1	140	35	250
B	Rear Body	1	140	35	400
C	Front Axle	1	60	30	250
D	Rear Axle	1	60	30	360
E	Axle Brace	2	130	9.5	200
F	Seat	1	170	19	230
G	Seat Support	2	- Offcuts from components H		
H	Crank Support	2	60	30	295
I	Crank	2	60	19	135
J	Handle	2	19mm dowel		100
K	Arm Support	2	60	30	445
L	Bucket Arm	1	65	30	600
M	Bucket Latch	1	28	15	445
N	Bucket Back	1	165	19	265
O	Bucket Base	1	165	19	265
P	Bucket Side	2	165	9.5	184
Q	Pivot Block	2	40	30	70
R	Wheel	4	135 diam x 45 thickness		

Note: Dowel dimensions for pivot axles etc. are specified in text.

General Points

1. The mechanical work is straightforward but rather time-consuming, so do not anticipate quick results. Although a jigsaw is specified for several operations, sharp handtools may be preferable to a low-powered jigsaw without a roller blade-guide, as the blades of such machines tend to wander off line badly during a cut.

2. All holes are drilled on the centrelines of the workpieces, unless otherwise specified.

Material Shopping List

1.WOOD The project lends itself to using up workshop scraps, as only small quantities of wood are required. The timbers that we used were chosen for strength and visual contrast. If the toy is likely to be left outside then durable timbers, and exterior grade plywood for the bucket sides and axle braces, should be used.

For the body and framework:
140 x 35 pine 1 @ 0.9m
70 x 35 pine 1 @ 2.4m

For the bucket and seat:
170 x 19 pine 1 @ 0.9m

Hardwood for the axles:
65 x 32 Ash 1 @ 0.9m

Contrasting colour latch and crank:
65 x 19 Jarrah 1 @ 0.9m

3 ply (9.5mm) plywood for braces and bucket: A piece about 1200mm x 600mm will be sufficient for laminated wheels as well. Solid wheels can be made if desired: for these you will need about 600mm of 140 x 45 timber – pine is satisfactory.

You will also need various short lengths of 12.7mm (1/2"), 19mm (3/4"), and 29mm (1 1/8") diameter dowels for pivots and handles, and some scrap materials, including 6mm ply, for the wheel sanding jig.

2. FASTENING
A strong, water resistant glue is required. We used Selleys "Liquid Nails" applied with a caulking gun, together with power-driven Phillips-head screws of appropriate length where required.

3. OTHER
About 600mm of 6mm diam. polythene rope for the bucket arm; 4 coach screws 3/8" (10mm) x 100mm long and 8 washers, for wheel spindles; (2) 30mm inside diameter spacing washers at the arm pivot; round-headed screws and washers to secure the latch bar; tow hook or ring if desired; rubber bump stop for bucket – we used a rubber "button" sold as a toilet seat bump rubber; one 3/8" x 4" (10 x 100mm) coach bolt, nut & washer for wheel sanding jig. See Figure 9.

4. FINISHING
No finish will last long on the moving parts in a sandpit! A durable polyurethane finish is most suitable to protect the wood from occasional showers, but if the toy is likely to be left outside then one of the UV stabilised finishes should be chosen.

1 Cut the front and rear parts of the body to length and make the angled cut on the rear section **(B)**. Carefully mark out the male and female parts of the hinge joint as shown in **Figure 1** and drill holes about 10mm diameter at the inside corners (in the waste section), to give the jigsaw blade room to turn.

With your jigsaw mounted in the Router and Jigsaw Table, use the router fence as a guide to cut the female part of the hinge, as shown in **Figure 2**. After making the first cut, turn the material over for the second, to ensure the slot remains central.

Remember to move the fence inwards by one blade width before cutting the male tongue. A push fit, with no slop is required between the two parts.

2 A 19mm hole to match the hinge dowel must now be drilled absolutely vertically through the mating parts **(A)** and **(B)**. Mount the 19mm spade bit in a drill press, or drill stand. Note that the dowel should be a firm push fit in the holes. Trial fit your dowel in a hole drilled in scrap first. If the resultant hole is too large for the dowel, carefully file or stone the sides of the spade bit down to reduce the cutting diameter. Take care to retain the clearance angle on the bit, and to remove the same amount from both sides of the bit.

Place some 8mm packing at the end of the tongue, between **(A)** and **(B)**, to provide clearance, and clamp two cheek pieces of scrap timber either side of the mated hinge to hold the pieces **(A)** and **(B)** in alignment.

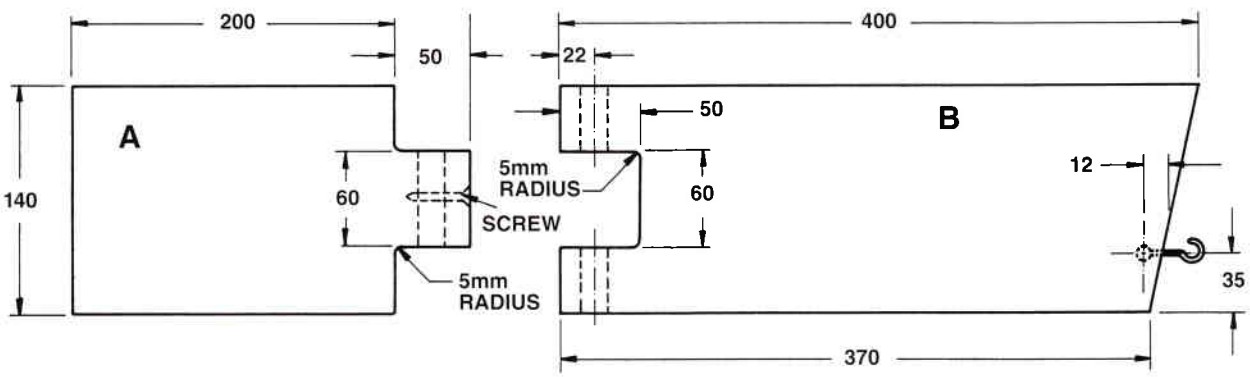


FIGURE 1: BODY COMPONENTS

Keeping the assembly quite vertical, drill at the marked positions through both pieces from each side so that the holes meet in the middle. **(Figure 3)**

Before unclamping the cheek pieces, check that a 140mm length of 19mm dowel can be tapped through the holes into position. The dowel is located when in use by a screw driven through the end grain of the male hinge piece, into the dowel (see **Figure 1**).

3 Take the hinge apart and round over all the long edges of the body. You may also have to round the front of the hinge tongue and slot to allow it to pivot freely.

If you intend to fit a towing hook or ring, then to prevent the threads pulling out of the end grain of the body, drill a 13mm diameter hole about 12mm from the rear edge and insert a short length of 1/2" (12.7mm) dowel into which the threads of the towhook will bite. **(Figure 1)**.

4 Rip the timber for the supports **(H)** and **(K)**, and bucket arm **(L)** to size. Cut the supports to length, and using the table saw mode make the angled cuts at their ends. The bucket arm support **(K)** is cut at 21 degrees on face **(A)** of the protractor, the crank support **(H)** at 34 degrees on face **(B)**. **(Figure 4)**.

Save the triangular pieces cut off the crank supports; they are used to support the seat.

Round the ends of the pieces, using your sanding disc, and round over the long edges with a router. Mark and drill the 29mm or 1 1/8" holes for the crank and bucket pivots, **(Figure 8)** clamping each pair of components together to ensure the holes are aligned.

The crank shaft dowel should be a loose fit, to enable it to turn easily, but the fit of the dowel in the bucket arm supports **(K)** should be tighter.

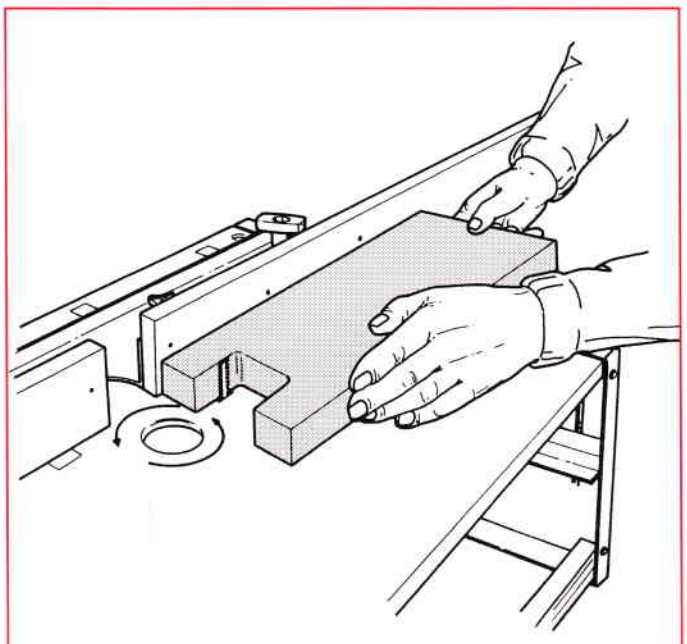


FIGURE 2

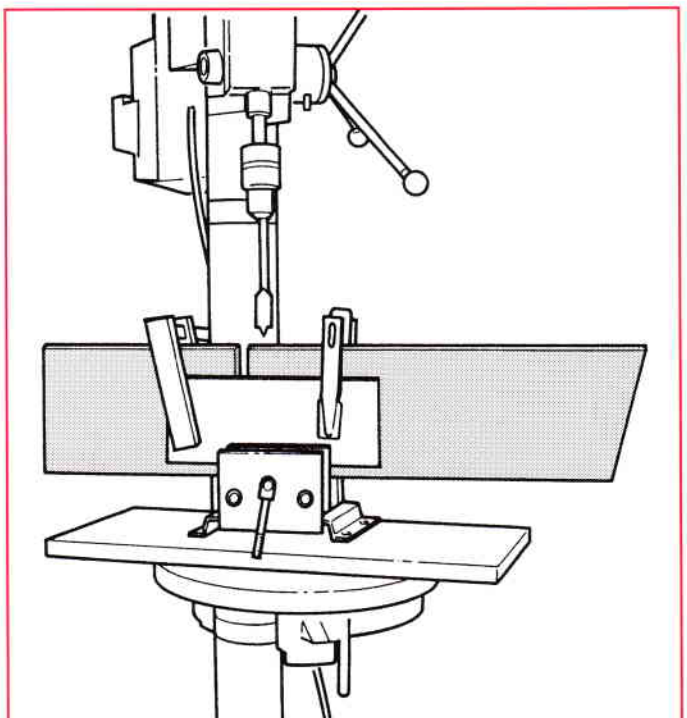


FIGURE 3

Construction Details

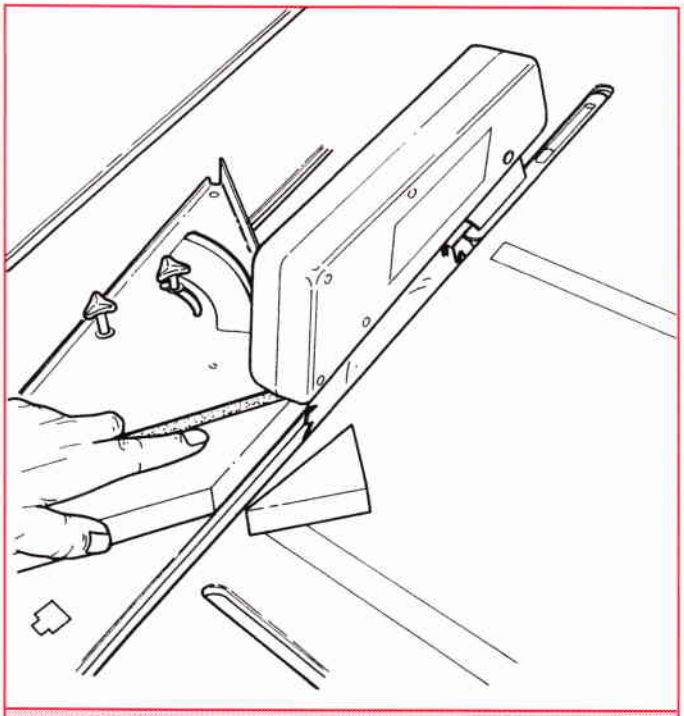


FIGURE 4

An expansive bit is the easiest way to achieve this. Set the adjustable bit for a sliding fit of the dowel into the bucket arm supports, and slightly enlarge the holes in the crank supports **(H)** using a round file or sandpaper wrapped around a smaller diameter dowel.

5 Round over the upper end and edges of the bucket arm **(L)**, but do not drill the 29mm arm pivot hole at this stage. Cut out the notch at the lower end in which the back of the bucket fits, using your jigsaw table and fence.

Mark and drill carefully the 19mm hole at the bottom end of **(L)** for the bucket pivot, and carefully round the end around the hole with the sanding disc. Drill and countersink the hole at the top for the rope. **(Figure 5)**

6 Now make the bucket. Cut the back and base to size, and carefully make a 48 degree bevel cut on the front edge of the bucket base **(O)**. Cut the sides **(P)** to shape and assemble the bucket with nails and waterproof glue. Cut the pivot blocks **(Q)** to size, clamp them together and drill a central hole for the pivot dowel through both blocks. Cut off their corners for better appearance, drill the pilot holes for the dowel fixing screws. **(Figure 5)**

7 Clamp the bucket centrally in the cutout of the bucket arm **(L)**, as shown in **Figure 6**, so that the centre of the 19mm pivot hole in the arm is 58mm from the top of the bucket. (This leaves a small gap between the top of the bucket and the end of the cutout notch, allowing the bucket to tilt freely). Push a short length of dowel through the pivot blocks and hole, and lightly clamp the clocks together pinching the arm. Drill for four block attachment screws and attach the blocks to the back of the bucket with screws and a strong glue.

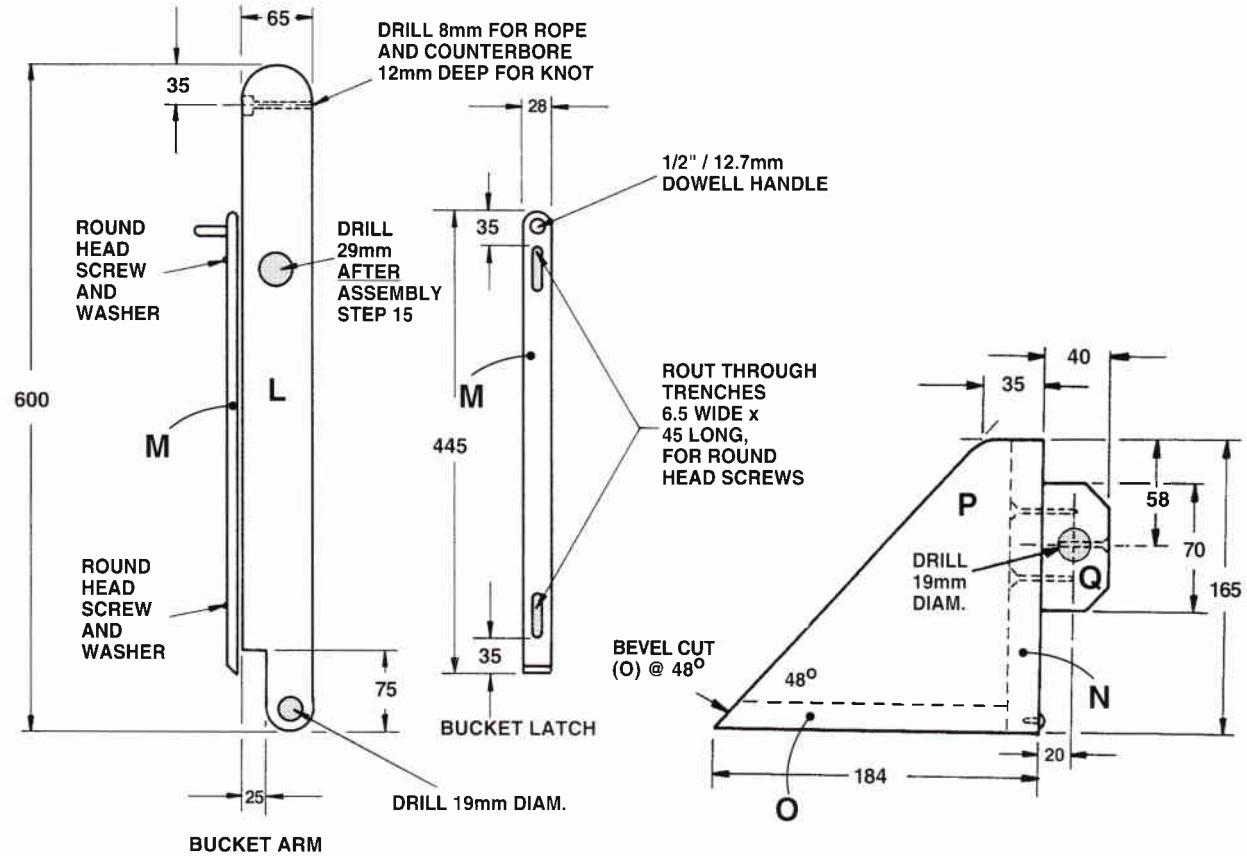


FIGURE 5

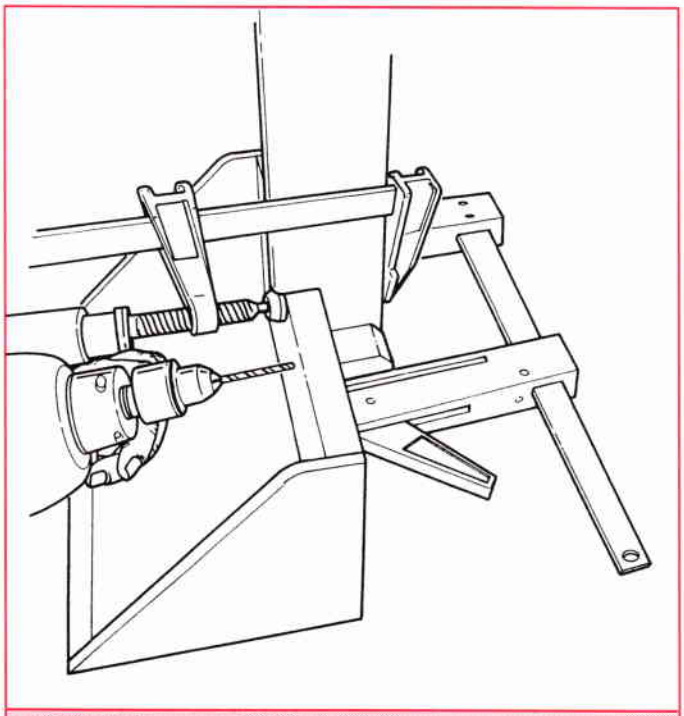


FIGURE 6

Cut the dowel pivot the length and drill and fix it in place with the fixing screws. Make sure the bucket pivots freely; you may need to take out the dowel and further round the lower end of the bucket arm to give greater clearance. Too small a clearance at this point will lead to sand grains jamming in the gap and interfering with the pivot action. Fit a bump rubber stop, if desired, to the lower back **(N)** of the bucket.

8 Make and fit the latch **(M)**. The top handle is simply a short length of dowel in a 13mm hole. The slots are best made with a 6.5mm straight cutter in your router table but can also be made with a drill and round file. Slope the bottom end of the latch at 45 degrees. Carefully fit the latch to the arm so that in operation the top edge of the bucket, when closing, will contact the angle cut and lift the latch – which drops back into place as the bucket pivots fully home.

Round-headed screws and flat washers are used in the slots. Do not try for too snug a fit – sand grains will jam the action unless the latch slides quite freely.

9 Cut the axles to length, and the axle braces **(E)** to shape, using face **(B)** of the protractor to cut the sloping sides.

Also cut the seat **(F)** to size (170 x 230mm), and round each corner. Round over all the edges of the seat, and the long edges of the axles.

Drill pilot holes for the coach screw threads about 75mm deep centrally into the end grain of each axle. Glue and screw the braces centrally in position on the axles **(Figure 7)**.

10 Glue and screw the bucket arm and crank supports to the front body **(A)**. Position the arm supports **(K)** as shown in **Figure 8**, and then butt the crank supports **(H)** up to their lower ends as shown. Use a piece of dowel through the pivot holes at their upper ends to ensure they remain in alignment while the screw holes are drilled.

Fit the seat using glue and two countersunk screws to the rear section of the body, flush with its end, and glue in extra supports each side, using the triangular offcuts from **(H)** set aside earlier.

Turn the body upside down and fit the axles, using glue and two long screws through each axle, and an additional shorter screw through the brace **(E)** into the body. The rear axle fits flush with the lower rear edge of the body, and the front axle 63mm back from the front of the body, directly beneath the bucket arm support **(K)**.

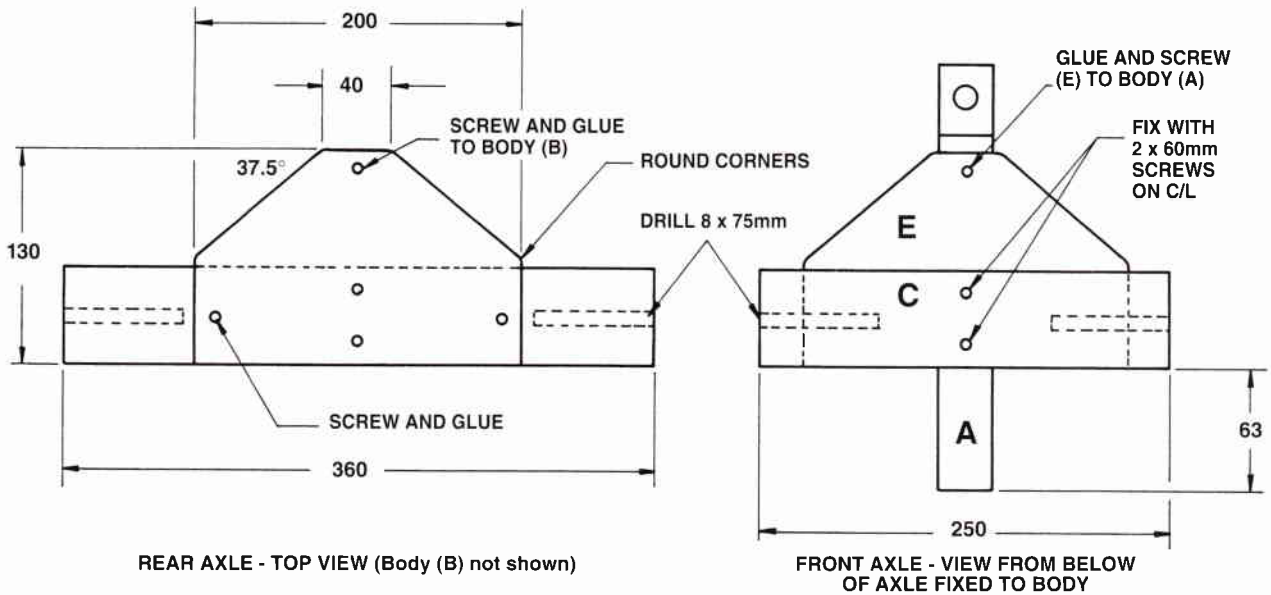
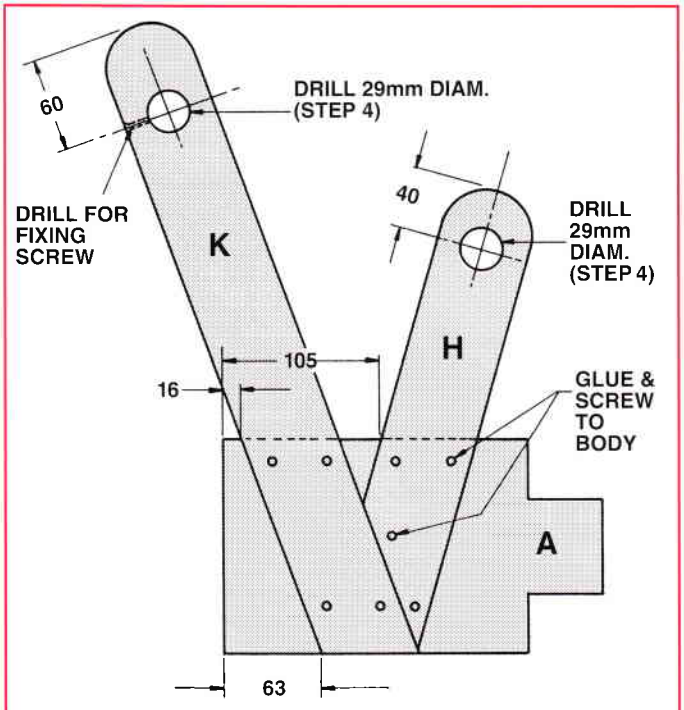


FIGURE 7: AXLES AND BRACES

Construction Details



FITTING BUCKET ARM & CRANK SUPPORTS

FIGURE 8

11 The next step is to make the four wheels. Either solid timber can be used, or the wheels can be laminated from five thicknesses of 9.5mm ply glued together.

Draw a 135mm diameter circle on each wheel blank with a compass. Counterbore each wheel centrally with a spade bit or expansive bit, the same diameter as the washers supplied with the coach screws, and deep enough to accept the head of the screw.

This is to ensure that the screw heads do not protrude beyond the wheels, for safety reasons. Using the centre hole provided by the spade bit point, drill through the wheel for the coach screw spindle. A drill press or stand is required for accuracy.

You may wish to bush the wheels for longer life, in which case hard copper tubing of 12.5mm O.D. and 9.5mm I.D can be used. Cut the wheels to a circular shape, as accurately as possible, with your jigsaw.

12 Make up a wheel sanding jig to sand the wheels perfectly circular, as shown in **Figure 9**. It is best to make the lower "plate" of the jig from 6mm plywood.

If you have a 9 1/4" inch sanding disc, you will then be able to sand the full thickness of the wheel. If you have a smaller disc, you will have to sand part of the wheel thickness into a circular shape, and then turn the wheel over to remove the step which remains.

Nail the parts of the jig together, place a block of scrap the same thichnesses the wheels in the gap between the two "plates", and drill the axle hole on a drill press or stand, right through from top to bottom. In use, a wheel is placed in the gap, and a short length of 3/8mm/10mm dowel inserted as an axle.

13 Clamp the jig to your Workcentre table, using a 3/8" 10mm coach bolt up through the rip fence rear fastening table slot.

Note that the jig is positioned so that the rotation of the sanding jig is **away** from your jig and the wheel to be sanded. See **Figure 10**.

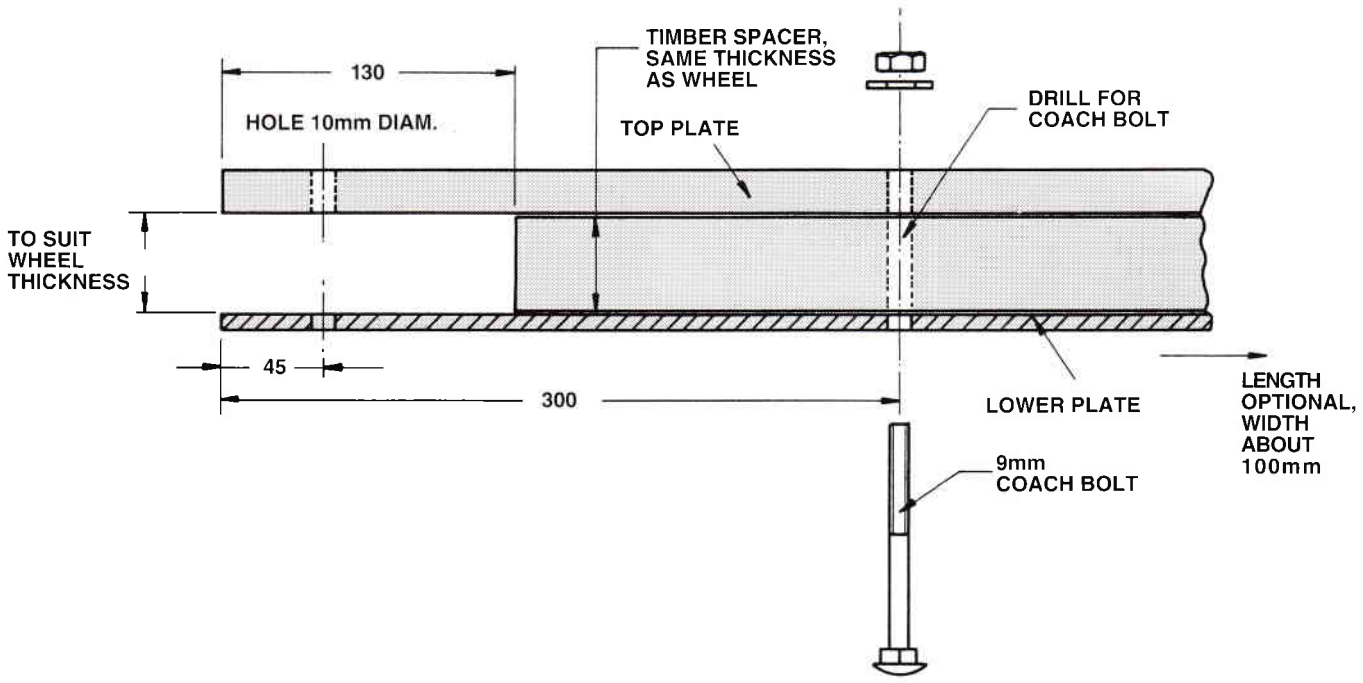


FIGURE 9: WHEEL SANDING JIG

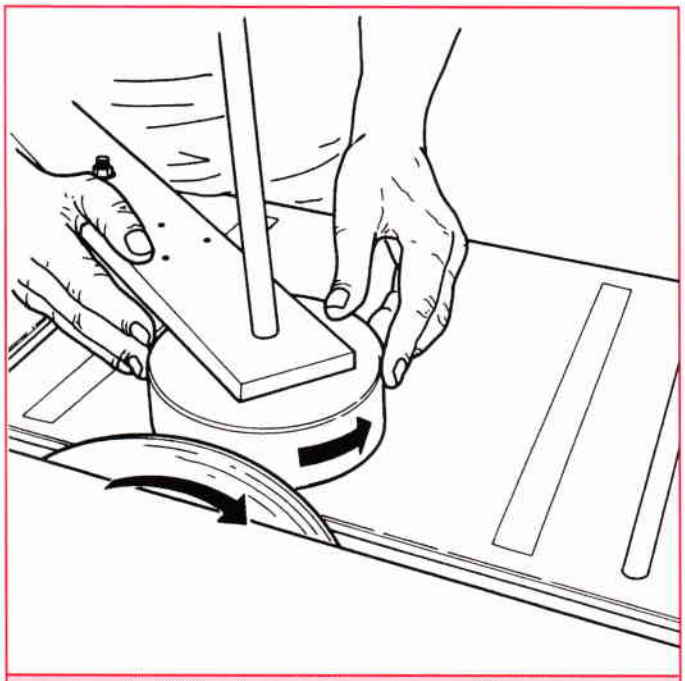


FIGURE 10

Do not tighten the clamping nut fully yet. Place a wheel in position, insert the axle and make sure it goes into the bottom hole. The wheel should turn freely on the axle. Slide the jig in the table slot until the wheel meets the sanding disc at a fairly steep angle, and in the middle (highest point) of the sanding disc, then lightly tighten the nut so that the jig is held firmly but is still free to pivot.

Switch on the sanding disc and pivot the jig while holding the wheel from turning with the fingers, until the wheel just contacts the sandpaper. Turn the wheel slowly by hand and smooth out the bumps in the perimeter. Repeat as necessary until the wheel appears to be round in shape.

The wheel can now be released and allowed to spin freely, dragging slightly on the sanding disc. It will spin very fast! To sand off more material, pivot the jig very slightly, and when satisfied leave the jig in position until the wheel stops spinning, thus indicating that the rim has been sanded to a perfect circle, concentric with the axle. Remove the wheel and repeat with the other three blanks.

14 Coat the unthreaded portion of the coach screws with candle wax or silicone lubricant and fit the wheels to the axles, using a washer under the screw head and another between the wheel and the end of the axle. Tighten the coach screws fully and then back off until the wheel is just free to turn without wobble.

15 The bucket arm assembly is now fitted in position. Stand the loader on its wheels on a flat surface, and place the bucket arm in position, with the closed bucket resting on material about 3mm thick so that it will just clear the floor when in use.

With the arm hard up against the vertical front of the body, the pivot holes already drilled in the arm supports **(K)** should fall on the centreline of the arm **(L)**. Clamp the arm in position and mark the pivot axle hole centre with the point of the expansive bit inserted through the hole in the support arm. **Figure 11** shows the procedure.

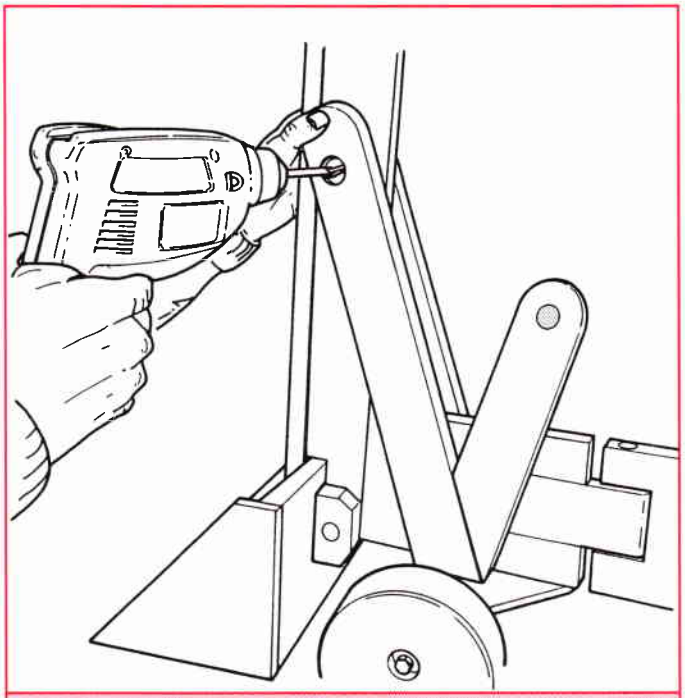


FIGURE 11

Remove the bucket assembly and drill the hole in the bucket arm **(L)** for the dowel axle. The bucket arm should pivot freely on the axle, and when satisfied cut the dowel to length and fit the bucket assembly, pinning the axle in place with two screws through the front of the support arms **(K)**. 30mm I.D. steel washers are placed wither side of the bucket arm to centralise it in the gap between the support arms.

16 The cranks **(I)** need to be made from hardwood for strength, and the holes drilled in them must be a tight fit on the dowels. Do not attempt to cut the cranks on the table saw without a taper ripping jig – use hand tools or your jigsaw instead.

Make the crank bodies as shown in **Figure 12**. To use the taper ripping jig, one side of the tapered body is first cut on each piece to the marked line, and then the piece is turned over and the jig adjusted to twice the angle, to cut the other side of the taper. **Figure 13** shows the procedure. Note that the taper ripping jig is pulled, rather than pushed, past the blade.

Drill the holes for the dowel crankshaft and the 19mm handles **(J)**, and pilot holes for the locking screws through the edge of the material.

Note that the lock screw holes are slightly offset from the centreline of the crank, to lessen any tendency for the wood to split along the grain.

Construction Details

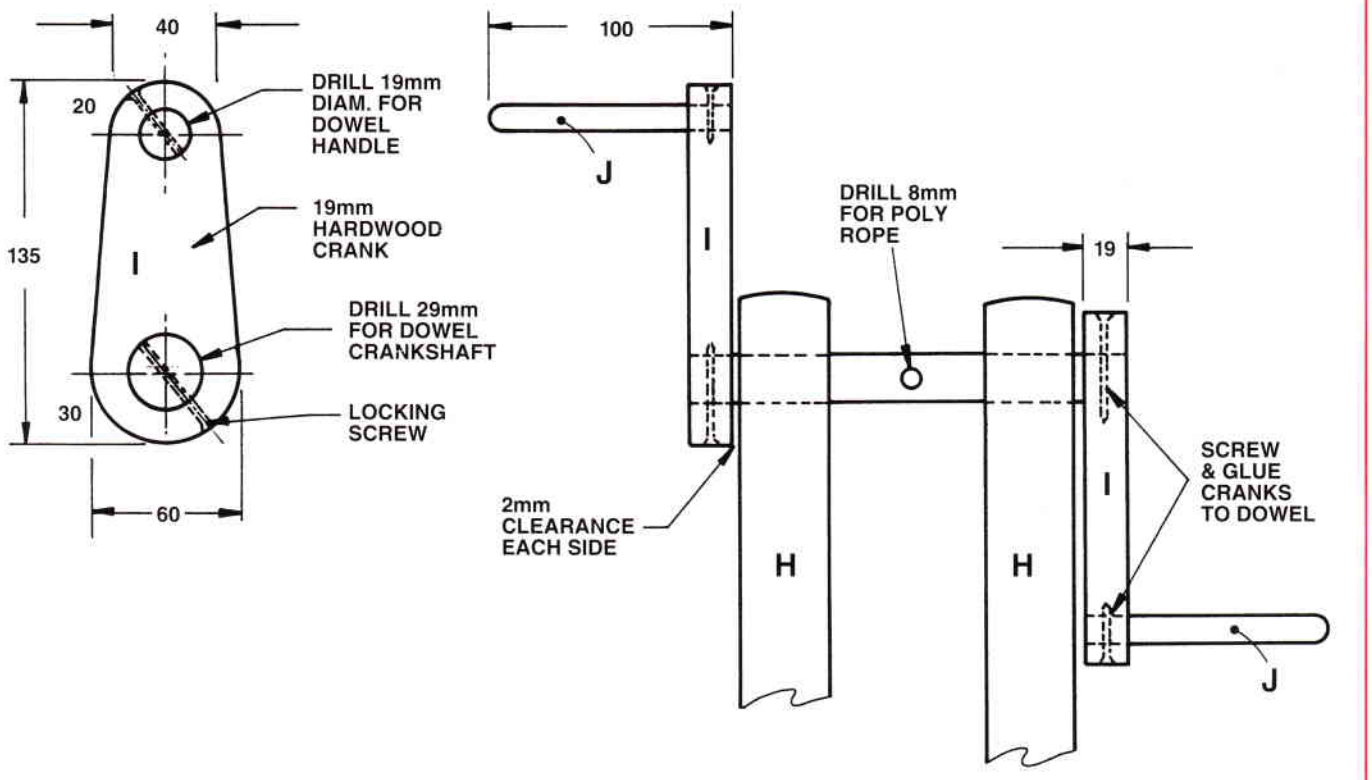


FIGURE 12: CRANK ASSEMBLY

Round over all edges with the router, using the Router table fence and guard even if your bit has a pilot bearing, for extra safety.

17 Fit a handle **(J)** to each crank, using glue and a locking screw in each. Cut a piece of dowel to length for the crankshaft, allowing for at least 2mm clearance on either side of the support arms **(H)**, and glue and screw one crank arm **(I)** to one end of the dowel.

Insert the assembly through the support arms and add the other crank arm at 180 degrees, glued and screwed in position as before. Drill an 8mm hole through the centre of the crankshaft and insert the polythene rope, retaining it with a knot. The upper end of the rope goes through the hole already drilled in the top of the bucket arm, and is also retained by a knot, which will sit in the counterbored recess.

The machine should now be fully operational. Turning the crank in either direction will raise the bucket arm assembly, while pulling on the latch will dump the bucket contents. The bucket automatically relatches in the closed position when lowered to the ground.

18 With all systems working correctly, the machine can be finished as desired. You may find it more convenient to remove the wheels and bucket arm assembly prior to finishing.

A spray can of polyurethane varnish or paint is the easiest way to coat the area around the cranks, which cannot be dismantled.

Wax is the best lubricant to use for the moving parts, as liquids or sprays tend to form a paste with sand grains, which eventually jams the movement.

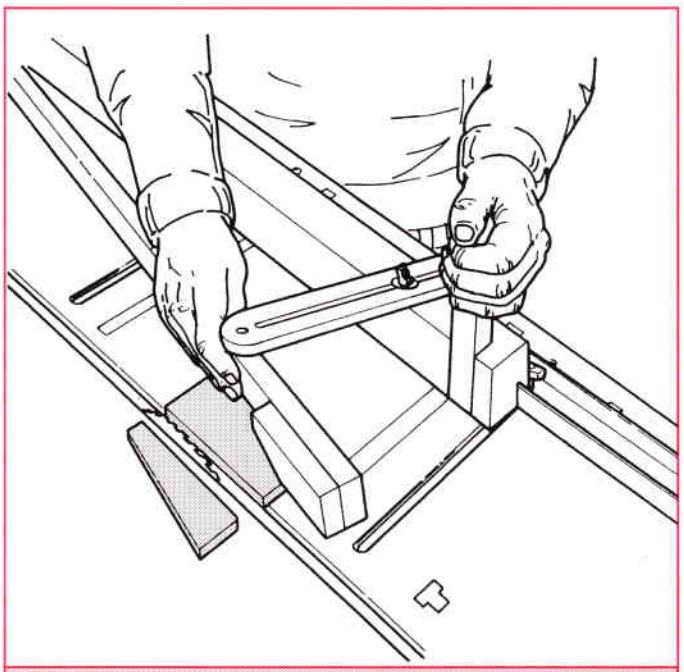


FIGURE 13